PRESIDÊNCIA DO CONSELHO DE MINISTROS

Despacho Normativo n.º 73/95

Nos termos e para os efeitos do artigo 72.º do Estatuto Orgânico de Macau, na versão da Lei n.º 13/90, de 10 de Maio, determino a publicação no *Boletim Oficial de Macau* dos seguintes diplomas:

a) Decretos-Leis n.ºs 40 200, 40 201, 44 920 e 221/71, os dois primeiros de 24 de Junho de 1955, o terceiro de 18 de Março de 1963 e o último de 26 de Maio, todos eles aprovando protocolos relativos a emendas à Convenção sobre a Aviação Civil Internacional, assinada em Chicago em 7 de Dezembro de 1944 e aprovada pelo Decreto-Lei n.º 36 158, de 17 de Fevereiro de 1947;

b) Anexos n.ºs 1 a 18 à Convenção referenciada na alínea anterior.

Presidência do Conselho de Ministros, 17 de Novembro de 1995. — O Primeiro-Ministro, *António Manuel de Oliveira Guterres.*

(D.R. n.º 273, I Série-B, de 25-11-1995)

部長會議事務部

規範性批示　第73／95號

根據經五月十日第13/90號法律修改之《澳門組織章程》第七十二條之規定及爲着該規定之效力，本人命令將下列法規公布於《澳門政府公報》：

a）一九五五年六月二十四日第40200號與第40201號法令、一九六三年三月十八日第44920號法令及五月二十六日第221/71號法令，以上各法令均通過關於修改《國際民用航空公約》之議定書，而該公約於一九四四年十二月七日在芝加哥簽訂，並由一九四七年二月十七日第36158號法令通過；

b）上項所指公約之第一號至第十八號附件。

一九九五年十一月十七日於部長會議事務部

總理

古德禮

MINISTÉRIO DOS NEGÓCIOS ESTRANGEIROS

Direcção-Geral dos Negócios Económicos e Consulares

Decreto-Lei n.º 40 200

Usando da faculdade conferida pela 2.ª parte do n.º 2.º do artigo 109.º da Constituição, o Governo decreta e eu promulgo, para valer como lei, o seguinte:

Artigo único. É aprovado, para ratificação, o Protocolo relativo a uma emenda à Convenção sobre Aviação Civil Internacional, elaborado em Montreal em 14 de Junho de 1954 e cujos textos, em inglês e na respectiva tradução em português, são os seguintes:

Protocol relating to an amendment to the Convention on International Civil Aviation

The Assembly of the International Civil Aviation Organization,

Having met in its eighth session, at Montreal, on the first day of June, 1954, and

Having considered it desirable to amend the Convention on International Civil Aviation done at Chicago on the seventh day of December, 1944,

Approved, on the fourteenth day of June of the year one thousand nine hundred and fifty-four, in accordance with the provisions of article 94 (*a*) of the Convention aforesaid, the following proposed amendment to the said Convention:

> At the end of article 45 of the Convention, the full stop shall be substituted by a comma, and the following shall be added, namely:
>
> «and otherwise than temporarily by decision of the Assembly, such decision to be taken by the number of votes specified by the Assembly. The number of votes so specified will not be less than three-fifths of the total number of contracting States.»,

Specified, pursuant to the provisions of the said article 94 (*a*) of the said Convention, forty-two as the number of contracting States upon whose ratification the proposed amendment aforesaid shall come into force, and

Resolved that the secretary general of the International Civil Aviation Organization draw up a Protocol, in the English, French and Spanish languages, each of which shall be of equal authenticity, embodying the proposed amendment above mentioned and the matters hereinafter appearing.

Consequently, pursuant to the aforesaid action of the Assembly,

This Protocol shall be signed by the president of the Assembly and its secretary general;

This Protocol shall be open to ratification by any State which has ratified or adhered to the said Convention on International Civil Aviation;

The instruments of ratification shall be deposited with the Internacional Civil Aviation Organization;

This Protocol shall come into force among the States which have ratified it on the date on which the forty-second instrument of ratification is so deposited;

The secretary general shall immediately notify all contracting States of the deposit of each ratification of this Protocol;

The secretary general shall immediately notify all States parties or signatories to the said Convention of the date on which this Protocol comes into force;

With respect to any contracting State ratifying this Protocol after the date aforesaid, the Protocol shall come into force upon deposit of its instrument of ratification with the International Civil Aviation Organization.

In faith whereof, the president and the secretary general of the eighth session of the Assembly of the International Civil Aviation Organization, being authorized thereto by the Assembly, sign this Protocol.

Done at Montreal on the fourteenth day of June of the year one thousand nine hundred and fifty-four in a single document in the English, French and Spanish languages, each of which shall be of equal authenticity. This Protocol shall remain deposited in the archives of the International Civil Aviation Organization; and certified copies thereof shall be transmitted by the secretary general of the Organization to all States parties or signatories to the Convention on International Civil Aviation done at Chicago on the seventh day of December, 1944.

Walter Binaghi.

President of the Assembly.

Carl Ljungberg.

Secretary general of the Assembly.

Protocolo relativo a uma emenda à Convenção sobre Aviação Civil Internacional

A Assembleia da Organização da Aviação Civil Internacional,

Tendo efectuado em Montreal, no dia 1 de Junho de 1954, a sua oitava reunião, e

Tendo considerado desejável introduzir uma emenda na Convenção sobre Aviação Civil Internacional, feita em Chicago, a 7 de Dezembro de 1944,

Aprovou, aos catorze dias do mês de Junho do ano de mil novecentos e cinquenta e quatro, de acordo com as disposições do artigo 94.º, alínea *a*), da Convenção acima mencionada, o projecto de emenda à dita Convenção, cujo texto é o seguinte:

> No fim do artigo 45.º, substituir o ponto final por uma vírgula e acrescentar as seguintes palavras:
>
> «e, não temporàriamente, por decisão da Assembleia, devendo esta decisão obter o número de votos fixado pela Assembleia. O número de votos assim fixado não será inferior a três quintos do número total de Estados contratantes.»,

Determinou, conforme o disposto no referido artigo 94.º, alínea *a*), da citada Convenção, que o projecto de emenda acima mencionado só entrará em vigor depois de ter sido ratificado por quarenta e dois Estados contratantes, e

Decidiu que o secretário-geral da Organização da Aviação Civil Internacional deverá redigir, nas línguas francesa, inglesa e espanhola, cada uma das quais fará igualmente fé, um Protocolo relativo ao dito projecto de emenda e que compreenda as disposições que adiante se indicam.

Por conseguinte, conforme a decisão anteriormente mencionada da Assembleia,

O presente Protocolo será assinado pelo presidente e pelo secretário-geral da Assembleia;

O presente Protocolo ficará aberto para ratificação de qualquer Estado que tenha ratificado a Convenção sobre Aviação Civil Internacional ou tenha aderido à mesma;

Os instrumentos de ratificação serão depositados na Organização da Aviação Civil Internacional;

O presente Protocolo entrará em vigor no dia do depósito do quadragésimo segundo instrumento de ratificação, entre os Estados que o tenham ratificado até essa data;

O secretário-geral notificará imediatamente todos os Estados contratantes do depósito de cada instrumento de ratificação deste Protocolo;

O secretário-geral notificará imediatamente todos os Estados partes ou signatários da Convenção da data da entrada em vigor do presente Protocolo;

O Protocolo entrará em vigor, para qualquer Estado contratante que o ratifique ulteriormente, no dia em que o respectivo instrumento de ratificação for depositado na Organização da Aviação Civil Internacional.

Em fé do que, o presidente e o secretário-geral da oitava reunião da Assembleia da Organização da Aviação Civil Internacional, autorizados para este efeito pela Assembleia, assinam o presente Protocolo.

Feito em Montreal, aos catorze dias do mês de Junho de mil novecentos e cinquenta e quatro, em um só exemplar, nas línguas francesa, inglesa e espanhola, cada uma das quais fará igualmente fé. O presente Protocolo será depositado no arquivo da Organização da Aviação Civil Internacional e o secretário-geral da Organização transmitirá cópias autenticadas a todos os Estados partes ou signatários da Convenção sobre Aviação Civil Internacional feita em Chicago a 7 de Dezembro de 1944.

Walter Binaghi.

Presidente da Assembleia.

Carl Ljungberg.

Secretário-geral da Assembleia.

Publique-se e cumpra-se como nele se contém.

Paços do Governo da República, 24 de Junho de 1955. — Francisco Higino Craveiro Lopes — *António de Oliveira Salazar — João Pinto da Costa Leite — Fernando dos Santos Costa — Joaquim Trigo de Negreiros — Artur Águedo de Oliveira — Américo Deus Rodrigues Thomaz — Paulo Arsénio Viríssimo Cunha — Eduardo de Arantes e Oliveira — Manuel Maria Sarmento Rodrigues — Fernando Andrade Pires de Lima — Ulisses Cruz de Aguiar Cortês — Manuel Gomes de Araújo — José Soares da Fonseca.*

(D. R. n.º 138, I Série, de 24-6-1955)

Decreto-Lei n.º 40 201

Usando da faculdade conferida pela 2.ª parte do n.º 2.º do artigo 109.º da Constituição, o Governo decreta e eu promulgo, para valer como lei, o seguinte:

Artigo único. É aprovado, para ratificação, o Protocolo relativo a algumas emendas à Convenção sobre Aviação Civil Internacional, elaborado em Montreal em 14 de Junho de 1954 e cujos textos, em inglês e na respectiva tradução em português, são os seguintes:

Protocol relating to certain amendments to the Convention on International Civil Aviation

The Assembly of the International Civil Aviation Organization,

Having met in its eighth session, at Montreal, on the first day of June, 1954, and

Having considered it desirable to amend the Convention on International Civil Aviation done at Chicago on the seventh day of December, 1944,

Approved, on the fourteenth day of June of the year one thousand nine hundred and fifty-four, in accordance with the provisions of article 94 (*a*) of the Convention aforesaid, the following proposed amendments to the said Convention:

> In article 48 (*a*), substitute for the word «annually» the expression «not less than once in three years»;

In article 49 (*e*), substitute for the expression «an annual budget» the expression «annual budgets»; and

In article 61, substitute for the expressions «an annual budget» and «vote the budget» the expressions «annual budgets» and «vote the budgets»,

Specified, pursuant to the provisions of the said article 94 (*a*) of the said Convention, forty-two as the number of contracting States upon whose ratification the proposed amendments aforesaid shall come into force, and

Resolved that the secretary general of the International Civil Aviation Organization draw up a Protocol, in the English, French and Spanish languages, each of which shall be of equal authenticity, embodying the proposed amendments above mentioned and the matters hereinafter appearing.

Consequently, pursuant to the aforesaid action of the Assembly,

This Protocol shall be signed by the president of the Assembly and its secretary general;

This Protocol shall be open to ratification by any State which has ratified or adhered to the said Convention on International Civil Aviation;

The instruments of ratification shall be deposited with the International Civil Aviation Organization;

This Protocol shall come into force among the States which have ratified it on the date on which the forty-second instrument of ratification is so deposited;

The secretary general shall immediately notify all contracting States of the deposit of each ratification of this Protocol;

The secretary general shall immediately notify all States parties or signatories to the said Convention of the date on which this Protocol comes into force;

With respect to any contracting State ratifying this Protocol after the date aforesaid, the Protocol shall come into force upon deposit of its instrument of ratification with the International Civil Aviation Organization.

In faith whereof, the president and the secretary general of the eighth session of the Assembly of the International Civil Aviation Organization, being authorized thereto by the Assembly, sign this Protocol.

Done at Montreal on the fourteenth day of June of the year one thousand nine hundred and fifty-four in a single document in the English, French and Spanish languages, each of which shall be of equal authenticity. This Protocol shall remain deposited in the archives of the International Civil Aviation Organization; and certified copies thereof shall be transmitted by the secretary general of the Organization to all States parties or signatories to the Convention on International Civil Aviation done at Chicago on the seventh day of December, 1944.

Walter Binaghi.

President of the Assembly.

Carl Ljungberg.

Secretary general of the Assembly.

Protocolo relativo a algumas emendas à Convenção sobre Aviação Civil Internacional

A Assembleia da Organização da Aviação Civil Internacional,

Tendo efectuado em Montreal, no dia 1 de Junho de 1954, a sua oitava reunião, e

Tendo considerado desejável introduzir emendas na Convenção sobre Aviação Civil Internacional, feita em Chicago, a 7 de Dezembro de 1944,

Aprovou, aos catorze dias do mês de Junho do ano de mil novecentos e cinquenta e quatro, de acordo com as disposições do artigo 94.º, alínea *a*), da Convenção acima mencionada, os projectos de emendas à dita Convenção, cujos textos são os seguintes:

No artigo 48.º, alínea *a*), substituir a palavra «anualmente» pela expressão «pelo menos uma vez em cada três anos»;

No artigo 49.º, alínea *e*), substituir a expressão «um orçamento anual» pelas palavras «orçamentos anuais»; e

No artigo 61.º, substituir a expressão «submeterá anualmente à Assembleia um orçamento, um extracto de contas e uma estimativa de receitas e despesas» por «submeterá à Assembleia orçamentos anuais, assim como extractos de contas e estimativas de receitas e despesas anuais» e substituir a expressão «votará o orçamento» pelas palavras «votará os orçamentos»,

Determinou, conforme o disposto no referido artigo 94.º, alínea *a*), da citada Convenção, que os projectos de emendas acima mencionados só entrarão em vigor depois de terem sido ratificados por quarenta e dois Estados contratantes, e

Decidiu que o secretário-geral da Organização da Aviação Civil Internacional deverá redigir, nas línguas francesa, inglesa e espanhola, cada uma das quais fará igualmente fé, um Protocolo relativo aos ditos projectos de emendas e que compreenda as disposições que adiante se indicam.

Por conseguinte, conforme a decisão anteriormente mencionada da Assembleia,

O presente Protocolo será assinado pelo presidente e pelo secretário-geral da Assembleia;

O presente Protocolo ficará aberto para ratificação de qualquer Estado que tenha ratificado a Convenção sobre Aviação Civil Internacional ou tenha aderido à mesma;

Os instrumentos de ratificação serão depositados na Organização da Aviação Civil Internacional;

O presente Protocolo entrará em vigor no dia do depósito do quadragésimo segundo instrumento de ratificação, entre os Estados que o tenham ratificado até essa data;

O secretário-geral notificará imediatamente todos os Estados contratantes do depósito de cada instrumento de ratificação deste Protocolo;

O secretário-geral notificará imediatamente todos os Estados partes ou signatários da Convenção da data da entrada em vigor do presente Protocolo;

O Protocolo entrará em vigor, para qualquer Estado contratante que o ratifique ulteriormente, no dia em que o respectivo instrumento de ratificação for depositado na Organização da Aviação Civil Internacional.

Em fé do que, o presidente e o secretário-geral da oitava reunião da Assembleia da Organização da Aviação Civil Internacional, autorizados para este efeito pela Assembleia, assinam o presente Protocolo.

Feito em Montreal, aos catorze dias do mês de Junho de mil novecentos e cinquenta e quatro, em um só exemplar, nas línguas francesa, inglesa e espanhola, cada uma das quais fará igualmente fé. O presente Protocolo será depositado no arquivo da Organização da Aviação Civil Internacional e o secretário-geral da Organização transmitirá cópias autenticadas a todos os Estados partes ou signatários da Convenção sobre Aviação Civil Internacional feita em Chicago a 7 de Dezembro de 1944.

Walter Binaghi.

Presidente da Assembleia.

Carl Ljungberg.

Secretário-geral da Assembleia.

Publique-se e cumpra-se como nele se contém.

Paços do Governo da República, 24 de Junho de 1955. — FRANCISCO HIGINO CRAVEIRO LOPES — *António de Oliveira Salazar — João Pinto da Costa Leite — Fernando dos Santos Costa — Joaquim Trigo de Negreiros — Artur Águedo de Oliveira — Américo Deus Rodrigues Thomaz — Paulo Arsénio Viríssimo Cunha — Eduardo de Arantes e Oliveira — Manuel Maria Sarmento Rodrigues — Fernando Andrade Pires de Lima — Ulisses Cruz de Aguiar Cortês — Manuel Gomes de Araújo — José Soares da Fonseca.*

(D.R. n.º 138, I Série, de 24-6-1955)

Decreto-Lei n.º 44 920

Usando da faculdade conferida pela 2.ª parte do n.º 2.º do artigo 109.º da Constituição, o Governo decreta e eu promulgo, para valer como lei, o seguinte:

Artigo único. É aprovado, para ratificação, o Protocolo relativo a uma emenda à Convenção da aviação civil internacional [artigo 48 (*a*)], assinado em Roma em 15 de Setembro de 1962, cujos textos, em francês e respectiva tradução para português, vão anexos ao presente decreto-lei.

Publique-se e cumpra-se como nele se contém.

Paços do Governo da República, 18 de Março de 1963. — AMÉRICO DEUS RODRIGUES THOMAZ — *António de Oliveira Salazar — José Gonçalo da Cunha Sottomayor Correia de Oliveira — Manuel Gomes de Araújo — Alfredo Rodrigues dos Santos Júnior — João de Matos Antunes Varela — António Manuel Pinto Barbosa — Joaquim da Luz Cunha — Fernando Quintanilha Mendonça Dias — Alberto Marciano Gorjão Franco Nogueira — Eduardo de Arantes e Oliveira — António Augusto Peixoto Correia — Inocêncio Galvão Teles — Luís Maria Teixeira Pinto — Carlos Gomes da Silva Ribeiro — José João Gonçalves de Proença — Pedro Mário Soares Martinez.*

Para ser presente à Assembleia Nacional.

Protocole concernant un amendement à la Convention relative à l'aviation civile internationale, signé à Rome le 15 septembre 1962.

L'Assemblée de l'Organisation de l'Aviation Civile Internationale,

S'étant réunie à Rome, le 21 août 1962, en sa quatorsième session,

Ayant pris acte du désir général des États contractants d'augmenter le nombre minimum d'États contractants requis pour que la convocation d'une assemblée extraordinaire puisse être demandée et qui est actuellement de dix,

Ayant estimé qu'il convenait de porter ce nombre au cinquième du nombre total des États contractants,

Et ayant estimé nécessaire d'amender à cette fin la Convention relative à l'aviation civile internationale faite à Chicago le 7 décembre 1944,

A adopté, le 15 septembre 1962, conformément aux dispositions de l'alinéa *a*) de l'article 94 de la Convention précitée, le projet d'amendement à ladite Convention dont le texte suit:

> Remplacer la seconde phrase de l'alinéa *a*) de l'article 48 de la Convention par le texte suivant: «Elle peut tenir une session extraordinaire à tout moment sur convocation du Conseil ou sur requête adressée au secrétaire général par un nombre d'États contractants égal au cinquième au moins du nombre total de ces États».

A fixé à 66 le nombre d'États contractants dont la ratification est nécessaire à l'entrée en vigueur dudit amendement, conformément aux dispositions de alinéa *a*) de l'article 94 de ladite Convention et

A décidé que le secrétaire général de l'Organisation de l'Aviation Civile Internationale devra établir en langues française, anglaise et espagnole, chacune faisant égalemente foi, un protocole concernant l'amendement précité et comprenant les dispositions ci-dessous.

En conséquence, conformément à la décision susmentionnée de l'assemblée,

Le présent Protocole a été établi par le secrétaire général de l'Organisation;

Il sera soumis à la ratification de tout État qui a ratifié la Convention relative à l'aviation civile internationale ou y a adhéré;

Les instruments de ratification seront déposés auprès de l'Organisation de l'Aviation Civile Internationale;

Le présent Protocole entrera en vigueur le jour du dépôt du 66ème instrument de ratification à l'égard des États qui l'auront ratifié;

Le secrétaire générale notifiera immédiatement à tous les États contractants la date du dépôt de chaque instrument de ratification dudit Protocole;

Le secrétaire général notifiera immédiatement à tous les États parties à ladite Convention ou qui l'ont signée la date à laquelle ledit Protocole entrera en vigueur;

Le présent Protocole entrera en vigueur, à l'égard de tout État contractant qui l'aura ratifié après la date précitée, dès que cet État aura déposé son instrument de ratification auprès de l'Organisation de l'Aviation Civile Internationale.

En foi de quoi, le président et le secrétaire général de la quatorzième session de l'Assemblée de l'Organisation de l'Aviation Civile Internationale, autorisés à cet effet par l'assemblée, signent le présent Protocole.

Fait à Rome, le 15 september 1962, en un seul exemplaire rédigé en langues française, anglaise et espagnole, chacune faisant également foi. Le présent Protocole restera déposé dans les archives de l'Organisation de l'Aviation Civile Internationale; le secrétaire général de l'Organisation en transmettra des copies conformes à tous les États qui sont parties à la Convention relative à l'aviation civile internationale, mentionnée ci-dessus, ou qui l'ont signée.

Protocolo relativo a uma emenda à Convenção da aviação civil internacional [artigo 48 (a)], assinado em Roma, em 15 de Setembro de 1962.

A assembleia da Organização da Aviação Civil Internacional, Tendo-se reunido em Roma, em 21 de Agosto de 1962, na sua décima quarta sessão,

Tendo em conta o desejo geral dos Estados Contratantes no sentido de ser aumentado o número mínimo requerido de Estados Contratantes para que possa ser pedida a convocação de uma assembleia extraordinária, e que é actualmente de dez,

Considerando que seria conveniente elevar este número até um quinto do número total dos Estados Contratantes,

E considerando necessário, para tal fim, emendar a Convenção relativa à aviação civil internacional assinada em Chicago em 7 de Dezembro de 1944,

Adoptou, em 15 de Setembro de 1962, em conformidade com as disposições da alínea *a*) do artigo 94 da citada Convenção, o projecto de emenda à mesma Convenção cujo texto segue:

> Substituir a segunda frase da alínea *a*) do artigo 48 da Convenção pelo texto seguinte: «A Assembleia poderá ter uma sessão extraordinária em qualquer momento por convocação do Conselho ou mediante pedido dirigido ao secretário-geral por um número de Estados Contratantes igual a um quinto pelo menos do número total dos mesmos Estados».

Fixou em 65 o número de Estados Contratantes cuja ratificação é necessária para a entrada em vigor da citada emenda, em conformidade com as disposições da alínea *a*) do artigo 94 da referida Convenção e

Decidiu que o secretário-geral da Organização da Aviação Civil Internacional deverá estabelecer nas línguas francesa, inglesa e espanhola, fazendo cada uma igualmente fé, um protocolo relativo à emenda anteriormente mencionada que compreende as disposições que a seguir se indicam:

Consequentemente, em conformidade com a mencionada decisão da Assembleia,

Foi estabelecido o presente Protocolo pelo secretário-geral da Organização;

O Protocolo será aberto à ratificação de todo o Estado que tenha ratificado ou aderido à Convenção relativa à aviação civil internacional;

Os instrumentos de ratificação serão depositados junto da Organização da Aviação Civil Internacional,

O presente Protocolo entrará em vigor no dia do depósito do 66.º instrumento de ratificação em relação aos Estados que o tenham ratificado;

O secretário-geral notificará imediatamente a todos os Estados Contratantes a data do depósito de cada instrumento de ratificação do mesmo Protocolo;

O secretário-geral notificará imediatamente todos os Estados partes na mencionada Convenção ou que a assinaram a data em que o mesmo Protocolo entrará em vigor;

O presente Protocolo entrará em vigor, em relação a todo o Estado Contratante que a tenha ratificado depois da data mencionada, a partir do momento em que o mesmo Estado tenha depositado o seu instrumento de ratificação junto da Organização da Aviação Civil Internacional.

Em fé do que, o presidente e o secretário-geral da décima quarta sessão da Assembleia da Organização da Aviação Civil Internacional, autorizados para este efeito pela assembleia, assinaram o presente Protocolo.

Concluído em Roma, a 15 de Setembro de 1962, num só exemplar redigido nas línguas francesa, inglesa e espanhola, fazendo cada uma igualmente fé. O presente Protocolo ficará depositado nos arquivos da Organização da Aviação Civil Internacional; o secretário-geral da Organização transmitirá cópias a todos os Estados partes da Convenção relativa à aviação civil internacional, acima mencionada, ou que a tenham assinado.

(D.R. n.º 65, I Série, de 18-3-1963)

Direcção-Geral dos Negócios Económicos

Decreto-Lei n.º 221/71 de 26 de Maio

Usando da faculdade conferida pela 2.ª parte do n.º 2.º do artigo 109.º da Constituição, o Governo decreta e eu promulgo, para valer como lei, o seguinte:

Artigo único. É aprovado, para ratificação, o Protocolo de Emenda à Convenção da Aviação Civil Internacional [artigo 50.º, *a*)], aprovada pelo Decreto-Lei n.º 36 158, de 17 de Fevereiro de 1947, assinado na sessão extraordinária da Assembleia da Organização Internacional da Aviação Civil, em 12 de Março de 1971, em Nova Iorque, cujo texto em francês e a respectiva tradução para português vão anexos ao presente decreto-lei.

Marcello Caetano — Horácio José de Sá Viana Rebelo — António Manuel Gonçalves Rapazote — Mário Júlio Brito de Almeida Costa — João Augusto Dias Rosas — Manuel Pereira Crespo — Rui Manuel de Medeiros d'Espiney Patrício — Rui Alves da Silva Sanches — Joaquim Moreira da Silva Cunha — José Veiga Simão — Baltasar Leite Rebelo de Sousa.

Promulgado em 7 de Maio de 1971.

Publique-se.

O Presidente da República, AMÉRICO DEUS RODRIGUES THOMAZ.

Protocole portant amendement à la Convention Relative à l'Aviation Civile Internationale [article 50, a)], signé à New-York le 12 mars 1971.

L'Assemblée de l'Organisation de l'Aviation Civile Internationale,

S'étant réunie à New-York, le 11 mars 1971, en session extraordinaire,

Ayant pris acte du désir général des États contractants d'augmenter le nombre des membres du Conseil,

Ayant jugé qu'il convient de pourvoir le Conseil de trois sièges en plus des six dont il a été pourvu par l'amendement à la Convention relative à l'Aviation civile internationale (Chicago, 1944) adopté le 21 juin 1961 et de porter, de ce fait, leur nombre total à trente,

Ayant jugé nécessaire d'amender à cette fin la Convention relative à l'Aviation civile internationale faite à Chicago le 7 décembre 1944,

A approuvé, le 12 mars 1971, conformément aux dispositions de l'alinéa *a*) de l'article 94 de la Convention précitée, le projet d'amendement à ladite Convention dont le texte suit:

> À l'alinéa *a*) de l'article 50 de la Convention, remplacer la deuxième phrase par: «Il se compose de trente États contractants élus par l'Assemblée.»

A fixé à quatre-vingts le nombre d'États contractants dont la ratification est nécessaire à l'entrée en vigueur dudit amendement, conformément aux dispositions de alinéa *a*) de l'article 94 de la dite Convention, et

A décidé que le secrétaire général de l'Organisation de l'Aviation civile internationale établirait, en langues française, anglaise et espagnole, chacune faisant également foi, un Protocole comportant l'amendement précité et les dispositions ci-dessous.

En conséquence, conformément à la décision susmentionnée de l'Assemblée,

Le présent Protocole a été établi par le secrétaire général de l'Organisation;

Le présent Protocole sera soumis à la ratification de tout État qui a ratifié la Convention relative à l'Aviation civile internationale ou y a adhéré;

Les instruments de ratification seront déposés auprès de l'Organisation de l'Aviation civile internationale;

Le présent Protocole entrera en vigueur, à l'égard des États qui l'auront ratifié, le jour du dépôt du quatre-vingtième instrument de ratification;

Le secrétaire général notifiera immédiatement à tous les États contractants la date du dépôt de chaque instrument de ratification du présent Protocole;

Le secrétaire général notifiera immédiatement à tous les États parties à ladite Convention la date à laquelle le présent Protocole entrera en vigueur;

Le présent Protocole entrera en vigueur, à l'égard de tout État contractant qui l'aura ratifié après la date précitée, dès que cet État aura déposé son instrument de ratification auprès de l'Organisation de l'Aviation civile internationale.

En foi de quoi, le président et le secrétaire général de la dite session extraordinaire de l'Assemblée de l'Organisation de l'Aviation civile internationale, autorisés à cet effet par l'Assemblée, signent le présent Protocole.

Fait à New-York, le 12 mars de l'an 1971, en un seul exemplaire rédigé en langues française, anglaise et espagnole, chacune faisant également foi. Le présent Protocole restera déposé dans les archives de l'Organisation de l'Aviation civile internationale et le secrétaire général de l'Organisation en transmettra des copies conformes à tous les États parties à la Convention relative à l'Aviation civile internationale, faite à Chicago le 7 décembre 1944.

Protocolo de emenda à Convenção da Aviação Civil Internacional [artigo 50.º, a)], concluído em Nova Iorque em 12 de Março de 1971.

A Assembleia da Organização da Aviação Civil Internacional,

Tendo-se reunido em Nova Iorque, em 11 de Março de 1971, em sessão extraordinária;

Tendo tomado nota do desejo geral dos Estados contratantes de aumentar o número de membros do Conselho;

Tendo considerado que convém atribuir ao Conselho mais três lugares além dos seis de que foi dotado pela emenda à Convenção da Aviação Civil Internacional (Chicago, 1944) adoptada em 21 de Junho de 1961, elevando assim o seu número total a trinta;

Tendo considerado necessário emendar, com esta finalidade, a Convenção da Aviação Civil Internacional, concluída em Chicago em 7 de Dezembro de 1944;

Aprovou, em 12 de Março de 1971, em conformidade com as disposições da alínea *a*) do artigo 94.º da Convenção supracitada, o projecto de emenda à dita Convenção, cujo texto segue:

> Na alínea *a*) do artigo 50.º da Convenção, substituir a segunda frase por: «Compõe-se de trinta Estados contratantes eleitos pela Assembleia.»

Fixou em oitenta o número de Estados contratantes cuja ratificação é necessária para a entrada em vigor da dita emenda, em conformidade com as disposições da alínea *a*) do artigo 94.º da dita Convenção; e

Decidiu que o secretário-geral da Organização da Aviação Civil Internacional redigirá, nas línguas francesa, inglesa e espanhola, cada uma fazendo igualmente fé, um Protocolo contendo a emenda supracitada e as disposições que seguem.

Em consequência, de conformidade com a mencionada decisão da Assembleia:

O presente Protocolo foi redigido pelo secretário-geral da Organização;

O presente Protocolo será submetido à ratificação de qualquer Estado que tenha ratificado a Convenção da Aviação Civil Internacional, ou a ele tenha aderido;

Os instrumentos de ratificação serão depositados junto da Organização da Aviação Civil Internacional;

O presente Protocolo entrará em vigor, em relação aos Estados que o tenham ratificado, no dia do depósito do octogésimo instrumento de ratificação;

O secretário-geral notificará imediatamente todos os Estados contratantes da data do depósito de cada instrumento de ratificação do presente Protocolo;

O secretário-geral notificará imediatamente todos os Estados partes na dita Convenção da data em que o presente Protocolo entrará em vigor;

O presente Protocolo entrará em vigor, em relação a qualquer Estado contratante que o tenha ratificado depois da data mencionada, a partir do momento em que tenha depositado o seu instrumento de ratificação junto da Organização da Aviação Civil Internacional.

Em fé do que, o presidente e o secretário-geral da dita sessão extraordinária da Assembleia da Organização da Aviação Civil Internacional, autorizados para este efeito pela Assembleia, assinaram o presente Protocolo.

Concluído em Nova Iorque, em 12 de Março do ano de 1971, num único exemplar, redigido nas línguas francesa, inglesa e espanhola, cada uma fazendo igualmente fé. O presente Protocolo ficará depositado nos arquivos da Organização da Aviação Civil Internacional e o secretário-geral da Organização dele transmitirá cópias conformes a todos os Estados partes na Convenção da Aviação Civil Internacional, concluída em Chicago, em 7 de Dezembro de 1944.

(D.R. n.º 123, I Série, de 26-5-1971)

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

PERSONNEL LICENSING

ANNEX 1

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

EIGHTH EDITION — JULY 1988

APPLICABLE — 16 NOVEMBER 1989

This edition incorporates all amendments adopted by the Council prior to 29 March 1988 and supersedes, on 16 November 1989, all previous editions of Annex 1.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced in the *ICAO Journal* and in the monthly supplements to the *Catalogue of ICAO Publications,* which holders of this publication should consult. These amendments are available free upon request.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-159	Incorporated in this edition		
160	10/11/94		ICAO

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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FOREWORD

Historical Background

Standards and Recommended Practices for Personnel Licensing were first adopted by the Council on 14 April 1948 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 1 to the Convention. They became effective on 15 September 1948.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Application of the PEL Standards

The present (Eighth) edition of Annex 1 contains Standards and Recommended Practices adopted by the International Civil Aviation Organization as the minimum standards for personnel licensing. It incorporates all amendments, including Amendment 160.

The Annex thus amended is applicable on 10 November 1994 to all applicants for and, on renewal, to all holders of the licences and ratings specified herein. However, if a licence or rating no longer foreseen in the Eighth Edition of Annex 1 (the senior commercial pilot licence, the flight radio operator licence, the controlled VFR rating and the flight instructor rating for gliders and free balloons), has been issued before 16 November 1989, the issuing State may maintain its validity until 15 November 1994, and such licences and ratings shall be recognized by other States.

The Council has decided that, in principle, amendments affecting existing licensing specifications are applicable to all applicants for, and holders of licences but, in considering their application to existing holders of licences, the assessment, if necessary, by re-examination of the knowledge, experience and proficiency of individual licence holders is left to the discretion of Contracting States.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any difference which may subsequently occur, or of the withdrawal of any difference previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

Use of the Annex text in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been written in such a way as to facilitate incorporation, without major textual changes, into national legislation.

General Information

The expression "licence" used throughout this Annex has the same meaning as the expressions "certificate of competency and license", "license or certificate" and "license" used in the Convention. Similarly the expression "flight crew member" has the same meaning as the expressions "member of the operating crew of an aircraft" and "operating personnel" used in the Convention while the expression "personnel other than flight crew members" includes the expression "mechanical personnel" used in the Convention.

Status of Annex Components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) Standards and Recommended Practices adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

It is to be noted that some Standards in this Annex incorporate, by reference, other specifications having the status of Recommended Practices. In such cases the text of the Recommended Practice becomes part of the Standard.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices (SARPs):*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of Language

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own language, and to notify the Organization accordingly.

Editorial Practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

It is to be noted that in the English text the following practice has been adhered to when writing the specifications: Standards employ the operative verb "shall" while Recommended Practices employ the operative verb "should".

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document which is identified by a number includes all subdivisions of that portion.

Table A. Amendments to Annex 1

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
1st Edition	Second Session of the PEL Division; January 1947.	Licensing of flight crew members and of key personnel responsible for air navigation services.	14 April 1948 15 September 1948 1 May 1949
1 to 123 (2nd Edition)	Third Session of the PEL Division; March 1948.	Modifications to existing Standards.	22 March 1950 1 September 1950 1 October 1951
124 to 129	Third Session of the PEL Division; March 1948.	Modifications to existing Standards.	27 June 1950 1 November 1950 1 October 1951
130 to 151 (3rd Edition)	Third and Fourth Sessions of the PEL Division; March 1948, February 1952.	Modifications to existing Standards.	25 November 1952 1 April 1953 1 April 1955
152	Special Meeting on Hearing and Visual Requirement for Personnel Licensing; 1955.	Hearing and Visual Requirement for Personnel Licensing.	22 February 1956 1 July 1956 1 December 1956
153	Air Navigation Commission.	New requirement for electrocardiograms.	16 April 1957 1 September 1957
154 (4th Edition)	Third Air Navigation Conference; 1956.	Amendment of SARPs.	13 June 1957 1 October 1957 1 December 1957
155 (5th Edition)	Recommendation from PEL/MED Meeting; May 1961.	Amendment of SARPs.	27 June 1962 1 November 1962 1 September 1963
156 (6th Edition)	Recommendations from PEL/TRG/ MED Divisional Meeting; October-November 1970.	Amendment of SARPs.	11 December 1972 11 April 1973 2 January 1975 } 26 January 1978 }
157	Council.	Use of Russian language in personnel licences.	28 June 1976 28 October 1976 21 April 1977
158 (7th Edition)	Correspondence and Secretariat, 21st Assembly and Council.	Modifications to existing Standards for medical examiners. New SARPs for assessment of medical fitness. Replacement of Physical and Mental Requirements by Classes of Medical Assessment.	4 May 1982 4 September 1982 25 November 1982
159 (8th Edition)	Second, Third and Fourth Meetings of the Personnel Licensing and Training (PELT) Panel; November 1983, April 1985, May 1986. Air Navigation Commission.	Amendment of SARPs dealing with the licensing of flight crew members. Deletion of the senior commercial pilot licence — aeroplane, the controlled VFR rating, the flight radio operator licence and the flight instructor rating for gliders and free balloons. The dividing line of 5 700 kg maximum take-off mass is replaced by a dividing line based on the crew complement required by certification. All helicopter provisions have the status of Standards. The requirements for the issue of a type rating for aircraft certificated for two-pilot operation are strengthened. The provisions for the issue of each licence and rating have been updated. Flight instruction requirements are established for the private, commercial, glider and free balloon pilot licences and for the instrument and flight instructor ratings.	28 March 1988 31 July 1988 16 November 1989
160	Air Navigation Commission.	Amendment of SARPs for air traffic controllers, aeronautical station operators and flight operations officers.	24 March 1993 26 July 1993 10 November 1994

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS AND GENERAL RULES CONCERNING LICENCES

1.1 Definitions

When the following terms are used in the Standards and Recommended Practices for Personnel Licensing, they have the following meanings:

Accredited medical conclusion. The conclusion reached by one or more medical experts acceptable to the Licensing Authority for the purposes of the case concerned, in consultation with flight operations or other experts as necessary.

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Aircraft avionics. A term designating any electronic device — including its electrical part — for use in an aircraft, including radio, automatic flight control and instrument systems.

Aircraft — category. Classification of aircraft according to specified basic characteristics, e.g. aeroplane, helicopter, glider, free balloon.

Aircraft certificated for single-pilot operation. A type of aircraft which the State of Registry has determined, during the certification process, can be operated safely with a minimum crew of one pilot.

Aircraft — type of. All aircraft of the same basic design including all modifications thereto except those modifications which result in a change in handling or flight characteristics.

Approved maintenance organization. An organization approved by a Contracting State to perform inspection, overhaul, maintenance, repair and/or modification of aircraft or parts thereof and operating under supervision approved by that State.

Note.— Nothing in this definition is intended to preclude that the organization and its supervision be approved by more than one State.

Approved training. Training carried out under special curricula and supervision approved by a Contracting State.

Balloon. A non-power-driven lighter-than-air aircraft.

Note.— For the purposes of this Annex, this definition applies to free balloons.

Certify as airworthy (to). To certify that an aircraft or parts thereof comply with current airworthiness requirements after being inspected, overhauled, repaired, modified or installed.

Co-pilot. A licensed pilot serving in any piloting capacity other than as pilot-in-command but excluding a pilot who is on board the aircraft for the sole purpose of receiving flight instruction.

Dual instruction time. Flight time during which a person is receiving flight instruction from a properly authorized pilot on board the aircraft.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aircraft during flight time.

Flight plan. Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Flight procedures trainer. *See* Synthetic flight trainer.

Flight simulator. *See* Synthetic flight trainer.

Flight time. The total time from the moment an aircraft first moves under its own power for the purpose of taking off until the moment it comes to rest at the end of the flight.

Note.— Flight time as here defined is synonymous with the term "block to block" time or "chock to chock" time in general usage which is measured from the time an aircraft moves from the loading point until it stops at the unloading point.

Glider. A non-power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Glider flight time. The total time occupied in flight, whether being towed or not, from the moment the glider first moves for the purpose of taking off until the moment it comes to rest at the end of the flight.

Helicopter. A heavier-than-air aircraft supported in flight chiefly by the reactions of the air on one or more power-driven rotors on substantially vertical axes.

Instrument flight time. Time during which a pilot is piloting an aircraft solely by reference to instruments and without external reference points.

Instrument ground time. Time during which a pilot is practising, on the ground, simulated instrument flight in a synthetic flight trainer approved by the Licensing Authority.

Instrument time. Instrument flight time or instrument ground time.

Licensing Authority. The Authority designated by a Contracting State as responsible for the licensing of personnel.

Note.— In the provisions of this Annex, the Licensing Authority is deemed to have been given the following responsibilities by the Contracting State:

a) assessment of an applicant's qualifications to hold a licence or rating;

b) issue and endorsement of licences and ratings;

c) designation and authorization of approved persons;

d) approval of training courses;

e) approval of the use of synthetic flight trainers and authorization for their use in gaining the experience or in demonstrating the skill required for the issue of a licence or rating; and

f) validation of licences issued by other Contracting States.

Medical Assessment. The evidence issued by a Contracting State that the licence holder meets specific requirements of medical fitness. It is issued following an evaluation by the Licensing Authority of the report submitted by the designated medical examiner who conducted the examination of the applicant for the licence.

Night. The hours between the end of evening civil twilight and the beginning of morning civil twilight or such other period between sunset and sunrise, as may be prescribed by the appropriate authority.

Note.— Civil twilight ends in the evening when the centre of the sun's disc is 6 degrees below the horizon and begins in the morning when the centre of the sun's disc is 6 degrees below the horizon.

Pilot (to). To manipulate the flight controls of an aircraft during flight time.

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Rated air traffic controller. An air traffic controller holding a licence and valid ratings appropriate to the privileges to be exercised.

Rating. An authorization entered on or associated with a licence and forming part thereof, stating special conditions, privileges or limitations pertaining to such licence.

Rendering (a licence) valid. The action taken by a Contracting State, as an alternative to issuing its own licence, in accepting a licence issued by any other Contracting State as the equivalent of its own licence.

Sign a maintenance release (to). To certify that the inspection and maintenance work has been completed satisfactorily in accordance with the methods prescribed in the Maintenance Manual by issuing the maintenance release referred to in Annex 6.

Solo flight time. Flight time during which a student pilot is the sole occupant of an aircraft.

Synthetic flight trainer. Any one of the following three types of apparatus in which flight conditions are simulated on the ground:

A flight simulator, which provides an accurate representation of the flight deck of a particular aircraft type to the extent that the mechanical, electrical, electronic, etc. aircraft systems control functions, the normal environment of flight crew members, and the performance and flight characteristics of that type of aircraft are realistically simulated;

A flight procedures trainer, which provides a realistic flight deck environment, and which simulates instrument responses, simple control functions of mechanical, electrical, electronic, etc. aircraft systems, and the performance and flight characteristics of aircraft of a particular class;

A basic instrument flight trainer, which is equipped with appropriate instruments, and which simulates the flight deck environment of an aircraft in flight in instrument flight conditions.

1.2 General rules concerning licences

Note 1.— Although the Convention on International Civil Aviation allocates to the State of Registry certain functions which that State is entitled to discharge, or obligated to discharge, as the case may be, the Assembly recognized, in Resolution A23-13 that the State of Registry may be unable to fulfil its responsibilities adequately in instances where aircraft are leased, chartered or interchanged — in particular without crew — by an operator of another State and that the Convention may not adequately specify the rights and obligations of the State of an operator in such instances until such time as Article 83 bis *of the Convention enters in force. Accordingly, the Council, urged that if, in the above-mentioned instances, the State of Registry finds itself unable to discharge adequately the functions allocated to it by the Convention, it delegates to the State of the Operator, subject to acceptance by the latter State, those functions of the State of Registry that can more adequately be discharged by the State of the Operator. It is understood that pending entry into force of Article 83* bis *of the Convention the foregoing action will only be a matter of practical convenience and will not affect either the provisions of the Chicago Convention prescribing the duties of the State of Registry or any third State.*

Note 2.— International Standards and Recommended Practices are established for licensing the following personnel:

a) Flight crew

— private pilot — aeroplane;

— commercial pilot — aeroplane;

— airline transport pilot — aeroplane;

— private pilot — helicopter;

— commercial pilot — helicopter;

— airline transport pilot — helicopter;

— glider pilot;

— free balloon pilot;

— flight navigator;

— flight engineer.

b) Other personnel

— aircraft maintenance (technician/engineer/mechanic) Type II;

— aircraft maintenance (technician/engineer/mechanic) Type I;

— air traffic controller;

— flight operations officer;

— aeronautical station operator.

1.2.1 Authority to act as a flight crew member

A person shall not act as a flight crew member of an aircraft unless a valid licence is held showing compliance with the specifications of this Annex and appropriate to the duties to be performed by that person. The licence shall have been issued by the State of Registry of that aircraft or by any other Contracting State and rendered valid by the State of Registry of that aircraft.

1.2.2 Method of rendering a licence valid

1.2.2.1 When a Contracting State renders valid a licence issued by another Contracting State, as an alternative to the issuance of its own licence, it shall establish validity by suitable authorization to be carried with the former licence accepting it as the equivalent of the latter. The validity of the authorization shall not extend beyond the period of validity of the licence.

Note.— This provision is not intended to preclude the State that issued the licence from extending, by a suitable notification, the period of validity of the licence without necessarily requiring either the physical return of the licence or the appearance of the licence holder before the authorities of that State.

1.2.2.2 **Recommendation.—** *A pilot licence issued by a Contracting State should be rendered valid by other Contracting States for use in private flights.*

Note.— Contracting States which, without formality, render valid a licence issued by another Contracting State for use in private flights are encouraged to notify this facility in their Aeronautical Information Publications.

1.2.3 Privileges of the holder of a licence

A Contracting State shall not permit the holder of a licence to exercise privileges other than those granted by that licence.

1.2.4 Medical fitness

Note 1.— Guidance material is published in the Manual of Civil Aviation Medicine *(Doc 8984).*

Note 2.— To satisfy the licensing requirements of medical fitness for the issue of various types of licences, the applicant must meet certain appropriate medical requirements which are specified as three classes of Medical Assessment. Details are given in 6.2, 6.3, 6.4 and 6.5. To provide the necessary evidence to satisfy the requirements of 1.2.4.1, the Licensing Authority issues the licence holder with the appropriate Medical Assessment, Class 1, Class 2 or Class 3. This can be done in several ways such as a suitably titled separate certificate, a statement on the licence, a national regulation stipulating that the Medical Assessment is an integral part of the licence, etc.

1.2.4.1 An applicant for a licence shall, when applicable, hold a Medical Assessment issued in accordance with the provisions of Chapter 6.

1.2.4.2 The duration of the period of currency of a Medical Assessment shall be in accordance with the provisions of 1.2.5. The period of currency shall begin on the date the Medical Assessment is issued.

1.2.4.3 Except as provided in 1.2.5.2.3, flight crew members or air traffic controllers shall not exercise the privileges of their licence unless they hold a current Medical Assessment appropriate to the licence.

1.2.4.4 Contracting States shall designate medical examiners, qualified and licensed in the practice of medicine, to conduct medical examinations of fitness of applicants for the issue or renewal of the licences or ratings specified in Chapters 2 and 3, and of the appropriate licences specified in Chapter 4.

1.2.4.4.1 Medical examiners shall have had, or shall receive, training in aviation medicine.

1.2.4.4.2 **Recommendation.—** *Medical examiners should acquire practical knowledge and experience of the conditions in which the holders of licences and ratings carry out their duties.*

1.2.4.5 Applicants for licences or ratings for which medical fitness is prescribed shall sign and furnish to the medical examiner a declaration stating whether they have previously undergone such an examination and, if so, with what result.

1.2.4.5.1 Any false declaration to a medical examiner made by an applicant for a licence or rating shall be reported to the Licensing Authority of the issuing State for such action as may be considered appropriate.

1.2.4.6 Having completed the medical examination of an applicant in accordance with Chapter 6, the medical examiner shall submit a signed report to the Licensing Authority, in accordance with its requirements, detailing the results of the examination.

1.2.4.6.1 If the medical examination is carried out by a constituted group of medical examiners, Contracting States shall appoint the head of the group to be responsible for co-ordinating the results of the examination and signing the report.

1.2.4.7 Contracting States shall use the services of physicians experienced in the practice of aviation medicine when it is necessary to evaluate reports submitted to the Licensing Authority by medical examiners.

1.2.4.8 If the medical Standards prescribed in Chapter 6 for a particular licence are not met, the appropriate Medical Assessment shall not be issued or renewed unless the following conditions are fulfilled:

a) accredited medical conclusion indicates that in special circumstances the applicant's failure to meet any requirement, whether numerical or otherwise, is such that exercise of the privileges of the licence applied for is not likely to jeopardize flight safety;

b) relevant ability, skill and experience of the applicant and operational conditions have been given due consideration; and

c) the licence is endorsed with any special limitation or limitations when the safe performance of the licence holder's duties is dependent on compliance with such limitation or limitations.

1.2.5 Validity of licences

1.2.5.1 A Contracting State, having issued a licence, shall ensure that the privileges granted by that licence, or by related ratings, are not exercised unless the holder maintains competency and meets the requirements for recent experience established by that State.

1.2.5.1.1 A Contracting State, having issued a licence, shall ensure that other Contracting States are enabled to be satisfied as to the validity of the licence.

Note 1.— The maintenance of competency of flight crew members, engaged in commercial air transport operations, may be satisfactorily established by demonstration of skill during proficiency flight checks completed in accordance with Annex 6.

Note 2.— Maintenance of competency may be satisfactorily recorded in the operator's records, or in the flight crew member's personal log book or licence.

Note 3.— Flight crew members may, to the extent deemed feasible by the State of Registry, demonstrate their continuing competency in synthetic flight trainers approved by that State.

1.2.5.1.1.1 A Contracting State, having issued before 16 November 1989 under the specifications of the previous (Seventh) edition of this Annex a licence or rating no longer foreseen in the present Annex, shall not extend the validity of such a licence or rating beyond 15 November 1994.

Note.— The licences and ratings no longer foreseen in this edition of Annex 1 are the following: the senior commercial pilot licence, the flight radio operator licence, the controlled VFR rating and the flight instructor rating for gliders and free balloons.

1.2.5.2 Except as provided in 1.2.5.2.1, 1.2.5.2.2 and 1.2.5.2.3, a report of medical fitness obtained in accordance with 1.2.4.5 and 1.2.4.6 shall be submitted at intervals of not greater than:

24 months for the private pilot licence — aeroplane;

12 months for the commercial pilot licence — aeroplane;

12 months for the airline transport pilot licence — aeroplane;

24 months for the private pilot licence — helicopter;

12 months for the commercial pilot licence — helicopter;

12 months for the airline transport pilot licence — helicopter;

24 months for the glider pilot licence;

24 months for the free balloon pilot licence;

12 months for the flight navigator licence;

12 months for the flight engineer licence;

24 months for the air traffic controller licence.

1.2.5.2.1 When the holders of airline transport pilot licences — aeroplane and helicopter have passed their 40th birthday, the 12-month interval specified in 1.2.5.2 shall be reduced to six months.

1.2.5.2.2 **Recommendation.—** *When the holders have passed their 40th birthday, the 24-month interval specified for the private pilot licences — aeroplane and helicopter, glider pilot licence, free balloon pilot licence, and air traffic controller licence should be reduced to 12 months, and the 12-month interval specified for the commercial pilot licences — aeroplane and helicopter should be reduced to six months.*

1.2.5.2.3 *Circumstances in which a medical examination may be deferred.* The prescribed re-examination of a licence holder operating in an area distant from designated medical examination facilities may be deferred at the discretion of the Licensing Authority, provided that such deferment shall only be made as an exception and shall not exceed:

a) a single period of six months in the case of a flight crew member of an aircraft engaged in non-commercial operations;

b) two consecutive periods each of three months in the case of a flight crew member of an aircraft engaged in commercial operations provided that in each case a favourable medical report is obtained after examination by a designated medical examiner of the area concerned, or, in cases where such a designated medical examiner is not available, by a physician legally qualified to practise medicine in that area. A report of the medical examination shall be sent to the Licensing Authority where the licence was issued;

c) in the case of a private pilot, a single period not exceeding 24 months where the medical examination is carried out by an examiner designated under 1.2.4.4 by the Contracting State in which the applicant is temporarily located. A report of the medical examination shall be sent to the Licensing Authority where the licence was issued.

1.2.6 Decrease in medical fitness

1.2.6.1 Licence holders shall not exercise the privileges of their licences and related ratings at any time when they are aware of any decrease in their medical fitness which might render them unable to safely exercise these privileges.

1.2.6.1.1 **Recommendation.—** *Each Contracting State should, as far as practicable, ensure that licence holders do not exercise the privileges of their licences and related ratings during any period in which their medical fitness has, from any cause, decreased to an extent that would have prevented the issue or renewal of their Medical Assessment.*

1.2.7 Approved training

Note.— The qualifications required for the issue of personnel licences can be more readily and speedily acquired by applicants who undergo closely supervised, systematic and continuous courses of training, conforming to a planned syllabus or curriculum. Provision has accordingly been made for some reduction in the experience requirements for the issue of certain licences and ratings prescribed in these Standards and Recommended Practices, in respect of an applicant who has satisfactorily completed a course of approved training.

Approved training shall provide a level of competency at least equal to that provided by the minimum experience requirements for personnel not receiving such approved training.

CHAPTER 2. LICENCES AND RATINGS FOR PILOTS

Note 1.— The present (Eighth) edition of Annex 1 no longer contains specifications for the senior commercial pilot licence — aeroplane and the controlled VFR rating. However, if such a licence or rating has been issued before 16 November 1989, the issuing State may maintain its validity until 15 November 1994.

Note 2.— The privileges for the commercial pilot licences — aeroplane and helicopter, as well as the circumstances in which class and type ratings are required, have been amended from the previous (Seventh) edition of Annex 1. Persons who have been issued with such a licence or rating before 16 November 1989 may be allowed by the issuing State to continue exercising the privileges set forth for these licences or ratings in the Seventh Edition of Annex 1, on international flights until 15 November 1994.

2.1 General rules concerning pilot licences and ratings

2.1.1 General licensing specifications

2.1.1.1 A person shall not act either as pilot-in-command or as co-pilot of an aircraft in any of the following categories unless that person is the holder of a pilot licence issued in accordance with the provisions of this Chapter:

— aeroplane
— helicopter
— glider
— free balloon

2.1.1.2 The category of aircraft shall be included in the title of the licence itself, or endorsed as a category rating on the licence.

2.1.1.2.1 When the holder of a pilot licence seeks a licence for an additional category of aircraft, the Licensing Authority shall either:

a) issue the licence holder with an additional pilot licence for that category of aircraft; or

b) endorse the original licence with the new category rating, subject to the conditions of 2.1.2.

Note.— The requirements for category ratings are given in terms of licensing specifications for pilots and at levels appropriate to the privileges to be granted to the licence holder.

2.1.1.3 An applicant shall, before being issued with any pilot licence or rating, meet such requirements in respect of age, knowledge, experience, flight instruction, skill and medical fitness, as are specified for that licence or rating.

2.1.1.3.1 An applicant for any pilot licence or rating shall demonstrate, in a manner determined by the Licensing Authority, such requirements for knowledge and skill as are specified for that licence or rating.

2.1.2 Category ratings

2.1.2.1 When established, category ratings shall be for categories of aircraft listed in 2.1.1.1.

2.1.2.2 Category ratings shall not be endorsed on a licence when the category is included in the title of the licence itself.

2.1.2.3 Any additional category rating endorsed on a pilot licence shall indicate the level of licensing privileges at which the category rating is granted.

2.1.2.4 The holder of a pilot licence seeking additional category ratings shall meet the requirements of this Annex appropriate to the privileges for which the category rating is sought.

2.1.3 Class and type ratings

2.1.3.1 Class ratings shall be established for aeroplanes certificated for single-pilot operation and shall comprise:

a) single-engine, land;

b) single-engine, sea;

c) multi-engine, land;

d) multi-engine, sea.

Note.— The provisions of this paragraph do not preclude the establishment of other class ratings within this basic structure.

2.1.3.1.1 **Recommendation.—** *Contracting States should consider establishing a class rating for those helicopters certificated for single-pilot operations and which have comparable handling, performance and other characteristics.*

2.1.3.2 Type ratings shall be established for:

a) each type of aircraft certificated for operation with a minimum crew of at least two pilots;

b) each type of helicopter certificated for single-pilot operation except where a class rating has been issued under 2.1.3.1.1; and

c) any type of aircraft whenever considered necessary by the Licensing Authority.

Note.— Requirements for class and type ratings for gliders and free balloons have not been determined.

2.1.3.3 When an applicant demonstrates skill and knowledge for the initial issue of a pilot licence, the category and the ratings appropriate to the class or type of aircraft used in the demonstration shall be entered on the licence.

2.1.4 Circumstances in which class and type ratings are required

2.1.4.1 A Contracting State having issued a pilot licence shall not permit the holder of such licence to act either as pilot-in-command or as co-pilot of an aeroplane or helicopter unless the holder has received authorization as follows:

a) the appropriate class rating specified in 2.1.3.1; or

b) a type rating when required in accordance with the provisions of 2.1.3.2.

2.1.4.1.1 When a type rating is issued limiting the privileges to act as co-pilot, such limitation shall be endorsed on the rating.

2.1.4.2 For the purpose of training, testing, or specific special purpose non-revenue, non-passenger carrying flights, special authorization may be provided in writing to the licence holder by the Licensing Authority in place of issuing the class or type rating in accordance with 2.1.4.1. This authorization shall be limited in validity to the time needed to complete the specific flight.

2.1.5 Requirements for the issue of class and type ratings

2.1.5.1 *Class rating*

The applicant shall have demonstrated a degree of skill appropriate to the licence in an aircraft of the class for which the rating is sought.

2.1.5.2 *Type rating as required by 2.1.3.2 a)*

The applicant shall have:

a) gained, under appropriate supervision, experience in the applicable type of aircraft and/or flight simulator in the following:
   - normal flight procedures and manoeuvres during all phases of flight;
   - abnormal and emergency procedures and manoeuvres in the event of failures and malfunctions of equipment, such as powerplant, systems and airframe;
   - where applicable, instrument procedures, including instrument approach, missed approach and landing procedures under normal, abnormal and emergency conditions, including simulated engine failure;
   - procedures for crew incapacitation and crew co-ordination including allocation of pilot tasks; crew co-operation and use of checklists;

Note.— Attention is called to Recommendation 2.1.8.2 on the qualifications required for pilots giving flight training.

b) demonstrated the skill and knowledge required for the safe operation of the applicable type of aircraft, relevant to the duties of a pilot-in-command or a co-pilot as applicable; and

c) demonstrated, at the airline transport pilot licence level, an extent of knowledge determined by the Licensing Authority on the basis of the requirements specified in 2.5.1.2 or 2.9.1.2, as applicable.

2.1.5.3 *Type rating as required by 2.1.3.2 b) and c)*

The applicant shall have demonstrated the skill and knowledge required for the safe operation of the applicable type of aircraft, relevant to the licensing requirements and piloting functions of the applicant.

2.1.6 Use of synthetic flight trainers for demonstrations of skill

The use of a synthetic flight trainer for performing any manoeuvre required during the demonstration of skill for the issue of a licence or rating shall be approved by the Licensing Authority which shall ensure that the synthetic flight trainer used is appropriate to the task.

2.1.7 Circumstances in which an instrument rating is required

A Contracting State, having issued a pilot licence, shall not permit the holder thereof to act either as pilot-in-command or as co-pilot of an aircraft under instrument flight rules (IFR) unless such holder has received proper authorization from such Contracting State. Proper authorization shall comprise an instrument rating appropriate to the aircraft category.

Note.— The instrument rating is included in the airline transport pilot licence — aeroplane, and the provisions of 2.1.7 do not preclude the issue of a licence having the instrument rating as an integral part thereof.

2.1.8 Circumstances in which authorization to conduct flight instruction is required

2.1.8.1 A Contracting State having issued a pilot licence shall not permit the holder thereof to carry out flight instruction required for the issue of a private pilot licence — aeroplane or helicopter, commercial pilot licence — aeroplane or helicopter, instrument rating — aeroplane or helicopter, or a flight instructor rating appropriate to aeroplanes and helicopters, unless such holder has received proper authorization from such Contracting State. Proper authorization shall comprise:

a) a flight instructor rating on the holder's licence; or

b) the authority to act as an agent of an approved organization authorized by the Licensing Authority to carry out flight instruction; or

c) a specific authorization granted by the Contracting State which issued the licence.

2.1.8.2 **Recommendation.—** *A Contracting State having issued a pilot licence should not permit the holder thereof to carry out flight instruction for the issue of any licence or rating not specified in 2.1.8.1 above unless such holder has received proper authorization from such Contracting State.*

2.1.9 Crediting of flight time

2.1.9.1 A student pilot or the holder of a pilot licence shall be entitled to be credited in full with all solo, dual instruction and pilot-in-command flight time towards the total flight time required for the initial issue of a pilot licence or the issue of a higher grade of pilot licence.

2.1.9.2 The holder of a pilot licence, when acting as co-pilot of an aircraft required to be operated with a co-pilot, shall be entitled to be credited with not more than 50 per cent of the co-pilot flight time towards the total flight time required for a higher grade of pilot licence.

2.1.9.3 The holder of a pilot licence, when acting as co-pilot performing under the supervision of the pilot-in-command the functions and duties of a pilot-in-command, shall be entitled to be credited in full with this flight time towards the total flight time required for a higher grade of pilot licence.

2.1.10 Curtailment of privileges of pilots who have attained their 60th birthday

2.1.10.1 A Contracting State, having issued pilot licences, shall not permit the holders thereof to act as pilot-in-command of an aircraft engaged in scheduled international air services or non-scheduled international air transport operations for remuneration or hire if the licence holders have attained their 60th birthday.

2.1.10.2 **Recommendation.—** *A Contracting State, having issued pilot licences, should not permit the holders thereof to act as co-pilot of an aircraft engaged in scheduled international air services or non-scheduled international air transport operations for remuneration or hire if the licence holders have attained their 60th birthday.*

2.2 Student pilot

2.2.1 A student pilot shall meet requirements prescribed by the Contracting State concerned. In prescribing such requirements, Contracting States shall ensure that the privileges granted would not permit student pilots to constitute a hazard to air navigation.

2.2.2 A student pilot shall not fly solo unless under the supervision of, or with the authority of, an authorized flight instructor.

2.2.2.1 A student pilot shall not fly solo in an aircraft on an international flight unless by special or general arrangement between the Contracting States concerned.

2.2.3 Medical Fitness

A Contracting State shall not permit a student pilot to fly solo unless that student pilot holds a current Class 2 Medical Assessment.

2.3 Private pilot licence — Aeroplane

Note.— The ICAO Training Manual *(Doc 7192), Part B-5, contains guidance material for a course of training for the private pilot licence — aeroplane.*

2.3.1 Requirements for the issue of the licence

2.3.1.1 *Age*

The applicant shall be not less than 17 years of age.

2.3.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a private pilot licence — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a private pilot licence — aeroplane; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation of aeroplane powerplants, systems and instruments;

c) operating limitations of aeroplanes and powerplants; relevant operational information from the flight manual or other appropriate document;

Flight performance and planning

d) effects of loading and mass distribution on flight characteristics; mass and balance calculations;

e) use and practical application of take-off, landing and other performance data;

f) pre-flight and en-route flight planning appropriate to private operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; position reporting procedures; altimeter setting procedures; operations in areas of high-density traffic;

Human performance and limitations

g) human performance and limitations relevant to the private pilot — aeroplane;

Meteorology

h) application of elementary aeronautical meteorology; use of, and procedures for obtaining, meteorological information; altimetry;

Navigation

i) practical aspects of air navigation and dead-reckoning techniques; use of aeronautical charts;

Operational procedures

j) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;

k) appropriate precautionary and emergency procedures, including action to be taken to avoid hazardous weather, wake turbulence and other operating hazards;

Principles of flight

l) principles of flight relating to aeroplanes;

Radiotelephony

m) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.

2.3.1.3 *Experience*

2.3.1.3.1 The applicant shall have completed not less than 40 hours of flight time as a pilot of aeroplanes. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 40 hours. Credit for such experience shall be limited to a maximum of 5 hours.

2.3.1.3.1.1 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.3.1.3.1 can be reduced accordingly.

2.3.1.3.2 The applicant shall have completed in aeroplanes not less than 10 hours of solo flight time under the supervision of an authorized flight instructor, including 5 hours of solo cross-country flight time with at least one cross-country flight totalling not less than 270 km (150 NM) in the course of which full-stop landings at two different aerodromes shall be made.

2.3.1.4 *Flight instruction*

2.3.1.4.1 The applicant shall have received dual instruction in aeroplanes from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the private pilot:

a) pre-flight operations, including mass and balance determination, aeroplane inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the aeroplane by external visual reference;

d) flight at critically slow airspeeds; recognition of, and recovery from, incipient and full stalls;

e) flight at critically high airspeeds; recognition of, and recovery from, spiral dives;

f) normal and cross-wind take-offs and landings;

g) maximum performance (short field and obstacle clearance) take-offs; short-field landings;

h) flight by reference solely to instruments, including the completion of a level 180° turn;

i) cross-country flying using visual reference, dead-reckoning and, where available, radio navigation aids;

j) emergency operations, including simulated aeroplane equipment malfunctions; and

k) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

2.3.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in aeroplanes in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.3.1.4.1 h) and the night flying experience specified in 2.3.1.4.2 do not entitle the holder of a private pilot licence — aeroplane to pilot aeroplanes under IFR.

2.3.1.5 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of an aeroplane, the procedures and manoeuvres described in 2.3.1.4 with a degree of competency appropriate to the privileges granted to the holder of a private pilot licence — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

2.3.1.6 *Medical fitness*

The applicant shall hold a current Class 2 Medical Assessment.

Note.— Attention is called to 2.6.1.5 on the medical fitness requirements for private pilot licence holders seeking an instrument rating.

2.3.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

2.3.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a private pilot licence — aeroplane shall be to act, but not for remuneration, as pilot-in-command or co-pilot of any aeroplane engaged in non-revenue flights.

2.3.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.3.1.4.2.

2.4 Commercial pilot licence — Aeroplane

Note.— The ICAO Training Manual *(Doc 7192), Part B-5, contains guidance material for a course of training for the commercial pilot licence — aeroplane.*

2.4.1 Requirements for the issue of the licence

2.4.1.1 *Age*

The applicant shall be not less than 18 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.4.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a commercial pilot licence — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a commercial pilot licence — aeroplane; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation and functioning of aeroplane powerplants, systems and instruments;

c) operating limitations of appropriate aeroplanes and powerplants; relevant operational information from the flight manual or other appropriate document;

d) use and serviceability checks of equipment and systems of appropriate aeroplanes;

e) maintenance procedures for airframes, systems and powerplants of appropriate aeroplanes;

Flight performance and planning

f) effects of loading and mass distribution on aeroplane handling, flight characteristics and performance; mass and balance calculations;

g) use and practical application of take-off, landing and other performance data;

h) pre-flight and en-route flight planning appropriate to operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;

Human performance and limitations

i) human performance and limitations relevant to the commercial pilot — aeroplane;

Meteorology

j) interpretation and application of aeronautical meteorological reports, charts and forecasts; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;

k) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems, the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions; hazardous weather avoidance;

Navigation

l) air navigation, including the use of aeronautical charts, instruments and navigation aids; an understanding of the principles and characteristics of appropriate navigation systems; operation of airborne equipment;

Operational procedures

m) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;

n) appropriate precautionary and emergency procedures;

o) operational procedures for carriage of freight; potential hazards associated with dangerous goods;

p) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from aeroplanes;

Principles of flight

q) principles of flight relating to aeroplanes;

Radiotelephony

r) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.

2.4.1.3 *Experience*

2.4.1.3.1 The applicant shall have completed not less than 200 hours of flight time, or 150 hours if completed during a course of approved training, as a pilot of aeroplanes. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 200 hours or 150 hours, as the case may be. Credit for such experience shall be limited to a maximum of 10 hours.

2.4.1.3.1.1 The applicant shall have completed in aeroplanes not less than:

a) 100 hours as pilot-in-command or, in the case of a course of approved training, 70 hours as pilot-in-command;

b) 20 hours of cross-country flight time as pilot-in-command including a cross-country flight totalling not less than 540 km (300 NM) in the course of which full-stop landings at two different aerodromes shall be made;

c) 10 hours of instrument instruction time of which not more than 5 hours may be instrument ground time; and

d) if the privileges of the licence are to be exercised at night, 5 hours of night flight time including 5 take-offs and 5 landings as pilot-in-command.

2.4.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.4.1.3.1 can be reduced accordingly.

2.4.1.4 *Flight instruction*

2.4.1.4.1 The applicant shall have received dual instruction in aeroplanes from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the commercial pilot:

a) pre-flight operations, including mass and balance determination, aeroplane inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the aeroplane by external visual reference;

d) flight at critically slow airspeeds; spin avoidance; recognition of, and recovery from, incipient and full stalls;

e) flight at critically high airspeeds; recognition of, and recovery from, spiral dives;

f) normal and cross-wind take-offs and landings;

g) maximum performance (short field and obstacle clearance) take-offs; short-field landings;

h) basic flight manoeuvres and recovery from unusual attitudes by reference solely to basic flight instruments;

i) cross-country flying using visual reference, dead-reckoning and radio navigation aids; diversion procedures;

j) abnormal and emergency procedures and manoeuvres; and

k) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

2.4.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in aeroplanes in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.4.1.3.1.1 c) and 2.4.1.4.1 h) and the night flying experience specified in 2.4.1.3.1.1 d) and 2.4.1.4.2 do not entitle the holder of a commercial pilot licence — aeroplane to pilot aeroplanes under IFR.

2.4.1.5 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of an aeroplane, the procedures and manoeuvres described in 2.4.1.4 with a degree of competency appropriate to the privileges granted to the holder of a commercial pilot licence — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

2.4.1.6 *Medical fitness*

The applicant shall hold a current Class 1 Medical Assessment.

2.4.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

2.4.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a commercial pilot licence — aeroplane shall be:

a) to exercise all the privileges of the holder of a private pilot licence — aeroplane;

b) to act as pilot-in-command in any aeroplane engaged in operations other than commercial air transportation;

c) to act as pilot-in-command in commercial air transportation in any aeroplane certificated for single-pilot operation; and

d) to act as co-pilot in commercial air transportation in aeroplanes required to be operated with a co-pilot.

2.4.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.4.1.3.1.1 d) and 2.4.1.4.2.

2.5 Airline transport pilot licence — Aeroplane

2.5.1 Requirements for the issue of the licence

2.5.1.1 *Age*

The applicant shall be not less than 21 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.5.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an airline transport pilot licence — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of an airline transport pilot licence — aeroplane; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) general characteristics and limitations of electrical, hydraulic, pressurization and other aeroplane systems; flight control systems, including autopilot and stability augmentation;

c) principles of operation, handling procedures and operating limitations of aeroplane powerplants; effects of atmospheric conditions on engine performance; relevant operational information from the flight manual or other appropriate document;

d) operating procedures and limitations of appropriate aeroplanes; effects of atmospheric conditions on aeroplane performance;

e) use and serviceability checks of equipment and systems of appropriate aeroplanes;

f) flight instruments; compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;

g) maintenance procedures for airframes, systems and powerplants of appropriate aeroplanes;

Flight performance and planning

h) effects of loading and mass distribution on aeroplane handling, flight characteristics and performance; mass and balance calculations;

i) use and practical application of take-off, landing and other performance data, including procedures for cruise control;

j) pre-flight and en-route operational flight planning; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;

Human performance and limitations

k) human performance and limitations relevant to the airline transport pilot — aeroplane;

Meteorology

l) interpretation and application of aeronautical meteorological reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;

m) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems; the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions;

n) causes, recognition and effects of engine and airframe icing; frontal zone penetration procedures; hazardous weather avoidance;

o) practical high altitude meteorology, including interpretation and use of weather reports, charts and forecasts; jetstreams;

Navigation

p) air navigation, including the use of aeronautical charts, radio navigation aids and area navigation systems; specific navigation requirements for long-range flights;

q) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of aeroplanes;

r) use, accuracy and reliability of navigation systems used in departure, en-route, approach and landing phases of flight; identification of radio navigation aids;

s) principles and characteristics of self-contained and external-referenced navigation systems; operation of airborne equipment;

Operational procedures

t) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations, and instrument procedure charts for departure, en-route, descent and approach;

u) precautionary and emergency procedures; safety practices associated with flight under IFR;

v) operational procedures for carriage of freight and dangerous goods;

w) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from aeroplanes;

Principles of flight

x) principles of flight relating to aeroplanes; sub-sonic aerodynamics; compressibility effects, manoeuvre boundary limits, wing design characteristics, effects of supplementary lift and drag devices; relationships between lift, drag and thrust at various airspeeds and in different flight configurations;

Radiotelephony

y) radiotelephony procedures and phraseology; action to be taken in case of communication failure.

2.5.1.3 *Experience*

2.5.1.3.1 The applicant shall have completed not less than 1 500 hours of flight time as a pilot of aeroplanes. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 1 500 hours. Credit for such experience shall be limited to a maximum of 100 hours, of which not more than 25 hours shall have been acquired in a flight procedure trainer or a basic instrument flight trainer.

2.5.1.3.1.1 The applicant shall have completed in aeroplanes not less than:

a) 250 hours, either as pilot-in-command, or made up by not less than 100 hours as pilot-in-command and the necessary additional flight time as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;

b) 200 hours of cross-country flight time, of which not less than 100 hours shall be as pilot-in-command or as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;

c) 75 hours of instrument time, of which not more than 30 hours may be instrument ground time; and

d) 100 hours of night flight as pilot-in-command or as co-pilot.

2.5.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.5.1.3.1 can be reduced accordingly.

2.5.1.4 *Flight instruction*

The applicant shall have received the dual flight instruction required for the issue of the commercial pilot licence — aeroplane (2.4.1.4) and for the issue of the instrument rating — aeroplane (2.6.1.3).

2.5.1.5 *Skill*

2.5.1.5.1 The applicant shall have demonstrated the ability to perform, as pilot-in-command of a multi-engined aeroplane required to be operated with a co-pilot, the following procedures and manoeuvres:

a) pre-flight procedures, including the preparation of the operational flight plan and filing of the air traffic services flight plan;

b) normal flight procedures and manoeuvres during all phases of flight;

c) procedures and manoeuvres for IFR operations under normal, abnormal and emergency conditions, including simulated engine failure, and covering at least the following:

— transition to instrument flight on take-off

— standard instrument departures and arrivals

— en-route IFR procedures and navigation

— holding procedures

— instrument approaches to specified minima

— missed approach procedures

— landings from instrument approaches

d) abnormal and emergency procedures and manoeuvres related to failures and malfunctions of equipment, such as powerplant, systems and airframe; and

e) procedures for crew incapacitation and crew co-ordination, including allocation of pilot tasks, crew co-operation and use of checklists.

2.5.1.5.1.1 The applicant shall have demonstrated the ability to perform the procedures and manoeuvres described in 2.5.1.5.1 with a degree of competency appropriate to the privileges granted to the holder of an airline transport pilot licence — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge;

e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never in doubt;

f) understand and apply crew co-ordination and incapacitation procedures; and

g) communicate effectively with the other flight crew members.

2.5.1.6 *Medical fitness*

The applicant shall hold a current Class 1 Medical Assessment.

2.5.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an airline transport pilot licence — aeroplane shall be:

a) to exercise all the privileges of the holder of a private and commercial pilot licence — aeroplane and of an instrument rating — aeroplane; and

b) to act as pilot-in-command and co-pilot in aeroplanes in air transportation.

2.6 Instrument rating — Aeroplane

Note.— The ICAO Training Manual *(Doc 7192), Part B-5, contains guidance material for a course of training for the instrument rating — aeroplane.*

2.6.1 Requirements for the issue of the rating

2.6.1.1 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an instrument rating — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to flight under IFR; related air traffic services practices and procedures;

Aircraft general knowledge

b) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of aeroplanes under IFR and in instrument meteorological conditions; use and limitations of autopilot;

c) compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;

Flight performance and planning

d) pre-flight preparations and checks appropriate to flight under IFR;

e) operational flight planning; preparation and filing of air traffic services flight plans under IFR; altimeter setting procedures;

Human performance and limitations

f) human performance and limitations relevant to instrument flight in aeroplanes;

Meteorology

g) application of aeronautical meteorology; interpretation and use of reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information; altimetry;

h) causes, recognition and effects of engine and airframe icing; frontal zone penetration procedures; hazardous weather avoidance;

Navigation

i) practical air navigation using radio navigation aids;

j) use, accuracy and reliability of navigation systems used in departure, en-route, approach and landing phases of flight; identification of radio navigation aids;

Operational procedures

k) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations, and instrument procedure charts for departure, en-route, descent and approach;

l) precautionary and emergency procedures; safety practices associated with flight under IFR;

Radiotelephony

m) radiotelephony procedures and phraseology as applied to aircraft operations under IFR; action to be taken in case of communication failure.

2.6.1.2 *Experience*

2.6.1.2.1 The applicant shall hold a private or commercial pilot licence — aeroplane.

2.6.1.2.2 The applicant shall have completed not less than:

a) 50 hours of cross-country flight time as pilot-in-command of aircraft in categories acceptable to the Licensing Authority, of which not less than 10 hours shall be in aeroplanes; and

b) 40 hours of instrument time in aeroplanes or helicopters of which not more than 20 hours, or 30 hours where a flight simulator is used, may be instrument ground time. The ground time shall be under the supervision of an authorized instructor.

2.6.1.3 *Flight instruction*

2.6.1.3.1 The applicant shall have gained not less than 10 hours of the instrument flight time required in 2.6.1.2.2 b) while receiving dual instrument flight instruction in aeroplanes from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the holder of an instrument rating:

a) pre-flight procedures, including the use of the flight manual or equivalent document, and appropriate air traffic services documents in the preparation of an IFR flight plan;

b) pre-flight inspection, use of checklists, taxiing and pre-take-off checks;

c) procedures and manoeuvres for IFR operation under normal, abnormal and emergency conditions covering at least:

— transition to instrument flight on take-off

— standard instrument departures and arrivals

— en-route IFR procedures

— holding procedures

— instrument approaches to specified minima

— missed approach procedures

— landings from instrument approaches

d) in-flight manoeuvres and particular flight characteristics.

2.6.1.3.2 If the privileges of the instrument rating are to be exercised on multi-engined aeroplanes, the applicant shall have received dual instrument flight instruction in such an aeroplane from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in the operation of the aeroplane solely by reference to instruments with one engine inoperative or simulated inoperative.

2.6.1.4 *Skill*

2.6.1.4.1 The applicant shall have demonstrated the ability to perform the procedures and manoeuvres described in 2.6.1.3.1 with a degree of competency appropriate to the privileges granted to the holder of an instrument rating — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

2.6.1.4.1.1 The applicant shall have demonstrated the ability to operate multi-engined aeroplanes solely by reference to instruments with one engine inoperative, or simulated inoperative, if the privileges of the instrument rating are to be exercised on such aeroplanes.

Note.— Attention is called to 2.1.6 on the use of synthetic flight trainers for demonstrations of skill.

2.6.1.5 *Medical fitness*

2.6.1.5.1 Applicants who hold a private pilot licence shall have established their hearing acuity on the basis of compliance with the hearing requirements for the issue of a Class 1 Medical Assessment.

2.6.1.5.2 **Recommendation.—** *Contracting States should consider requiring the holder of a private pilot licence to comply with the physical and mental, and visual requirements for the issue of a Class 1 Medical Assessment.*

2.6.2 Privileges of the holder of the rating and the conditions to be observed in exercising such privileges

2.6.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an instrument rating — aeroplane shall be to pilot aeroplanes under IFR.

2.6.2.2 Before exercising the privileges on multi-engined aeroplanes, the holder of the rating shall have complied with the requirements of 2.6.1.4.1.1.

Note.— Attention is called to 2.10.3 on the exercise of joint privileges of the instrument rating — aeroplane and of the instrument rating — helicopter.

2.7 Private pilot licence — Helicopter

2.7.1 Requirements for the issue of the licence

2.7.1.1 *Age*

The applicant shall be not less than 17 years of age.

2.7.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a private pilot licence — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a private pilot licence — helicopter; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation of helicopter powerplants, transmission (power-trains), systems and instruments;

c) operating limitations of helicopters and powerplants; relevant operational information from the flight manual;

Flight performance and planning

d) effects of loading and mass distribution on flight characteristics; mass and balance calculations;

e) use and practical application of take-off, landing and other performance data;

f) pre-flight and en-route flight planning appropriate to private operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; position reporting procedures; altimeter setting procedures; operations in areas of high-density traffic;

Human performance and limitations

g) human performance and limitations relevant to the private pilot — helicopter;

Meteorology

h) application of elementary aeronautical meteorology; use of, and procedures for obtaining, meteorological information; altimetry;

Navigation

i) practical aspects of air navigation and dead-reckoning techniques; use of aeronautical charts;

Operational procedures

j) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;

k) appropriate precautionary and emergency procedures, including action to be taken to avoid hazardous weather and wake turbulence; settling with power, ground resonance, roll-over and other operating hazards;

Principles of flight

l) principles of flight relating to helicopters;

Radiotelephony

m) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.

2.7.1.3 *Experience*

2.7.1.3.1 The applicant shall have completed not less than 40 hours of flight time as a pilot of helicopters. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 40 hours. Credit for such experience shall be limited to a maximum of 5 hours.

2.7.1.3.1.1 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.7.1.3.1 can be reduced accordingly.

2.7.1.3.2 The applicant shall have completed in helicopters not less than 10 hours of solo flight time under the supervision of an authorized flight instructor, including 5 hours of solo cross-country flight time with at least one cross-country flight totalling not less than 180 km (100 NM) in the course of which landings at two different points shall be made.

2.7.1.4 *Flight instruction*

2.7.1.4.1 The applicant shall have received not less than 20 hours of dual instruction time in helicopters from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the private pilot:

a) pre-flight operations, including mass and balance determination, helicopter inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the helicopter by external visual reference;

d) recovery at the incipient stage from settling with power; recovery techniques from low-rotor rpm within the normal range of engine rpm;

e) ground manoeuvring and run-ups; hovering; take-offs and landings — normal, out of wind and sloping ground;

f) take-offs and landings with minimum necessary power; maximum performance take-off and landing techniques; restricted site operations; quick stops;

g) cross-country flying using visual reference, dead reckoning and, where available, radio navigation aids, including a flight of at least one hour;

h) emergency operations, including simulated helicopter equipment malfunctions; autorotative approach and landing; and

i) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

2.7.1.4.1.1 **Recommendation.**— *The applicant should have received dual instrument flight instruction from an authorized flight instructor. The instructor should ensure that the applicant has operational experience in flight solely by reference to instruments, including the completion of a level 180° turn, in a suitably instrumented helicopter.*

2.7.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in helicopters in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.7.1.4.1.1 and the night flying experience specified in 2.7.1.4.2 do not entitle the holder of a private pilot licence — helicopter to pilot helicopters under IFR.

2.7.1.5 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of a helicopter, the procedures and manoeuvres described in 2.7.1.4 with a degree of competency appropriate to the privileges granted to the holder of a private pilot licence — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

2.7.1.6 *Medical fitness*

The applicant shall hold a current Class 2 Medical Assessment.

Note.— Attention is called to 2.10.1.5 on the medical fitness requirements for private pilot licence holders seeking an instrument rating.

2.7.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

2.7.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a private pilot licence — helicopter shall be to act, but not for remuneration, as pilot-in-command or co-pilot of any helicopter engaged in non-revenue flights.

2.7.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.7.1.4.2.

2.8 Commercial pilot licence — Helicopter

2.8.1 Requirements for the issue of the licence

2.8.1.1 *Age*

The applicant shall be not less than 18 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.8.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a commercial pilot licence — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a commercial pilot licence — helicopter; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation and functioning of helicopter powerplants, transmission (power-trains), systems and instruments;

c) operating limitations of appropriate helicopters and powerplants; relevant operational information from the flight manual;

d) use and serviceability checks of equipment and systems of appropriate helicopters;

e) maintenance procedures for airframes, systems and powerplants of appropriate helicopters;

Flight performance and planning

f) effects of loading and mass distribution, including external loads, on helicopter handling, flight characteristics and performance; mass and balance calculations;

g) use and practical application of take-off, landing and other performance data;

h) pre-flight and en-route flight planning appropriate to operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;

Human performance and limitations

i) human performance and limitations relevant to the commercial pilot — helicopter;

Meteorology

j) interpretation and application of aeronautical meteorological reports, charts and forecasts; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;

k) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems, the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions; hazardous weather avoidance;

Navigation

l) air navigation, including the use of aeronautical charts, instruments and navigation aids; an understanding of the principles and characteristics of appropriate navigation systems; operation of airborne equipment;

Operational procedures

m) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;

n) appropriate precautionary and emergency procedures; settling with power, ground resonance, roll-over and other operating hazards;

o) operational procedures for carriage of freight, including external loads; potential hazards associated with dangerous goods;

p) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from helicopters;

Principles of flight

q) principles of flight relating to helicopters;

Radiotelephony

r) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.

2.8.1.3 *Experience*

2.8.1.3.1 The applicant shall have completed not less than 150 hours of flight time, or 100 hours if completed during a course of approved training, as a pilot of helicopters. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 150 hours or 100 hours, as the case may be. Credit for such experience shall be limited to a maximum of 10 hours.

2.8.1.3.1.1 The applicant shall have completed in helicopters not less than:

a) 35 hours as pilot-in-command;

b) 10 hours of cross-country flight time as pilot-in-command including a cross-country flight in the course of which landings at two different points shall be made;

c) 10 hours of instrument instruction time of which not more than 5 hours may be instrument ground time; and

d) if the privileges of the licence are to be exercised at night, 5 hours of night flight time including 5 take-offs and 5 landing patterns as pilot-in-command.

2.8.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.8.1.3.1 can be reduced accordingly.

2.8.1.4 *Flight instruction*

2.8.1.4.1 The applicant shall have received dual instruction in helicopters from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the commercial pilot:

a) pre-flight operations, including mass and balance determination, helicopter inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the helicopter by external visual reference;

d) recovery at the incipient stage from settling with power; recovery techniques from low-rotor rpm within the normal range of engine rpm;

e) ground manoeuvring and run-ups; hovering; take-offs and landings — normal, out of wind and sloping ground; steep approaches;

f) take-offs and landings with minimum necessary power; maximum performance take-off and landing techniques; restricted site operations; quick stops;

g) hovering out of ground effect; operations with external load, if applicable; flight at high altitude;

h) basic flight manoeuvres and recovery from unusual attitudes by reference solely to basic flight instruments;

i) cross-country flying using visual reference, dead-reckoning and radio navigation aids; diversion procedures;

j) abnormal and emergency procedures, including simulated helicopter equipment malfunctions, autorotative approach and landing; and

k) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

2.8.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in helicopters in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.8.1.3.1.1 c) and 2.8.1.4.1 h) and the night flying experience specified in 2.8.1.3.1.1 d) and 2.8.1.4.2 do not entitle the holder of a commercial pilot licence — helicopter to pilot helicopters under IFR.

2.8.1.5 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of a helicopter, the procedures and manoeuvres described in 2.8.1.4 with a degree of competency appropriate to the privileges granted to the holder of a commercial pilot licence — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

2.8.1.6 *Medical fitness*

The applicant shall hold a current Class 1 Medical Assessment.

2.8.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

2.8.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a commercial pilot licence — helicopter shall be:

a) to exercise all the privileges of the holder of a private pilot licence — helicopter;

b) to act as pilot-in-command in any helicopter engaged in operations other than commercial air transportation;

c) to act as pilot-in-command in commercial air transportation in any helicopter certificated for single-pilot operation; and

d) to act as co-pilot in commercial air transportation in helicopters required to be operated with a co-pilot.

2.8.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.8.1.3.1.1 d) and 2.8.1.4.2.

2.9 Airline transport pilot licence — Helicopter

2.9.1 Requirements for the issue of the licence

2.9.1.1 *Age*

The applicant shall be not less than 21 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.9.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an airline transport pilot licence — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of an airline transport pilot licence — helicopter; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) general characteristics and limitations of electrical, hydraulic, and other helicopter systems; flight control systems, including autopilot and stability augmentation;

c) principles of operation, handling procedures and operating limitations of helicopter powerplants; transmission (power-trains); effects of atmospheric conditions on engine performance; relevant operational information from the flight manual;

d) operating procedures and limitations of appropriate helicopters; effects of atmospheric conditions on helicopter performance; relevant operational information from the flight manual;

e) use and serviceability checks of equipment and systems of appropriate helicopters;

f) flight instruments; compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;

g) maintenance procedures for airframes, systems and powerplants of appropriate helicopters;

Flight performance and planning

h) effects of loading and mass distribution, including external loads, on helicopter handling, flight characteristics and performance; mass and balance calculations;

i) use and practical application of take-off, landing and other performance data, including procedures for cruise control;

j) pre-flight and en-route operational flight planning; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;

Human performance and limitations

k) human performance and limitations relevant to the airline transport pilot — helicopter;

Meteorology

l) interpretation and application of aeronautical meteorological reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;

m) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems, the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions;

n) causes, recognition and effects of engine, airframe and rotor icing; hazardous weather avoidance;

Navigation

o) air navigation, including the use of aeronautical charts, radio navigation aids and area navigation systems; specific navigation requirements for long-range flights;

p) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of helicopters;

q) use, accuracy and reliability of navigation systems; identification of radio navigation aids;

r) principles and characteristics of self-contained and external-referenced navigation systems; operation of airborne equipment;

Operational procedures

s) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;

t) precautionary and emergency procedures; settling with power, ground resonance, retreating blade stall, dynamic roll-over and other operating hazards; safety practices associated with flight under VFR;

u) operational procedures for carriage of freight, including external loads, and dangerous goods;

v) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from helicopters;

Principles of flight

w) principles of flight relating to helicopters;

Radiotelephony

x) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.

2.9.1.3 *Experience*

2.9.1.3.1 The applicant shall have completed not less than 1 000 hours of flight time as a pilot of helicopters.

The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 1 000 hours. Credit for such experience shall be limited to a maximum of 100 hours, of which not more than 25 hours shall have been acquired in a flight procedure trainer or a basic instrument flight trainer.

2.9.1.3.1.1 The applicant shall have completed in helicopters not less than:

a) 250 hours, either as pilot-in-command, or made up by not less than 100 hours as pilot-in-command and the necessary additional flight time as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;

b) 200 hours of cross-country flight time, of which not less than 100 hours shall be as pilot-in-command or as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;

c) 30 hours of instrument time, of which not more than 10 hours may be instrument ground time; and

d) 50 hours of night flight as pilot-in-command or as co-pilot.

2.9.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.9.1.3.1 can be reduced accordingly.

2.9.1.4 *Flight instruction*

The applicant shall have received the flight instruction required for the issue of the commercial pilot licence — helicopter (2.8.1.4).

Note.— The instrument time specified in 2.9.1.3.1.1 c) and the night flying time specified in 2.9.1.3.1.1 d) do not entitle the holder of the airline transport pilot licence — helicopter to pilot helicopters under IFR.

2.9.1.5 *Skill*

2.9.1.5.1 The applicant shall have demonstrated the ability to perform, as pilot-in-command of a helicopter required to be operated with a co-pilot, the following procedures and manoeuvres:

a) pre-flight procedures, including the preparation of the operational flight plan and filing of the air traffic services flight plan;

b) normal flight procedures and manoeuvres during all phases of flight;

c) abnormal and emergency procedures and manoeuvres related to failures and malfunctions of equipment, such as powerplant, systems and airframe; and

d) procedures for crew incapacitation and crew co-ordination including allocation of pilot tasks, crew co-operation and use of checklists.

2.9.1.5.1.1 The applicant shall have demonstrated the ability to perform the procedures and manoeuvres described in 2.9.1.5.1 with a degree of competency appropriate to the privileges granted to the holder of an airline transport pilot licence — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge;

e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never in doubt;

f) understand and apply crew co-ordination and incapacitation procedures; and

g) communicate effectively with the other flight crew members.

2.9.1.6 *Medical fitness*

The applicant shall hold a current Class 1 Medical Assessment.

2.9.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an airline transport pilot licence — helicopter shall be:

a) to exercise all the privileges of the holder of a private and commercial pilot licence — helicopter; and

b) to act as pilot-in-command and co-pilot in helicopters in air transportation.

2.10 Instrument rating — Helicopter

2.10.1 Requirements for the issue of the rating

2.10.1.1 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an instrument rating — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to flight under IFR; related air traffic services practices and procedures;

Aircraft general knowledge

b) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of helicopters under IFR and in instrument meteorological conditions; use and limitations of autopilot;

c) compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;

Flight performance and planning

d) pre-flight preparations and checks appropriate to flight under IFR;

e) operational flight planning; preparation and filing of air traffic services flight plans under IFR; altimeter setting procedures;

Human performance and limitations

f) human performance and limitations relevant to instrument flight in helicopters;

Meteorology

g) application of aeronautical meteorology; interpretation and use of reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information; altimetry;

h) causes, recognition and effects of engine, airframe and rotor icing; frontal zone penetration procedures; hazardous weather avoidance;

Navigation

i) practical air navigation using radio navigation aids;

j) use, accuracy and reliability of navigation systems used in departure, en-route, approach and landing phases of flight; identification of radio navigation aids;

Operational procedures

k) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations, and instrument procedure charts for departure, en route, descent and approach;

l) precautionary and emergency procedures; safety practices associated with flight under IFR;

Radiotelephony

m) radiotelephony procedures and phraseology as applied to aircraft operations under IFR; action to be taken in case of communication failure.

2.10.1.2 *Experience*

2.10.1.2.1 The applicant shall hold a private, commercial or airline transport pilot licence — helicopter.

2.10.1.2.2 The applicant shall have completed not less than:

a) 50 hours of cross-country flight time as pilot-in-command of aircraft in categories acceptable to the Licensing Authority, of which not less than 10 hours shall be in helicopters; and

b) 40 hours of instrument time in helicopters or aeroplanes of which not more than 20 hours, or 30 hours where a flight simulator is used, may be instrument ground time. The ground time shall be under the supervision of an authorized instructor.

2.10.1.3 *Flight instruction*

The applicant shall have gained not less than 10 hours of the instrument flight time required in 2.10.1.2.2 b) while receiving dual instrument flight instruction in helicopters from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas and to the level of performance required for the holder of an instrument rating:

a) pre-flight procedures, including the use of the flight manual or equivalent document, and appropriate air traffic services documents in the preparation of an IFR flight plan;

b) pre-flight inspection, use of checklists, taxiing and pre-take-off checks;

c) procedures and manoeuvres for IFR operation under normal, abnormal and emergency conditions covering at least:

— transition to instrument flight on take-off

— standard instrument departures and arrivals

— en-route IFR procedures

— holding procedures

— instrument approaches to specified minima

— missed approach procedures

— landings from instrument approaches

d) in-flight manoeuvres and particular flight characteristics; and

e) if appropriate, operation of a multi-engined helicopter solely by reference to instruments with one engine inoperative or simulated inoperative.

2.10.1.4 *Skill*

The applicant shall have demonstrated the ability to perform the procedures and manoeuvres specified in 2.10.1.3 with a degree of competency appropriate to the privileges granted to the holder of an instrument rating — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

Note.— Attention is called to 2.1.6 on the use of synthetic flight trainers for demonstrations of skill.

2.10.1.5 *Medical fitness*

2.10.1.5.1 Applicants who hold a private pilot licence shall have established their hearing acuity on the basis of compliance with the hearing requirements for the issue of a Class 1 Medical Assessment.

2.10.1.5.2 **Recommendation.**— *Contracting States should consider requiring the holder of a private pilot licence to comply with the physical and mental, and visual requirements for the issue of a Class 1 Medical Assessment.*

2.10.2 Privileges of the holder of the rating and the conditions to be observed in exercising such privileges

Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an instrument rating — helicopter shall be to pilot helicopters under IFR.

2.10.3 Exercise of joint privileges of the instrument rating — aeroplane and the instrument rating — helicopter

The privileges given in 2.6.2 and 2.10.2 may be conferred by a single instrument rating in lieu of issuing separate instrument ratings for aeroplanes and helicopters provided that the requirements for the issue of both ratings, as specified in 2.6 and 2.10, have been met.

2.11 Flight instructor rating appropriate to aeroplanes and helicopters

2.11.1 Requirements for the issue of the rating

2.11.1.1 *Knowledge*

The applicant shall have met the knowledge requirements for the issue of a commercial pilot licence as specified in 2.4.1.2 or 2.8.1.2 as appropriate. In addition, the applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a flight instructor rating, in at least the following areas:

a) techniques of applied instruction;

b) assessment of student performance in those subjects in which ground instruction is given;

c) the learning process;

d) elements of effective teaching;

e) student evaluation and testing, training philosophies;

f) training programme development;

g) lesson planning;

h) classroom instructional techniques;

i) use of training aids;

j) analysis and correction of student errors;

k) human performance and limitations relevant to flight instruction; and

l) hazards involved in simulating system failures and malfunctions in the aircraft.

2.11.1.2 *Experience*

The applicant shall have met the experience requirements for the issue of a commercial pilot licence as specified in 2.4.1.3 or 2.8.1.3, as appropriate.

2.11.1.3 *Flight instruction*

The applicant shall, under the supervision of a flight instructor accepted by the Licensing Authority for that purpose:

a) have received instruction in flight instructional techniques including demonstration, student practices, recognition and correction of common student errors; and

b) have practised instructional techniques in those flight manoeuvres and procedures in which it is intended to provide flight instruction.

2.11.1.4 *Skill*

The applicant shall have demonstrated, in the category of aircraft for which flight instructor privileges are sought, the ability to instruct in those areas in which flight instruction is to be given, including pre-flight, post-flight and ground instruction as appropriate.

2.11.2 Privileges of the holder of the rating and the conditions to be observed in exercising such privileges

Subject to compliance with the requirements specified in 1.2.5 and 2.1, the privileges of the holder of a flight instructor rating shall be:

a) to supervise solo flights by student pilots; and

b) to carry out flight instruction for the issue of a private pilot licence, a commercial pilot licence, an instrument rating, and a flight instructor rating

provided that the flight instructor:

1) holds at least the licence and rating for which instruction is being given, in the appropriate aircraft category;

2) holds the licence and rating necessary to act as the pilot-in-command of the aircraft on which the instruction is given; and

3) has the flight instructor privileges granted entered on the licence.

2.12 Glider pilot licence

2.12.1 Requirements for the issue of the licence

2.12.1.1 *Age*

The applicant shall be not less than 16 years of age.

2.12.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a glider pilot licence, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a glider pilot licence; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation of glider systems and instruments;

c) operating limitations of gliders; relevant operational information from the flight manual or other appropriate document;

Flight performance and planning

d) effects of loading and mass distribution on flight characteristics; mass and balance considerations;

e) use and practical application of launching, landing and other performance data;

f) pre-flight and en-route flight planning appropriate to operations under VFR; appropriate air traffic services procedures; altimeter setting procedures; operations in areas of high-density traffic;

Human performance and limitations

g) human performance and limitations relevant to the glider pilot;

Meteorology

h) application of elementary aeronautical meteorology; use of, and procedures for obtaining, meteorological information; altimetry;

Navigation

i) practical aspects of air navigation and dead-reckoning techniques; use of aeronautical charts;

Operational procedures

j) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;

k) different launch methods and associated procedures;

l) appropriate precautionary and emergency procedures, including action to be taken to avoid hazardous weather and wake turbulence and other operating hazards;

Principles of flight

m) principles of flight relating to gliders.

2.12.1.2.1 **Recommendation.**— *The applicant should have demonstrated a level of knowledge appropriate to the privileges to be granted to the holder of a glider pilot licence, in radiotelephony procedures and phraseology as appropriate to VFR operations and on action to be taken in case of communication failure.*

2.12.1.3 *Experience*

2.12.1.3.1 The applicant shall have completed not less than six hours of flight time as a pilot of gliders including two hours' solo flight time during which not less than 20 launches and landings have been performed.

2.12.1.3.1.1 When the applicant has flight time as a pilot of aeroplanes, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.12.1.3.1 can be reduced accordingly.

2.12.1.3.2 The applicant shall have gained, under appropriate supervision, operational experience in gliders in at least the following areas:

a) pre-flight operations, including glider assembly and inspection;

b) techniques and procedures for the launching method used, including appropriate airspeed limitations, emergency procedures and signals used;

c) traffic pattern operations, collision avoidance precautions and procedures;

d) control of the glider by external visual reference;

e) flight throughout the flight envelope;

f) recognition of, and recovery from, incipient and full stalls and spiral dives;

g) normal and cross-wind launches, approaches and landings;

h) cross-country flying using visual reference and dead-reckoning;

i) emergency procedures.

2.12.1.4 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of a glider, the procedures and manoeuvres described in 2.12.1.3.2 with a degree of competency appropriate to the privileges granted to the holder of a glider pilot licence, and to:

a) operate the glider within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the glider at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

2.12.1.5 *Medical fitness*

The applicant shall hold a current Class 2 Medical Assessment.

2.12.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

2.12.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a glider pilot licence shall be to act as pilot-in-command of any glider provided the licence holder has operational experience in the launching method used.

2.12.2.2 **Recommendation.**— *If passengers are to be carried, the licence holder should have completed not less than 10 hours of flight time as a pilot of gliders.*

2.13 Free balloon pilot licence

Note.— The provisions of the free balloon pilot licence apply to free balloons using hot air or gas.

2.13.1 Requirements for the issue of the licence

2.13.1.1 *Age*

The applicant shall be not less than 16 years of age.

2.13.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a free balloon pilot licence, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a free balloon pilot licence; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation of free balloon systems and instruments;

c) operating limitations of free balloons; relevant operational information from the flight manual or other appropriate document;

d) physical properties and practical application of gases used in free balloons;

Flight performance and planning

e) effects of loading on flight characteristics; mass calculations;

f) use and practical application of launching, landing and other performance data, including the effect of temperature;

g) pre-flight and en-route flight planning appropriate to operations under VFR; appropriate air traffic services procedures; altimeter setting procedures; operations in areas of high-density traffic;

Human performance and limitations

h) human performance and limitations relevant to the free balloon pilot;

Meteorology

i) application of elementary aeronautical meteorology; use of, and procedures for obtaining, meteorological information; altimetry;

Navigation

j) practical aspects of air navigation and dead-reckoning techniques; use of aeronautical charts;

Operational procedures

k) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;

l) appropriate precautionary and emergency procedures, including action to be taken to avoid hazardous weather, wake turbulence and other operating hazards;

Principles of flight

m) principles of flight relating to free balloons.

2.13.1.2.1 **Recommendation.—** *The applicant should have demonstrated a level of knowledge appropriate to the privileges to be granted to the holder of a free balloon pilot licence, in radiotelephony procedures and phraseology as appropriate to VFR operations and on action to be taken in case of communication failure.*

2.13.1.3 *Experience*

2.13.1.3.1 The applicant shall have completed not less than 16 hours of flight time as a pilot of free balloons including at least eight launches and ascents of which one must be solo.

2.13.1.3.2 The applicant shall have gained, under appropriate supervision, operational experience in free balloons in at least the following areas:

a) pre-flight operations, including balloon assembly, rigging, inflation, mooring and inspection;

b) techniques and procedures for the launching and ascent, including appropriate limitations, emergency procedures and signals used;

c) collision avoidance precautions;

d) control of a free balloon by external visual reference;

e) recognition of, and recovery from, rapid descents;

f) cross-country flying using visual reference and dead-reckoning;

g) approaches and landings, including ground handling;

h) emergency procedures.

2.13.1.3.3 If the privileges of the licence are to be exercised at night, the applicant shall have gained, under appropriate supervision, operational experience in free balloons in night flying.

2.13.1.4 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of a free balloon, the procedures and manoeuvres described in 2.13.1.3.2 with a degree of competency appropriate to the privileges granted to the holder of a free balloon pilot licence, and to:

a) operate the free balloon within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

e) maintain control of the free balloon at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.

2.13.1.5 *Medical fitness*

The applicant shall hold a current Class 2 Medical Assessment.

2.13.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

2.13.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a free balloon pilot licence shall be to act as pilot-in-command of any free balloon provided that the licence holder has operational experience in hot air or gas balloons as appropriate.

2.13.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.13.1.3.3.

CHAPTER 3. LICENCES FOR FLIGHT CREW MEMBERS OTHER THAN LICENCES FOR PILOTS

Note.— The present (Eighth) edition of Annex 1 no longer contains specifications for the flight radio operator licence. However, if such a licence has been issued before 16 November 1989, the issuing State may maintain its validity until 15 November 1994.

3.1 General rules concerning flight navigator and flight engineer licences

3.1.1 An applicant shall, before being issued with a flight navigator licence or a flight engineer licence, meet such requirements in respect of age, knowledge, experience, skill and medical fitness as are specified for those licences.

3.1.1.1 An applicant for a flight navigator licence or a flight engineer licence shall demonstrate such requirements for knowledge and skill as are specified for those licences, in a manner determined by the Licensing Authority.

3.2 Flight navigator licence

3.2.1 Requirements for the issue of the licence

3.2.1.1 *Age*

The applicant shall be not less than 18 years of age.

3.2.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a flight navigator licence, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a flight navigator licence; appropriate air traffic services practices and procedures;

Flight performance and planning

b) effects of loading and mass distribution on aircraft performance;

c) use of take-off, landing and other performance data including procedures for cruise control;

d) pre-flight and en-route operational flight planning; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;

Human performance and limitations

e) human performance and limitations relevant to the flight navigator;

Meteorology

f) interpretation and practical application of aeronautical meteorological reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;

g) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems; the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions;

Navigation

h) dead-reckoning, pressure-pattern and celestial navigation procedures; the use of aeronautical charts, radio navigation aids and area navigation systems; specific navigation requirements for long-range flights;

i) use, limitation and serviceability of avionics and instruments necessary for the navigation of the aircraft;

j) use, accuracy and reliability of navigation systems used in departure, en-route and approach phases of flight; identification of radio navigation aids;

k) principles, characteristics and use of self-contained and external-referenced navigation systems; operation of airborne equipment;

l) the celestial sphere including the movement of heavenly bodies and their selection and identification for the purpose of observation and reduction of sights;

calibration of sextants; the completion of navigation documentation;

m) definitions, units and formulae used in air navigation;

Operational procedures

n) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes, abbreviations, and instrument procedure charts for departure, en-route, descent and approach;

Principles of flight

o) principles of flight;

Radiotelephony

p) radiotelephony procedures and phraseology.

3.2.1.3 *Experience*

3.2.1.3.1 The applicant shall have completed in the performance of the duties of a flight navigator, not less than 200 hours of flight time acceptable to the Licensing Authority, in aircraft engaged in cross-country flights, including not less than 30 hours by night.

3.2.1.3.1.1 When the applicant has flight time as a pilot, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 3.2.1.3.1 can be reduced accordingly.

3.2.1.3.2 The applicant shall produce evidence of having satisfactorily determined the aircraft's position in flight, and used that information to navigate the aircraft, as follows:

a) by night — not less than 25 times by celestial observations; and

b) by day — not less than 25 times by celestial observations in conjunction with self-contained or external-referenced navigation systems.

3.2.1.4 *Skill*

The applicant shall have demonstrated the ability to perform as flight navigator of an aircraft with a degree of competency appropriate to the privileges granted to the holder of a flight navigator licence, and to:

a) exercise good judgement and airmanship;

b) apply aeronautical knowledge;

c) perform all duties as part of an integrated crew; and

d) communicate effectively with the other flight crew members.

3.2.1.5 *Medical fitness*

The applicant shall hold a current Class 1 Medical Assessment.

3.2.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

Subject to compliance with the requirements specified in 1.2.5 and 1.2.6, the privileges of the holder of a flight navigator licence shall be to act as flight navigator of any aircraft.

3.3 Flight engineer licence

3.3.1 Requirements for the issue of the licence

3.3.1.1 *Age*

The applicant shall be not less than 18 years of age.

3.3.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a flight engineer licence, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a flight engineer licence; rules and regulations governing the operation of civil aircraft pertinent to the duties of a flight engineer;

Aircraft general knowledge

b) basic principles of powerplants, gas turbines and/or piston engines; characteristics of fuels, fuel systems including fuel control; lubricants and lubrication systems; afterburners and injection systems, function and operation of engine ignition and starter systems;

c) principles of operation, handling procedures and operating limitations of aircraft powerplants; effects of atmospheric conditions on engine performance;

d) airframes, flight controls, structures, wheel assemblies, brakes and anti-skid units, corrosion and fatigue life; identification of structural damage and defects;

e) ice and rain protection systems;

f) pressurization and air-conditioning systems, oxygen systems;

g) hydraulic and pneumatic systems;

h) basic electrical theory, electric systems (AC and DC), aircraft wiring systems, bonding and screening;

i) principles of operation of instruments, compasses, auto-pilots, radio communication equipment, radio and radar navigation aids, flight management systems, displays and avionics;

j) limitations of appropriate aircraft;

k) fire protection, detection, suppression and extinguishing systems;

l) use and serviceability checks of equipment and systems of appropriate aircraft;

Flight performance and planning

m) effects of loading and mass distribution on aircraft handling, flight characteristics and performance; mass and balance calculations;

n) use and practical application of performance data including procedures for cruise control;

Human performance and limitations

o) human performance and limitations relevant to the flight engineer;

Operational procedures

p) principles of maintenance, procedures for the maintenance of airworthiness, defect reporting, pre-flight inspections, precautionary procedures for fuelling and use of external power; installed equipment and cabin systems;

q) normal, abnormal and emergency procedures;

r) operational procedures for carriage of freight and dangerous goods;

Principles of flight

s) fundamentals of aerodynamics;

Radiotelephony

t) radiotelephony procedures and phraseology.

3.3.1.2.1 **Recommendation.—** *The applicant should have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a flight engineer licence in at least the following subjects:*

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a) fundamentals of navigation; principles and operation of self-contained systems; and

b) operational aspects of meteorology.

3.3.1.3 *Experience*

3.3.1.3.1 The applicant shall have completed, under the supervision of a person accepted by the Licensing Authority for that purpose, not less than 100 hours of flight time in the performance of the duties of a flight engineer. The Licensing Authority shall determine whether experience as a flight engineer in a flight simulator, which it has approved, is acceptable as part of the total flight time of 100 hours. Credit for such experience shall be limited to a maximum of 50 hours.

3.3.1.3.1.1 When the applicant has flight time as a pilot, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 3.3.1.3.1 can be reduced accordingly.

3.3.1.3.2 The applicant shall have operational experience in the performance of the duties of a flight engineer, under the supervision of a flight engineer accepted by the Licensing Authority for that purpose, in at least the following areas:

a) *Normal procedures*

— pre-flight inspections
— fuelling procedures, fuel management
— inspection of maintenance documents
— normal flight deck procedures during all phases of flight
— crew co-ordination and procedures in case of crew incapacitation
— defect reporting

b) *Abnormal and alternate (standby) procedures*

— recognition of abnormal functioning of aircraft systems
— use of abnormal and alternate (standby) procedures

c) *Emergency procedures*

— recognition of emergency conditions
— use of appropriate emergency procedures

3.3.1.4 *Skill*

The applicant shall have demonstrated the ability to perform as flight engineer of an aircraft, the duties and procedures described in 3.3.1.3.2 with a degree of competency appropriate to the privileges granted to the holder of a flight engineer licence, and to:

a) use aircraft systems within the aircraft's capabilities and limitations;

b) exercise good judgement and airmanship;

c) apply aeronautical knowledge;

d) perform all the duties as part of an integrated crew with the successful outcome never in doubt; and

e) communicate effectively with the other flight crew members.

3.3.1.4.1 The use of a synthetic flight trainer for performing any of the procedures required during the demonstration of skill described in 3.3.1.4 shall be approved by the Licensing Authority, which shall ensure that the synthetic flight trainer is appropriate to the task.

3.3.1.5 *Medical fitness*

The applicant shall hold a current Class 1 Medical Assessment.

3.3.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

3.3.2.1 Subject to compliance with the requirements specified in 1.2.5 and 1.2.6, the privileges of the holder of a flight engineer licence shall be to act as flight engineer of any type of aircraft on which the holder has demonstrated a level of knowledge and skill, as determined by the Licensing Authority on the basis of those requirements specified in 3.3.1.2 and 3.3.1.4 which are applicable to the safe operation of that type of aircraft.

3.3.2.2 The types of aircraft on which the holder of a flight engineer licence is authorized to exercise the privileges of that licence, shall be either entered on the licence or recorded elsewhere in a manner acceptable to the Licensing Authority.

3.4 Flight radiotelephone operator

Note 1.— Where the knowledge and skill of an applicant have been established as satisfactory in respect of the certification requirements for the radiotelephone operator's restricted certificate specified in the general radio regulations annexed to the International Telecommunication Convention and the applicant has met the requirements that are pertinent to the operation of the radiotelephone on board an aircraft, a Contracting State may endorse a licence already held by the applicant (as provided for in 5.1.1 XIII) or issue a separate licence as appropriate.

Note 2.— Skill and knowledge requirements on radiotelephony procedures and phraseology have been developed as an integral part of all pilot aeroplane and helicopter licences.

CHAPTER 4. LICENCES AND RATINGS FOR PERSONNEL OTHER THAN FLIGHT CREW MEMBERS

4.1 General rules concerning licences and ratings for personnel other than flight crew members

4.1.1 An applicant shall, before being issued with any licence or rating for personnel other than flight crew members, meet such requirements in respect of age, knowledge, experience and where appropriate, medical fitness and skill, as are specified for that licence or rating.

4.1.2 An applicant, for any licence or rating for personnel other than flight crew members, shall demonstrate, in a manner determined by the Licensing Authority, such requirements in respect of knowledge and skill as are specified for that licence or rating.

4.2 Aircraft maintenance (technician/engineer/mechanic) Type II

Note 1.— The terms in brackets are given as acceptable additions to the title of the licence. Each Contracting State is expected to use in its own regulations the one it prefers.

Note 2.— The following specifications allow for the issue of an aircraft maintenance Type II licence, granting privileges with respect to the maintenance of aircraft in their entirety or restricted to such parts of the aircraft as are entered in the licence.

4.2.1 Requirements for the issue of the licence

4.2.1.1 *Age*

The applicant shall be not less than 18 years of age.

4.2.1.2 *Knowledge*

The applicant shall satisfy the Licensing Authority as to knowledge of:

a) the regulations pertinent to the duties of an aircraft maintenance Type II licence holder; and

b) the assembly, functioning, inspection, servicing, maintenance and principles of construction of whichever of the following are appropriate to the privileges to be granted:

1) aircraft in their entirety;

2) airframes;

3) aircraft powerplants including their accessories;

4) aircraft systems including their components;

5) aircraft instruments; and

6) aircraft avionics.

4.2.1.3 *Experience*

The applicant shall have had the following experience in the inspection, servicing and maintenance of aircraft or its components:

a) for the issue of a licence with privileges for signing a Maintenance Release (Certificate of Safety for Flight), at least:

1) three years; or

2) two years if the applicant has satisfactorily completed an approved training course which will provide an equivalent level of practical experience; and

b) for the issue of a licence with privileges restricted in accordance with 4.2.2.2 b) or c), a period of time that will enable a level of competency equivalent to that required in a) to be attained, provided that this is not less than:

1) two years; or

2) such a period as the State considers necessary to provide an equivalent level of practical experience to applicants who have satisfactorily completed an approved training course.

4.2.1.4 *Skill*

The applicant shall have demonstrated the ability to perform those functions applicable to the privileges to be granted.

4.2.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

4.2.2.1 Subject to compliance with the requirements specified in 4.2.2.2, the privileges of the holder of an aircraft maintenance Type II licence shall be:

a) for a licence conferring privileges with respect to aircraft in their entirety:

— to certify the aircraft as airworthy after a minor repair, authorized minor modification or installation of a previously approved powerplant, accessory, instrument, and/or item of equipment, and to sign a Maintenance Release (Certificate of Safety for Flight) following inspection, maintenance operations and/or routine servicing; and

b) for a licence conferring privileges restricted in accordance with 4.2.2.2 b) or c):

— to certify as airworthy such parts of aircraft as are entered on the licence, after an inspection, a minor repair or authorized minor modification.

4.2.2.2 The privileges of the holder of an aircraft maintenance Type II licence specified in 4.2.2.1 shall be exercised only:

a) in respect of such aircraft as are entered on the licence in their entirety either specifically or under broad categories; or

b) in respect of such airframes and powerplants and aircraft systems or components as are entered on the licence either specifically or under broad categories; and/or

c) in respect of such aircraft avionic systems or components as are entered on the licence either specifically or under broad categories;

d) provided that the holder has become familiar with all pertinent and current information relating to the maintenance and airworthiness of the particular type of aircraft for which the holder is signing a Maintenance Release (Certificate of Safety for Flight) or such airframe, powerplant, aircraft component, aircraft system and aircraft avionic system or component which the holder is certifying as being airworthy; and

e) on condition that, within the preceding 24 months, either the holder has exercised the appropriate privileges of the holder of an aircraft maintenance Type II licence for not less than six months, or has satisfied the Licensing Authority of the ability to meet the standards prescribed for the issue of a licence with the appropriate privileges.

4.2.3 Vesting of privileges in an approved maintenance organization

The Standards in 4.2.1 and 4.2.2 apply to the granting of licences to individuals. Where, as an alternative to this method, privileges equivalent to those in 4.2.2.1 are vested in an approved maintenance organization, the Contracting State shall ensure by the requirements it imposes for approval of the organization that an equivalent level of competency is maintained. In such an approved maintenance organization the Contracting State shall ensure that the privilege of signing a maintenance release is restricted to individuals who have knowledge and experience equivalent to that of 4.2.1.2 and 4.2.1.3.

4.3 Aircraft maintenance (technician/engineer/mechanic) Type I

Note 1.— The terms in brackets are given as acceptable additions to the title of the licence. Each Contracting State is expected to use in its own regulations the one it prefers.

Note 2.— The following specifications allow for the issue of an aircraft maintenance Type I licence granting privileges with respect to overhaul, authorized repair or authorized modification of aircraft in their entirety or restricted to such parts of the aircraft as are entered in the licence.

4.3.1 Requirements for the issue of the licence

4.3.1.1 *Age*

The applicant shall be not less than 21 years of age.

4.3.1.2 *Knowledge*

The applicant shall satisfy the Licensing Authority as to knowledge of:

a) the regulations pertinent to the duties of an aircraft maintenance Type I licence holder;

b) the assembly, functioning, inspection, and principles of construction of whichever of the following are appropriate to the privileges to be granted:

1) aircraft in their entirety;

2) airframes;

3) aircraft powerplants including their accessories;

4) aircraft systems including their components;

5) aircraft instruments; and

6) aircraft avionics; and

c) methods and procedures for inspection and approval of the repair, overhaul and functional testing of whichever of the following are appropriate to the privileges to be granted:

1) aircraft in their entirety;

2) airframes;

3) aircraft powerplants including their respective components, accessories, instruments and items of equipment and installation thereof;

4) aircraft systems including their components;

5) aircraft instruments; and

6) aircraft avionics.

4.3.1.3 *Experience*

The applicant shall have had the following experience in the inspection, overhaul, authorized repair and approved modification of aircraft or its parts:

a) for the issue of a licence with privileges for certifying the airworthiness of aircraft, at least:

1) five years; or

2) three years if the applicant has satisfactorily completed an approved training course that will give an equivalent level of practical experience; and

b) for the issue of a licence with privileges restricted in accordance with 4.3.2.2 b), a period of time that will enable a level of competency equivalent to that given in a) to be attained, provided that this is not less than:

1) three years; or

2) such a period as the State considers necessary to give an equivalent level of practical experience to applicants who have satisfactorily completed an approved training course.

Note.— Appropriate experience gained as the holder of a Type II licence may be taken into consideration when satisfying the experience requirements for the issue of a Type I licence.

4.3.1.4 *Skill*

The applicant shall have demonstrated the ability to perform those functions applicable to the privileges to be granted.

4.3.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

4.3.2.1 Subject to compliance with the requirements specified in 4.3.2.2, the privileges of the holder of an aircraft maintenance Type I licence shall be:

a) for a licence conferring privileges with respect to aircraft, in their entirety:

— to certify as airworthy any overhaul, authorized repair or authorized modification of an aircraft, airframe or powerplant including their respective accessories, instruments, items of equipment and aircraft avionics and installation thereof; provided that such overhauls, repairs and/or modifications incorporate the fitment only of approved parts and components; and

b) for a licence conferring privileges restricted in accordance with 4.3.2.2 b):

— to certify as airworthy such parts of aircraft as are entered on the licence, after overhaul, authorized repair or authorized modifications, including the fitment of approved parts and components.

Note.— These privileges do not include the privilege of signing a Maintenance Release (Certificate of Safety for Flight) except as provided in 4.3.3.

4.3.2.2 The privileges of the holder of an aircraft maintenance Type I licence specified in 4.3.2.1 shall be exercised only:

a) in respect of such operations and such aircraft as are entered on the licence in their entirety, either specifically or under broad categories; or

b) in respect of such operations and such airframes, powerplants, aircraft systems or components and aircraft avionics systems or components as are entered on the licence either specifically or under broad categories;

c) provided that the holder has become familiar with all pertinent and current information relating to the airworthiness of the particular type of aircraft, airframe, powerplant, aircraft system or component and aircraft avionics which the holder certifies as airworthy after overhaul, authorized repair, or authorized modification; and

d) on condition that within the preceding 24 months, either the holder has exercised the appropriate privileges of the holder of an aircraft maintenance Type I licence for not less than six months, or has satisfied the Licensing Authority of the ability to meet the standards prescribed for the issue of a licence with the appropriate privileges.

4.3.3 Exercise of joint privileges of Type I and Type II licences

The privileges given in 4.2.2.1 and 4.3.2.1 may be conferred by a single licence in lieu of issuing separate Type I and Type II licences provided that the requirements for the issue of these licences, as specified in 4.2.1 and 4.3.1 have been met. The privileges so granted shall be exercised in accordance with the conditions stated in 4.2.2.2 and 4.3.2.2.

4.3.4 Vesting of privileges in an approved maintenance organization

The Standards in 4.3.1 and 4.3.2 apply to the granting of licences to individuals. Where, as an alternative to this method, privileges equivalent to those in 4.3.2.1 are vested in an approved maintenance organization, the Contracting State shall ensure by the requirements it imposes for approval of the organization that an equivalent level of competency is maintained.

4.4 Air traffic controller licence

4.4.1 Requirements for the issue of the licence

Before issuing an air traffic controller licence, a Contracting State shall require the applicant to meet the requirements of 4.4.1 and the requirements of at least one of the ratings set out in 4.5. Unlicensed State employees may operate as air traffic controllers on condition that they meet the same requirements.

4.4.1.1 *Age*

The applicant shall be not less than 21 years of age.

4.4.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the holder of an air traffic controller licence, in at least the following subjects:

Air law

a) rules and regulations relevant to the air traffic controller;

Air traffic control equipment

b) principles, use and limitations of equipment used in air traffic control;

General knowledge

c) principles of flight; principles of operation and functioning of aircraft, powerplants and systems; aircraft performances relevant to air traffic control operations;

Human performance and limitations

d) human performance and limitations relevant to air traffic control;

Language

e) the language or languages nationally designated for use in air traffic control and ability to speak such language or languages without accent or impediment which would adversely affect radio communication;

Meteorology

f) aeronautical meteorology; use and appreciation of meteorological documentation and information; origin and characteristics of weather phenomena affecting flight operations and safety; altimetry;

Navigation

g) principles of air navigation; principle, limitation and accuracy of navigation systems and visual aids; and

Operational procedures

h) air traffic control, communication, radiotelephony and phraseology procedures (routine, non routine and emergency); use of the relevant aeronautical documentation; safety practices associated with flight.

4.4.1.3 *Experience*

The applicant shall have completed an approved training course and not less than three months' satisfactory service engaged in the actual control of air traffic under the supervision of an appropriately rated air traffic controller. The experience requirements specified for air traffic controller ratings in 4.5 may be credited as part of the experience specified in this paragraph.

4.4.1.4 *Medical fitness*

The applicant shall hold a current Class 3 Medical Assessment.

4.5 Air traffic controller ratings

4.5.1 Categories of air traffic controller ratings

4.5.1.1 Air traffic controller ratings shall comprise the following categories:

a) aerodrome control rating;

b) approach control rating;

c) approach radar control rating;

d) approach precision radar control rating;

e) area control rating; and

f) area radar control rating.

Note.— The World Meteorological Organization has specified requirements for personnel making meteorological observations which apply to air traffic controllers providing such a service.

4.5.2 Requirements for air traffic controller ratings

4.5.2.1 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted, in at least the following subjects in so far as they affect the area of responsibility:

a) *aerodrome control rating:*

1) aerodrome layout; physical characteristics and visual aids;

2) airspace structure;

3) applicable rules, procedures and source of information;

4) air navigation facilities;

5) air traffic control equipment and its use;

6) terrain and prominent landmarks;

7) characteristics of air traffic;

8) weather phenomena; and

9) emergency and search and rescue plans;

b) *approach control and area control ratings:*

1) airspace structure;

2) applicable rules, procedures and source of information:

3) air navigation facilities;

4) air traffic control equipment and its use;

5) terrain and prominent landmarks;

6) characteristics of air traffic and traffic flow;

7) weather phenomena; and

8) emergency and search and rescue plans; and

c) *approach radar, approach precision radar and area radar control ratings:* The applicant shall meet the requirements specified in b) in so far as they affect the area of responsibility, and shall have demonstrated a level of knowledge appropriate to the privileges granted, in at least the following additional subjects:

1) principles, use and limitations of radar, other surveillance systems and associated equipment; and

2) procedures for the provision of approach, precision approach or area radar control services, as appropriate, including procedures to ensure appropriate terrain clearance.

4.5.2.2 *Experience*

4.5.2.2.1 The applicant shall have:

a) satisfactorily completed an approved training course;

b) provided, satisfactorily, under the supervision of an appropriately rated air traffic controller:

1) *aerodrome control rating:* an aerodrome control service, for a period of not less than 90 hours or one month, whichever is greater, at the unit for which the rating is sought;

2) *approach, approach radar, area or area radar control rating:* the control service for which the rating is sought, for a period of not less than 180 hours or three months, whichever is greater, at the unit for which the rating is sought; and

3) *approach precision radar control rating:* not less than 200 precision approaches of which not more than 100 shall have been carried out on a radar simulator approved for that purpose by the Licensing Authority. Not less than 50 of those precision approaches shall have been carried out at the unit and on the equipment for which the rating is sought; and

c) if the privileges of the approach radar control rating include surveillance radar approach duties, the experience shall include not less than 25 plan position indicator (PPI) approaches on the surveillance equipment of the type in use at the unit for which the rating is sought and under the supervision of an appropriately rated approach radar controller.

4.5.2.2.2 The experience specified in 4.5.2.2.1 b) shall have been completed within the 6-month period immediately preceding application.

4.5.2.2.3 When the applicant already holds an air traffic controller rating in another category, or the same rating for another unit, the Licensing Authority shall determine whether the experience requirement of 4.5.2.2 can be reduced, and if so, to what extent.

4.5.2.3 *Skill*

The applicant shall have demonstrated, at a level appropriate to the privileges being granted, the skill, judgement and performance required to provide a safe, orderly and expeditious control service.

4.5.2.4 *Concurrent issuance of two air traffic controller ratings*

When two air traffic controller ratings are sought concurrently, the Licensing Authority shall determine the applicable requirements on the basis of the requirements for each rating. These requirements shall not be less than those of the more demanding rating.

4.5.3 Privileges of the holder of the air traffic controller rating(s) and the conditions to be observed in exercising such privileges

4.5.3.1 Subject to compliance with the requirements specified in 1.2.5 and 1.2.6, the privileges of the holder of an air traffic controller licence endorsed with one or more of the undermentioned ratings shall be:

a) *aerodrome control rating:* to provide or to supervise the provision of aerodrome control service for the aerodrome for which the licence holder is rated;

b) *approach control rating:* to provide or to supervise the provision of approach control service for the aerodrome or aerodromes for which the licence holder is rated, within the airspace or portion thereof, under the jurisdiction of the unit providing approach control service;

c) *approach radar control rating:* to provide and/or supervise the provision of approach control service with the use of radar or other surveillance systems for the aerodrome or aerodromes for which the licence holder is rated, within the airspace or portion thereof, under the jurisdiction of the unit providing approach control service;

 1) subject to compliance with the provisions of 4.5.2.2.1 c), the privileges shall include the provision of surveillance radar approaches;

d) *approach precision radar control rating:* to provide and/ or supervise the provision of precision approach radar service at the aerodrome for which the licence holder is rated;

e) *area control rating:* to provide and/or supervise the provision of area control service within the control area or portion thereof, for which the licence holder is rated; and

f) *area radar control rating:* to provide and/or supervise the provision of area control service with the use of radar, within the control area or portion thereof, for which the licence holder is rated.

4.5.3.2 Before exercising the privileges indicated in 4.5.3.1, the licence holder shall be familiar with all pertinent and current information.

4.5.3.3 A Contracting State having issued an air traffic controller licence shall not permit the holder thereof to carry out instruction in an operational environment unless such holder has received proper authorization from such Contracting State.

4.5.3.4 *Validity of ratings*

A rating shall become invalid when an air traffic controller has ceased to exercise the privileges of the rating for a period determined by the Licensing Authority. That period shall not exceed six months. A rating shall remain invalid until the controller's ability to exercise the privileges of the rating has been re-established.

4.6 Flight operations officer/flight dispatcher licence

4.6.1 Requirements for the issue of the licence

4.6.1.1 *Age*

The applicant shall be not less than 21 years of age.

4.6.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a flight operations officer licence, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a flight operations officer licence; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation of aeroplane powerplants, systems and instruments;

c) operating limitations of aeroplanes and powerplants;

d) minimum equipment list;

Flight performance calculation and planning procedures

e) effects of loading and mass distribution on aircraft performance and flight characteristics; mass and balance calculations;

f) operational flight planning; fuel consumption and endurance calculations; alternate airport selection procedures; en-route cruise control; extended range operation;

g) preparation and filing of air traffic services flight plans;

h) basic principles of computer-assisted planning systems;

Meteorology

i) aeronautical meteorology; the movement of pressure systems; the structure of fronts, and the origin and characteristics of signifiant weather phenomena which affect take-off, en-route and landing conditions;

j) interpretation and application of aeronautical meteorological reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information;

Navigation

k) principles of air navigation with particular reference to instrument flight;

Operational procedures

l) use of aeronautical documentation;

m) operational procedures for the carriage of freight and dangerous goods;

n) procedures relating to aircraft accidents and incidents; emergency flight procedures;

o) procedures relating to unlawful interference and sabotage of aircraft;

Principles of flight

p) principles of flight relating to the appropriate category of aircraft; and

Radiocommunication

q) procedures for communicating with aircraft and relevant ground stations.

4.6.1.3 *Experience*

4.6.1.3.1 The applicant shall have gained the following experience:

a) a total of two years' service in any one or in any combination of the capacities specified in 1) to 3) inclusive, provided that in any combination of experience the period serviced in any capacity shall be at least one year:

1) a flight crew member in air transportation; or

2) a meteorologist in an organization dispatching aircraft in air transportation; or

3) an air traffic controller; or a technical supervisor of flight operations officers or air transportation flight operations systems;

or

b) at least one year as an assistant in the dispatching of air transport;

or

c) have satisfactorily completed a course of approved training.

4.6.1.3.2 The applicant shall have served under the supervision of a flight operations officer for at least 90 working days within the six months immediately preceding the application.

4.6.1.4 *Skill*

The applicant shall have demonstrated the ability to:

a) make an accurate and operationally acceptable weather analysis from a series of daily weather maps and weather reports; provide an operationally valid briefing on weather conditions prevailing in the general neighbourhood of a specific air route; forecast weather trends pertinent to air transportation with particular reference to destination and alternates;

b) determine the optimum flight path for a given segment, and create accurate manual and/or computer generated flight plans; and

c) provide operating supervision and all other assistance to a flight in actual or simulated adverse weather conditions, as appropriate to the duties of the holder of a flight operations officer licence.

4.6.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges

Subject to compliance with the requirements specified in 1.2.5, the privileges of the holder of a flight operations officer licence shall be to serve in that capacity with responsibility for each area for which the applicant meets the requirements specified in Annex 6.

4.7 Aeronautical station operator licence

Note.— This licence is not intended for personnel providing Aerodrome Flight Information Service (AFIS). Guidance on the qualifications to be met by these personnel *can be found in ICAO Circular 211,* Aerodrome Flight Information Service (AFIS).

4.7.1 Requirements for the issue of the licence

4.7.1.1 Before issuing an aeronautical station operator licence, a Contracting State shall require the applicant to meet the requirements of 4.7.1. Unlicensed individuals may operate as aeronautical station operators on the condition that the State from which they operate ensures that they meet the same requirements.

4.7.1.2 *Age*

The applicant shall be not less than 18 years of age.

4.7.1.3 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the holder of an aeronautical station operator, in at least the following subjects:

General knowledge

a) air traffic services provided within the State;

Language

b) the language or languages nationally designated for use in air-ground communications and ability to speak such language or languages without accent or impediment which would adversely affect radio communication;

Operational procedures

c) radiotelephony procedures; phraseology; telecommunication network;

Rules and regulations

d) rules and regulations applicable to the aeronautical station operator; and

Telecommunication equipment

e) principles, use and limitations of telecommunication equipment in an aeronautical station.

4.7.1.4 *Experience*

4.7.1.4.1 The applicant shall have:

a) satisfactorily completed an approved training course within the 12-month period immediately preceding application, and have served satisfactorily under a qualified aeronautical station operator for not less than two months; or

b) satisfactorily served under a qualified aeronautical station operator for not less than six months during the 12-month period immediately preceding application.

4.7.1.5 *Skill*

The applicant shall demonstrate, or have demonstrated, competency in:

a) operating the telecommunication equipment in use; and

b) transmitting and receiving radiotelephony messages with efficiency and accuracy.

4.7.2 Privileges of the aeronautical station operator and the conditions to be observed in exercising such privileges

4.7.2.1 Subject to compliance with the requirements specified in 1.2.5, the privileges of the holder of an aeronautical station operator licence shall be to act as an operator in an aeronautical station. Before exercising the privileges of the licence, the holder shall be familiar with all pertinent and current information regarding the types of equipment and operating procedures used at that aeronautical station.

CHAPTER 5. SPECIFICATIONS FOR PERSONNEL LICENCES

5.1 Personnel licences issued by a Contracting State in accordance with the relevant provisions of this Annex shall conform to the following specifications:

5.1.1 Detail

The following details shall appear on the licence:

I) Name of State (in bold type);

II) Title of licence (in very bold type);

III) Serial number of the licence, in arabic numerals, given by the authority issuing the licence;

IV) Name of holder in full (in roman alphabet also if script of national language is other than roman);

V) Address of holder;

VI) Nationality of holder;

VII) Signature of holder;

VIII) Authority and, where necessary, conditions under which the licence is issued;

IX) Certification concerning validity and authorization for holder to exercise privileges appropriate to licence;

X) Signature of officer issuing the licence and the date of such issue;

XI) Seal or stamp of authority issuing the licence;

XII) Ratings, e.g., category, class, type of aircraft, airframe, aerodrome control, etc.;

XIII) Remarks, i.e., special endorsements relating to limitations and endorsements for privileges;

XIV) Any other details desired by the State issuing the licence.

5.1.2 Material

First quality paper or other suitable material shall be used and the items mentioned in 5.1.1 shown clearly thereon.

5.1.3 Colour

5.1.3.1 Where the same coloured material is used for all licences issued by a Contracting State, that colour shall be white.

5.1.3.2 Where licences issued by a Contracting State carry a distinguishing colour marking, the colours shall be as follows:

a) private pilot — aeroplane	— light brown
b) commercial pilot — aeroplane	— light blue
c) airline transport pilot — aeroplane	— dark green
d) private pilot — helicopter	— light grey
e) commercial pilot — helicopter	— dark grey
f) airline transport pilot — helicopter	— two or more dark grey stripes on white background
g) glider pilot	— pink
h) free balloon pilot	— violet
i) flight navigator	— red
j) flight engineer	— brown
k) aircraft maintenance (technician/engineer/mechanic) Type II	— maroon
l) aircraft maintenance (technician/engineer/mechanic) Type I	— maroon
m) air traffic controller	— yellow
n) flight operations officer	— light green
o) aeronautical station operator	— two or more orange stripes on white background

5.1.4 Language

Licences shall be issued in the national language with a translation of items I), II), VI), IX), XII), XIII) and XIV) as indicated in 5.1.1 in English, French, Russian or Spanish where the national language is other than one of these.

5.1.5 Arrangement of items

Item headings on the licence shall be uniformly numbered in roman numerals as indicated in 5.1.1, so that on any licence the number will, under any arrangement, refer to the same item heading.

Note.— Item headings may be arranged in such order as may best suit the convenience of the Contracting State issuing the licence.

CHAPTER 6. MEDICAL PROVISIONS FOR LICENSING

Note 1.— Guidance material to assist Licensing Authorities and medical examiners is published separately in the current edition of the ICAO Manual of Civil Aviation Medicine *(Doc 8984).*

Note 2.— The Standards and Recommended Practices established in this Chapter cannot, on their own, be sufficiently detailed to cover all possible individual situations. Of necessity many decisions relating to the evaluation of medical fitness must be left to the judgement and discretion of the individual designated medical examiner. The evaluation must, therefore, be based on a medical examination conducted throughout in accordance with the high standards of medical practice. Due regard must be given to the privileges granted by the licence applied for or held by the applicant for the Medical Assessment, and the conditions under which the licence holder is going to exercise those privileges in carrying out assigned duties.

Note 3.— Attention is called to the administrative clause in 1.2.4.8 dealing with accredited medical conclusion.

6.1 Medical Assessments — General

6.1.1 Classes of Medical Assessment

Three classes of Medical Assessment shall be established as follows:

a) Class 1 Medical Assessment;

applies to applicants for, and holders of:

— commercial pilot licences — aeroplane and helicopter
— airline transport pilot licences — aeroplane and helicopter
— flight navigator licences
— flight engineer licences

b) Class 2 Medical Assessment;

applies to applicants for, and holders of:

— private pilot licences — aeroplane and helicopter
— glider pilot licences
— free balloon pilot licences

c) Class 3 Medical Assessment;

applies to applicants for, and holders of:

— air traffic controller licences.

6.1.2 The applicant for a Medical Assessment shall provide the medical examiner with a personally certified statement of medical facts concerning personal, familial and hereditary history. The applicant shall be made aware of the necessity for giving a statement that is as complete and accurate as the applicant's knowledge permits, and any false statement shall be dealt with in accordance with 1.2.4.5.1.

6.1.3 The medical examiner shall report to the Licensing Authority any individual case where, in the examiner's judgement, an applicant's failure to meet any requirement, whether numerical or otherwise, is such that exercise of the privileges of the licence being applied for, or held, is not likely to jeopardize flight safety (1.2.4.8).

6.1.4 The requirements to be met for the renewal of a Medical Assessment are the same as those for the initial assessment except where otherwise specifically stated.

Note.— The intervals between routine medical examinations for the purpose of renewing Medical Assessments are specified in 1.2.5.2.

6.2 Requirements for Medical Assessments

6.2.1 General

An applicant for a Medical Assessment issued in accordance with the terms of 1.2.4.1 shall undergo a medical examination based on the following requirements:

a) physical and mental;

b) visual and colour perception; and

c) hearing.

6.2.2 Physical and mental requirements

An applicant for any class of Medical Assessment shall be required to be free from:

a) any abnormality, congenital or acquired, or

b) any active, latent, acute or chronic disability, or

c) any wound, injury or sequelae from operation,

such as would entail a degree of functional incapacity which is likely to interfere with the safe operation of an aircraft or with the safe performance of duties.

6.2.3 Visual requirements

The methods in use for the measurement of visual acuity are likely to lead to differing evaluations. To achieve uniformity, therefore, Contracting States shall ensure that equivalence in the evaluation of methods be obtained.

6.2.3.1 **Recommendation.—** *The following should be adopted for tests of visual acuity:*

a) For a visual acuity test in a lighted room a test illumination level of approximately 50 lx, normally corresponding to a brightness of 30 cd per square metre should be adopted. The light level of the room should be approximately one-fifth of the test illumination level.

b) For a visual acuity test in a darkened, or semi-darkened room, a test illumination level of approximately 15 lx, normally corresponding to a brightness of 10 cd per square metre should be adopted.

c) Visual acuity should be measured by means of a series of optotypes of Landolt, or similar optotypes, placed at a distance of 6 m from the candidate, or 5 m as appropriate to the method of testing adopted.

6.2.4 Colour perception requirements

Contracting States shall use such methods of examination as will guarantee reliable testing of colour perception.

6.2.4.1 The applicant shall be required to demonstrate the ability to perceive readily those colours the perception of which is necessary for the safe performance of duties.

6.2.4.2 The applicant shall be tested for the ability to correctly identify a series of pseudoisochromatic plates (tables) in daylight or in artificial light of the same colour temperature such as that provided by Illuminant "C" or "D" as specified by the International Commission on Illumination (ICI).

6.2.4.2.1 **Recommendation.—** *An applicant obtaining a satisfactory score as prescribed by the Licensing Authority should be assessed as fit. An applicant failing to obtain a satisfactory score in such a test may nevertheless be assessed as fit provided the applicant is able to readily and correctly identify aviation coloured lights displayed by means of a recognized colour perception lantern.*

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6.2.5 Hearing requirements

Hearing requirements are established in addition to the ear examinations conducted during the medical examination for the physical and mental requirements.

6.2.5.1 The applicant shall be required to be free from any hearing defect which would interfere with the safe performance of duties in exercising the privileges of the licence.

Note 1.— The reference zero for calibration of puretone audiometers used for applying 6.3.4.1 and 6.5.4.1 is that of the International Organization for Standardization (ISO) Recommendation R389, 1964.

Note 2.— The frequency composition of the background noise referred to in 6.3.4.1 a) and 6.5.4.1 a) is defined only to the extent that the frequency range 600 to 4 800 Hz is adequately represented.

Note 3.— In the choice of speech material, aviationtype material is not to be used exclusively for the above tests. Lists of phonetically-balanced words in use by a number of Contracting States have given satisfactory results.

Note 4.— A quiet room for the purposes of testing the hearing requirements is a room in which the intensity of the background noise is less than 50 dB when measured on "slow" response of an "A"-weighted sound level meter.

Note 5.— For the purposes of hearing requirements the sound level of an average conversational voice at point of output ranges from 85 to 95 dB.

6.3 Class 1 Medical Assessment

6.3.1 Assessment issue and renewal

6.3.1.1 An applicant for a commercial pilot licence — aeroplane or helicopter, an airline transport pilot licence — aeroplane or helicopter, a flight engineer licence or a flight navigator licence, shall undergo an initial medical examination for the issue of a Class 1 Medical Assessment.

6.3.1.2 Except where otherwise stated in this section, holders of commercial pilot licences — aeroplane or helicopter, airline transport pilot licences — aeroplane or helicopter, flight engineer licences or flight navigator licences, shall have their Class 1 Medical Assessments renewed at intervals not exceeding those specified in 1.2.5.2.

6.3.1.3 When the Licensing Authority is satisfied that the requirements of this section and the general provisions of 6.1 and 6.2 have been met, a Class 1 Medical Assessment shall be issued to the applicant.

6.3.2 Physical and mental requirements

The medical examination shall be based on the following requirements.

6.3.2.1 The applicant shall not suffer from any disease or disability which could render that applicant likely to become suddenly unable either to operate an aircraft safely or to perform assigned duties safely.

6.3.2.2 The applicant shall have no established medical history or clinical diagnosis of:

a) a psychosis;

b) alcoholism;

c) drug dependence;

d) any personality disorder, particularly if severe enough to have repeatedly resulted in overt acts;

e) a mental abnormality, or neurosis of a significant degree;

such as might render the applicant unable to safely exercise the privileges of the licence applied for or held, unless accredited medical conclusion indicates that in special circumstances, the applicant's failure to meet the requirement is such that exercise of the privileges of the licence applied for is not likely to jeopardize flight safety.

6.3.2.2.1 **Recommendation.—** *The applicant should have no established medical history or clinical diagnosis of any mental abnormality, personality disorder or neurosis which, according to accredited medical conclusion, makes it likely that within two years of the examination the applicant will be unable to safely exercise the privileges of the licence or rating applied for or held.*

Note.— A history of acute toxic psychosis need not be regarded as disqualifying, provided that the applicant has suffered no permanent impairment.

6.3.2.3 The applicant shall have no established medical history or clinical diagnosis of any of the following:

a) a progressive or non-progressive disease of the nervous system, the effects of which, according to accredited medical conclusion, are likely to interfere with the safe exercise of the applicant's licence and rating privileges;

b) epilepsy;

c) any disturbance of consciousness without satisfactory medical explanation of cause.

6.3.2.4 Cases of head injury, the effects of which, according to accredited medical conclusion, are likely to interfere with the safe exercise of the applicant's licence and rating privileges shall be assessed as unfit.

6.3.2.5 The applicant shall not possess any abnormality of the heart, congenital or acquired, which is likely to interfere with the safe exercise of the applicant's licence and rating privileges. A history of proven myocardial infarction shall be disqualifying.

Note.— Such commonly occurring conditions as respiratory arrhythmia, occasional extrasystoles which disappear on exercise, increase of pulse rate from excitement or exercise, or a slow pulse not associated with auriculoventricular dissociation may be regarded as being within "normal" limits.

6.3.2.5.1 Electrocardiography shall form part of the heart examination for the first issue of a licence and shall be included in re-examinations of applicants between the ages of 30 and 40 no less frequently than every two years, and thereafter no less frequently than annually.

Note 1.— The purpose of routine electrocardiography is case finding. It does not provide sufficient evidence to justify disqualification without further thorough cardiovascular investigation.

Note 2.— Guidance on resting and exercise electrocardiography is published in the Manual of Civil Aviation Medicine.

6.3.2.6 The systolic and diastolic blood pressures shall be within normal limits.

Note 1.— The use of drugs for control of high blood pressure is disqualifying except for those drugs, the use of which, according to accredited medical conclusion, is compatible with the safe exercise of the applicant's licence and rating privileges.

Note 2.— Extensive guidance on the subject is published in the Manual of Civil Aviation Medicine.

6.3.2.7 There shall be no significant functional nor structural abnormality of the circulatory tree.

6.3.2.8 There shall be no acute disability of the lungs nor any active disease of the structures of the lungs, mediastinum or pleura. Radiography shall form a part of the medical examination in all doubtful clinical cases.

6.3.2.8.1 **Recommendation.—** *Radiography should form a part of the initial chest examination and should be repeated periodically thereafter.*

6.3.2.9 Any extensive mutilation of the chest wall with collapse of the thoracic cage and sequelae of surgical procedures resulting in decreased respiratory efficiency at altitude shall be assessed as unfit.

6.3.2.10 **Recommendation.—** *Cases of pulmonary emphysema should be assessed as unfit if the condition is causing symptoms.*

6.3.2.11 Cases of active pulmonary tuberculosis, duly diagnosed, shall be assessed as unfit. Cases of quiescent or healed lesions which are known to be tuberculous, or are presumably tuberculous in origin, may be assessed as fit.

Note 1.— Guidance material on assessment of respiratory diseases is published in the Manual of Civil Aviation Medicine.·

Note 2.— Guidance material on hazards of medications is published in the Manual of Civil Aviation Medicine.

6.3.2.12 Cases of disabling disease with important impairment of function of the gastrointestinal tract or its adnexae shall be assessed as unfit.

6.3.2.13 The applicant shall be required to be completely free from those hernias that might give rise to incapacitating symptoms.

6.3.2.14 Any sequelae of disease or surgical intervention on any part of the digestive tract or its adnexae, likely to cause incapacity in flight, in particular any obstructions due to stricture or compression shall be assessed as unfit.

6.3.2.14.1 **Recommendation.—** *An applicant who has undergone a major surgical operation on the biliary passages or the digestive tract or its adnexae, which has involved a total or partial excision or a diversion of any of these organs should be assessed as unfit until such time as the medical authority designated for the purpose by the Contracting State and having access to the details of the operation concerned considers that the effects of the operation are not likely to cause incapacity in the air.*

6.3.2.15 Cases of metabolic, nutritional or endocrine disorders likely to interfere with the safe exercise of the applicant's licence and rating privileges shall be assessed as unfit.

6.3.2.16 Proven cases of diabetes mellitus shown to be satisfactorily controlled without the use of any anti-diabetic drug, may be assessed as fit.

6.3.2.17 Cases of severe and moderate enlargement of the spleen persistently below the costal margin shall be assessed as unfit.

6.3.2.18 Cases of significant localized and generalized enlargement of the lymphatic glands and of diseases of the blood shall be assessed as unfit, except in cases where accredited medical conclusion indicates that the condition is not likely to affect the safe exercise of the applicant's licence and rating privileges.

6.3.2.18.1 **Recommendation.—** *Possession of the sickle cell trait should not be a reason for disqualification unless there is positive medical evidence to the contrary.*

6.3.2.18.2 **Recommendation.—** *Cases in 6.3.2.18 due to a transient condition should be assessed as only temporarily unfit.*

6.3.2.19 Cases presenting any signs of organic disease of the kidney shall be assessed as unfit; those due to a transient condition may be assessed as temporarily unfit. The urine shall contain no abnormal element considered by the medical examiner to be of pathological significance. Cases of affections of the urinary passages and of the genital organs shall be assessed as unfit; those due to a transient condition may be assessed as temporarily unfit.

6.3.2.20 Any sequelae of disease or surgical procedures on the kidneys and the urinary tract likely to cause incapacity, in particular any obstructions due to stricture or compression, shall be assessed as unfit. Compensated nephrectomy without hypertension or uraemia may be assessed as fit.

6.3.2.20.1 **Recommendation.—** *An applicant who has undergone a major surgical operation on the urinary system which has involved a total or partial excision or a diversion of any of its organs should be assessed as unfit until such time as the medical authority designated for the purpose by the Contracting State and having access to the details of the operation concerned considers that the effects of the operation are not likely to cause incapacity in the air.*

6.3.2.21 An applicant for the first issue of a licence who has a personal history of syphilis shall be required to furnish evidence, satisfactory to the medical examiner, that the applicant has undergone adequate treatment.

6.3.2.22 Applicants who have a history of severe menstrual disturbances that have proved unamenable to treatment and that are likely to interfere with the safe exercise of the applicant's licence and rating privileges shall be assessed as unfit.

6.3.2.22.1 **Recommendation.—** *Applicants who have undergone gynaecological operations should be considered individually.*

6.3.2.23 Pregnancy shall be a cause of temporary unfitness.

6.3.2.23.1 **Recommendation.—** *In the absence of significant abnormalities, accredited medical conclusion may indicate fitness during the middle months of pregnancy.*

6.3.2.24 Following confinement or termination of pregnancy, the applicant shall not be permitted to exercise the privileges of her licence until she has undergone re-examination and has been assessed as fit.

6.3.2.25 Any active disease of the bones, joints, muscles or tendons and all serious functional sequelae of congenital or acquired disease shall be assessed as unfit. Functional after-effects of lesion affecting the bones, joints, muscles or tendons and certain anatomical defects compatible with the safe exercise of the applicant's licence and rating privileges may be assessed as fit.

6.3.2.26 **There shall be:**

a) no active pathological process, acute or chronic, of the internal ear or of the middle ear;

b) no unhealed (unclosed) perforation of the tympanic membranes. A single dry perforation need not render the applicant unfit. Licences shall not be issued or renewed in these circumstances unless the appropriate hearing requirements in 6.3.4 are complied with;

c) no permanent obstruction of the Eustachian tubes;

d) no permanent disturbances of the vestibular apparatus. Transient conditions may be assessed as temporarily unfit.

Note.— The details of the hearing requirements are set out in 6.3.4.

6.3.2.27 There shall be free nasal air entry on both sides. There shall be no serious malformation nor serious, acute or chronic affection of the buccal cavity or upper respiratory tract. Cases of speech defects and stuttering shall be assessed as unfit.

6.3.3 Visual requirements

The medical examination shall be based on the following requirements.

6.3.3.1 The function of the eyes and their adnexae shall be normal. There shall be no active pathological condition, acute or chronic, of either eye or adnexae which is likely to interfere with its proper function to an extent that would interfere with the safe exercise of the applicant's licence and rating privileges.

6.3.3.2 The applicant shall be required to have normal fields of vision.

6.3.3.3 The applicant shall be required to have a distant visual acuity of not less than 6/9 (20/30, 0.7) in each eye separately, with or without the use of correcting lenses. Where this standard of visual acuity can be obtained only with correcting lenses, the applicant may be assessed as fit provided that:

a) the applicant possesses a visual acuity without correction in each eye separately, not less than 6/60 (20/200, 0.1) or the refractive error falls within the range of ±3 dioptres (equivalent spherical error);

b) such correcting lenses are worn when exercising the privileges of the licence or rating applied for or held; and

c) a spare set of suitable correcting lenses shall be readily available when exercising the privileges of the applicant's licence.

Note 1.— 6.3.3.3 c) is the subject of Standards in Annex 6, Part I.

Note 2.— An applicant accepted as meeting those provisions of 6.3.3.3 a) which refer to refractive error is deemed to continue to do so unless there is reason to suspect otherwise, in which case refraction is repeated at the discretion of the Licensing Authority. The uncorrected visual acuity is measured and recorded at each re-examination. Conditions which indicate a need to redetermine the refractive error include: a refractive state close to the limit of acceptability, a substantial decrease in the uncorrected visual acuity, and the occurrence of eye disease, eye injury or eye surgery.

6.3.3.4 The applicant shall have the ability to read the N5 chart or its equivalent at a distance selected by that applicant in the range of 30 to 50 cm and the ability to read the N14 chart or its equivalent at a distance of 100 cm. If this requirement is met only by the use of correcting lenses, the applicant may be assessed as fit provided that such lenses are available for immediate use when exercising the privileges of the licence. No more than one pair of correcting lenses shall be used in demonstrating compliance with this visual requirement. Single-vision near correction shall not be acceptable.

Note 1.— N5 and N14 refer to "Times Roman" type-face.

Note 2.— An applicant who needs correction to meet this requirement will require "lookover", bifocal or perhaps trifocal lenses in order to read the instruments and a chart or manual held in the hand, and also to make use of distant vision through the windscreen without removing the lenses. Single-vision near correction (full lenses of one power only, appropriate to reading) significantly reduces distant visual acuity. Whenever there is a requirement to obtain or renew correcting lenses, an applicant is expected to advise the refractionist of reading distances for the visual flight deck tasks relevant to the types of aircraft in which the applicant is likely to function.

6.3.3.4.1 **Recommendation.—** *An applicant should have a near point of accommodation of 30 cm while wearing the correcting lenses, if any, required by 6.3.3.3.*

An applicant who does not meet this provision may nevertheless be assessed as fit if able to produce evidence, satisfactory to the Licensing Authority, of having been fitted with correction for near and intermediate-range vision, or of not requiring such correction at present. Such an applicant should be required to wear the correction needed for near and intermediate-range vision, in addition to any correction required by 6.3.3.3, while exercising the privileges of the licence.

6.3.4 Hearing requirements

The medical examination shall be based on the following requirements.

6.3.4.1 The applicant, tested on a pure-tone audiometer at first issue of licence, not less than once every five years up to the age of 40 years, and thereafter not less than once every three years, shall not have a hearing loss, in either ear separately, of more than 35 dB at any of the frequencies 500, 1 000 or 2 000 Hz, or more than 50 dB at 3 000 Hz. However, an applicant with a hearing loss greater than the above may be declared fit provided that:

a) the applicant has a hearing performance in each ear separately equivalent to that of a normal person, against a background noise that will simulate the masking properties of flight deck noise upon speech and beacon signals; and

b) the applicant has the ability to hear an average conversational voice in a quiet room, using both ears, at a distance of 2 m from the examiner, with the back turned to the examiner.

6.3.4.1.1 Alternatively, other methods providing equivalent results to those specified in 6.3.4.1 shall be used.

6.4 Class 2 Medical Assessment

6.4.1 Assessment issue and renewal

6.4.1.1 An applicant for a private pilot licence — aeroplane or helicopter, a glider pilot licence or a free balloon pilot licence shall undergo an initial medical examination for the issue of a Class 2 Medical Assessment.

6.4.1.2 Except where otherwise stated in this section, holders of private pilot licences — aeroplane or helicopter, glider pilot licences or free balloon pilot licences, shall have their Class 2 Medical Assessments renewed at intervals not exceeding those specified in 1.2.5.2.

6.4.1.3 When the Licensing Authority is satisfied that the requirements of this section and the general provisions of 6.1 and 6.2 have been met, a Class 2 Medical Assessment shall be issued to the applicant.

6.4.2 Physical and mental requirements

The medical examination shall be based on the following requirements.

6.4.2.1 The applicant shall not suffer from any disease or disability which could render that applicant likely to become suddenly unable either to operate an aircraft safely or to perform assigned duties safely.

6.4.2.2 The applicant shall have no established medical history or clinical diagnosis of:

a) a psychosis;

b) alcoholism;

c) drug dependence;

d) any personality disorder, particularly if severe enough to have repeatedly resulted in overt acts;

e) a mental abnormality, or neurosis of a significant degree;

such as might render the applicant unable to safely exercise the privileges of the licence applied for or held, unless accredited medical conclusion indicates that in special circumstances, the applicant's failure to meet the requirement is such that exercise of the privileges of the licence applied for is not likely to jeopardize flight safety.

6.4.2.2.1 **Recommendation.—** *The applicant should have no established medical history or clinical diagnosis of any mental abnormality, personality disorder or neurosis which, according to accredited medical conclusion, makes it likely that within two years of the examination the applicant will be unable to safely exercise the privileges of the licence or rating applied for or held.*

Note.— A history of acute toxic psychosis need not be regarded as disqualifying, provided that the applicant has suffered no permanent impairment.

6.4.2.3 The applicant shall have no established medical history or clinical diagnosis of any of the following:

a) a progressive or non-progressive disease of the nervous system, the effects of which, according to accredited medical conclusion, are likely to interfere with the safe exercise of the applicant's licence and rating privileges;

b) epilepsy;

c) any disturbance of consciousness without satisfactory medical explanation of cause.

6.4.2.4 Cases of head injury, the effects of which, according to accredited medical conclusion, are likely to interfere with the safe exercise of the applicant's licence and rating privileges shall be assessed as unfit.

6.4.2.5 The applicant shall not possess any abnormality of the heart, congenital or acquired, which is likely to interfere with the safe exercise of the applicant's licence and rating privileges. A history of proven myocardial infarction shall be disqualifying.

Note.— Such commonly occurring conditions as respiratory arrhythmia, occasional extrasystoles which disappear on exercise, increase of pulse rate from excitement or exercise, or a slow pulse not associated with auriculoventricular dissociation may be regarded as being within "normal" limits.

6.4.2.5.1 **Recommendation.—** *Electrocardiography should form part of the heart examination for the first issue of a licence, at the first re-examination after the age of 40 and thereafter no less frequently than every five years, and in re-examinations in all doubtful cases.*

Note 1.— The purpose of routine electrocardiography is case finding. It does not provide sufficient evidence to justify disqualification without further thorough cardiovascular investigation.

Note 2.— Guidance on resting and exercise electrocardiography is published in the Manual of Civil Aviation Medicine.

6.4.2.6 The systolic and diastolic blood pressures shall be within normal limits.

Note 1.— The use of drugs for control of high blood pressure is disqualifying except for those drugs, the use of which, according to accredited medical conclusion, is compatible with the safe exercise of the applicant's licence and rating privileges.

Note 2.— Extensive guidance on the subject is published in the Manual of Civil Aviation Medicine.

6.4.2.7 There shall be no significant functional nor structural abnormality of the circulatory tree. The presence of varicosities does not necessarily entail unfitness.

6.4.2.8 There shall be no acute disability of the lungs nor any active disease of the structures of the lungs, mediastinum or pleura. Radiography shall form a part of the medical examination in all doubtful clinical cases.

6.4.2.8.1 **Recommendation.—** *Radiography should form a part of the initial chest examination and should be repeated periodically thereafter.*

6.4.2.9 Any extensive mutilation of the chest wall with collapse of the thoracic cage and sequelae of surgical procedures resulting in decreased respiratory efficiency at altitude shall be assessed as unfit.

6.4.2.10 **Recommendation.—** *Cases of pulmonary emphysema should be assessed as unfit only if the condition is causing symptoms.*

6.4.2.11 Cases of active pulmonary tuberculosis, duly diagnosed, shall be assessed as unfit. Cases of quiescent or healed lesions which are known to be tuberculous, or are presumably tuberculous in origin, may be assessed as fit.

Note 1.— Guidance material on assessment of respiratory diseases is published in the Manual of Civil Aviation Medicine.

Note 2.— Guidance material on hazards of medications is published in the Manual of Civil Aviation Medicine.

6.4.2.12 Cases of disabling disease with important impairment of function of the gastrointestinal tract or its adnexae shall be assessed as unfit.

6.4.2.13 The applicant shall be required to be completely free from those hernias that might give rise to incapacitating symptoms.

6.4.2.14 Any sequelae of disease or surgical intervention on any part of the digestive tract or its adnexae, likely to cause incapacity in flight, in particular any obstructions due to stricture or compression shall be assessed as unfit.

6.4.2.14.1 **Recommendation.—** *An applicant who has undergone a major surgical operation on the biliary passages or the digestive tract or its adnexae, which has involved a total or partial excision or a diversion of any of these organs should be assessed as unfit until such time as the medical authority designated for the purpose by the Contracting State and having access to the details of the operation concerned considers that the effects of the operation are not likely to cause incapacity in the air.*

6.4.2.15 Cases of metabolic, nutritional or endocrine disorders likely to interfere with the safe exercise of the applicant's licence and rating privileges shall be assessed as unfit.

6.4.2.16 Proven cases of diabetes mellitus shown to be satisfactorily controlled without the use of any antidiabetic drug, may be assessed as fit. The use of antidiabetic drugs for the control of diabetes mellitus is disqualifying except for those oral drugs administered under conditions permitting appropriate medical supervision and control and which, according to accredited medical conclusion, are compatible with the safe exercise of the applicant's licence and rating privileges.

6.4.2.17 Cases of significant localized and generalized enlargement of the lymphatic glands and of diseases of the blood shall be assessed as unfit, except in cases where accredited medical conclusion indicates that the condition is not likely to affect the safe exercise of the applicant's licence and rating privileges.

6.4.2.17.1 **Recommendation.—** *Possession of the sickle cell trait should not be a reason for disqualification unless there is positive medical evidence to the contrary.*

6.4.2.17.2 **Recommendation.—** *Cases in 6.4.2.17 due to a transient condition should be assessed as only temporarily unfit.*

6.4.2.18 Cases presenting any signs of organic disease of the kidney shall be assessed as unfit; those due to a transient condition may be assessed as temporarily unfit. The urine shall contain no abnormal element considered by the medical examiner to be of pathological significance. Cases of affections of the urinary passages and of the genital organs shall be assessed as unfit; those due to a transient condition may be assessed as temporarily unfit.

6.4.2.19 Any sequelae of disease or surgical procedures on the kidneys and the urinary tract likely to cause incapacity, in particular any obstructions due to stricture or compression, shall be assessed as unfit. Compensated nephrectomy without hypertension or uraemia may be assessed as fit.

6.4.2.19.1 **Recommendation.—** *An applicant who has undergone a major surgical operation on the urinary system which has involved a total or partial excision or a diversion of any of its organs should be assessed as unfit until such time as the medical authority designated for the purpose by the Contracting State and having access to the details of the operation concerned considers that the effects of the operation are not likely to cause incapacity in the air.*

6.4.2.20 An applicant for the first issue of a licence who has a personal history of syphilis shall be required to furnish evidence, satisfactory to the medical examiner, that the applicant has undergone adequate treatment.

6.4.2.21 Applicants who have a history of severe menstrual disturbances that have proved unamenable to treatment and that are likely to interfere with the safe exercise of the applicant's licence and rating privileges shall be assessed as unfit.

6.4.2.21.1 **Recommendation.—** *Applicants who have undergone gynaecological operations should be considered individually.*

6.4.2.22 Pregnancy shall be a cause of temporary unfitness.

6.4.2.22.1 **Recommendation.—** *In the absence of any significant abnormalities, accredited medical conclusion may indicate fitness during the middle months of pregnancy.*

6.4.2.23 Following confinement or termination of pregnancy, the applicant shall not be permitted to exercise the privileges of her licence until she has undergone re-examination and has been assessed as fit.

6.4.2.24 Any active disease of the bones, joints, muscles or tendons and all serious functional sequelae of congenital or acquired disease shall be assessed as unfit. Certain qualifying functional after-effects of lesion affecting the bones, joints, muscles or tendons and certain anatomical defects compatible with the safe exercise of the applicant's licence and rating privileges may be assessed as fit.

6.4.2.25 There shall be:

a) no active pathological process, acute or chronic, of the internal ear or of the middle ear;

b) no permanent disturbances of the vestibular apparatus. Transient conditions may be assessed as temporarily unfit.

Note.— The details of the hearing requirements are set out in 6.4.4.

6.4.2.26 There shall be no serious malformation nor serious, acute or chronic affection of the buccal cavity or upper respiratory tract.

6.4.3 Visual requirements

The medical examination shall be based on the following requirements.

6.4.3.1 The function of the eyes and their adnexae shall be normal. There shall be no active pathological condition, acute or chronic, of either eye or adnexae which is likely to interfere with its proper function to an extent that would interfere with the safe exercise of the applicant's licence and rating privileges.

6.4.3.2 The applicant shall be required to have normal fields of vision.

6.4.3.3 The applicant shall be required to have a distant visual acuity of not less than 6/12 (20/40, 0.5) in each eye separately, with or without the use of correcting lenses. Where this standard of visual acuity can be obtained only with correcting lenses, the applicant may be assessed as fit provided that:

a) such correcting lenses are worn when exercising the privileges of the licence or rating applied for or held; and

b) a spare set of suitable correcting lenses shall be readily available when exercising the privileges of the applicant's licence.

6.4.3.3.1 **Recommendation.**— *If the visual acuity required by 6.4.3.3 is obtained only by the use of correcting lenses and the uncorrected visual acuity in either eye is less than 6/60 (20/200, 0.1), applicants whose refractive error in each eye falls within the range of ±5 dioptres (equivalent spherical error) may be assessed as fit. Applicants whose refractive error in either eye falls outside the range of ±5 dioptres (equivalent spherical error) may however be accepted as fit according to accredited medical conclusion.*

Note.— An applicant accepted as meeting these provisions is deemed to continue to do so unless there is reason to suspect otherwise, in which case refraction is repeated at the discretion of the Licensing Authority. The uncorrected visual acuity is measured and recorded at each re-examination. Conditions which indicate a need to redetermine the refractive error include: a refractive state close to the limit of acceptability, a substantial decrease in the uncorrected visual acuity, and the occurrence of eye disease, eye injury or eye surgery.

6.4.3.4 The applicant shall have the ability to read the N5 chart or its equivalent at a distance selected by that applicant in the range of 30 to 50 cm. If this requirement is met only by the use of correcting lenses, the applicant may be assessed as fit provided that such lenses are available for immediate use when exercising the privileges of the licence. No more than one pair of correcting lenses shall be used in demonstrating compliance with this visual requirement. Single-vision near correction shall not be acceptable.

Note 1.— Single-vision near correction (full lenses of one power only, appropriate to reading) significantly reduces distant visual acuity.

Note 2.— Whenever there is a requirement to obtain or renew correcting lenses, an applicant is expected to advise the refractionist of the reading distances for the visual flight deck tasks relevant to the types of aircraft in which the applicant is likely to function.

6.4.4 Hearing requirements

The medical examination shall be based on the following requirements.

6.4.4.1 The applicant shall be able to hear an average conversational voice in a quiet room, using both ears, at a distance of 2 m from the examiner, with the back turned to the examiner.

6.5 Class 3 Medical Assessment

6.5.1 Assessment issue and renewal

6.5.1.1 An applicant for an air traffic controller licence shall undergo an initial medical examination for the issue of a Class 3 Medical Assessment.

6.5.1.2 Except where otherwise stated in this section, holders of air traffic controller licences shall have their Class 3 Medical Assessments renewed at intervals not exceeding those specified in 1.2.5.2.

6.5.1.3 When the Licensing Authority is satisfied that the requirements of this section and the general provisions of 6.1 and 6.2 have been met, a Class 3 Medical Assessment shall be issued to the applicant.

6.5.2 Physical and mental requirements

The medical examination shall be based on the following requirements.

6.5.2.1 The applicant shall not suffer from any disease or disability which could render that applicant likely to become suddenly unable to perform duties safely.

6.5.2.2 The applicant shall have no established medical history or clinical diagnosis of:

a) a psychosis;

b) alcoholism;

c) drug dependence;

d) any personality disorder, particularly if severe enough to have repeatedly resulted in overt acts;

e) a mental abnormality, or neurosis of a significant degree;

such as might render the applicant unable to safely exercise the privileges of the licence applied for or held, unless accredited medical conclusion indicates that in special circumstances, the applicant's failure to meet the requirement is such that exercise of the privileges of the licence applied for is not likely to jeopardize flight safety.

6.5.2.2.1 **Recommendation.**— *The applicant should have no established medical history or clinical diagnosis of any mental abnormality, personality disorder or neurosis which, according to accredited medical conclusion, makes it likely that within two years of the examination the applicant will be unable to safely exercise the privileges of the licence or rating applied for or held.*

Note.— A history of acute toxic psychosis need not be regarded as disqualifying, provided that the applicant has suffered no permanent impairment.

6.5.2.3 The applicant shall have no established medical history or clinical diagnosis of any of the following:

a) a progressive or non-progressive disease of the nervous system, the effects of which, according to accredited medical conclusion, are likely to interfere with the safe exercise of the applicant's licence and rating privileges;

b) epilepsy;

c) any disturbance of consciousness without satisfactory medical explanation of cause.

6.5.2.4 Cases of head injury, the effects of which, according to accredited medical conclusion, are likely to interfere with the safe exercise of the applicant's licence privileges shall be assessed as unfit.

6.5.2.5 The applicant shall not possess any abnormality of the heart, congenital or acquired, which is likely to interfere with the safe exercise of the applicant's licence privileges. An applicant indicated by accredited medical conclusion to have made a satisfactory recovery from myocardial infarction may be assessed as fit.

Note.— Such commonly occurring conditions as respiratory arrhythmia, occasional extrasystoles which disappear on exercise, increase of pulse rate from excitement or exercise, or a slow pulse not associated with auriculoventricular dissociation may be regarded as being within "normal" limits.

6.5.2.5.1 **Recommendation.—** *Electrocardiography should form part of the heart examination for the first issue of a licence, at the first re-examination after the age of 40 and thereafter no less frequently than every five years, and in re-examinations in all doubtful cases.*

Note 1.— The purpose of routine electrocardiography is case finding. It does not provide sufficient evidence to justify disqualification without further thorough cardiovascular investigation.

Note 2.— Guidance on resting and exercise electrocardiography is published in the Manual of Civil Aviation Medicine.

6.5.2.6 The systolic and diastolic blood pressures shall be within normal limits.

Note 1.— The use of drugs for control of high blood pressure is disqualifying except for those drugs, the use of which, according to accredited medical conclusion, is compatible with the safe exercise of the applicant's licence privileges.

Note 2.— Extensive guidance on the subject is published in the Manual of Civil Aviation Medicine.

6.5.2.7 There shall be no significant functional nor structural abnormality of the circulatory tree. The presence of varicosities does not necessarily entail unfitness.

6.5.2.8 There shall be no acute disability of the lungs nor any active disease of the structures of the lungs, mediastinum or pleura. Radiography shall form a part of the medical examination in all doubtful clinical cases.

6.5.2.8.1 **Recommendation.—** *Radiography should form a part of the initial chest examination and should be repeated periodically thereafter.*

6.5.2.9 **Recommendation.—** *Cases of pulmonary emphysema should be assessed as unfit only if the condition is causing symptoms.*

6.5.2.10 Cases of active pulmonary tuberculosis, duly diagnosed, shall be assessed as unfit. Cases of quiescent or healed lesions which are known to be tuberculous, or are presumably tuberculous in origin, may be assessed as fit.

Note 1.— Guidance material on assessment of respiratory diseases is published in the Manual of Civil Aviation Medicine.

Note 2.— Guidance material on hazards of medications is published in the Manual of Civil Aviation Medicine.

6.5.2.11 Cases of disabling disease with important impairment of function of the gastrointestinal tract or its adnexae shall be assessed as unfit.

6.5.2.12 The applicant shall be required to be completely free from those hernias that might give rise to incapacitating symptoms.

6.5.2.13 Any sequelae of disease or surgical intervention on any part of the digestive tract or its adnexae, liable to cause incapacity, in particular any obstructions due to stricture or compression shall be assessed as unfit.

6.5.2.14 Cases of metabolic, nutritional or endocrine disorders likely to interfere with the safe exercise of the applicant's licence privileges shall be assessed as unfit.

6.5.2.15 Proven cases of diabetes mellitus shown to be satisfactorily controlled without the use of any anti-diabetic drug, may be assessed as fit. The use of anti-diabetic drugs for the control of diabetes mellitus is disqualifying except for those oral drugs administered under conditions permitting appropriate medical supervision and control and which, according to accredited medical conclusion, are compatible with the safe exercise of the applicant's licence privileges.

6.5.2.16 Cases of significant localized and generalized enlargement of the lymphatic glands and of diseases of the blood shall be assessed as unfit, except in cases where accredited medical conclusion indicates that the condition is not likely to affect the safe exercise of the applicant's licence privileges.

6.5.2.16.1 **Recommendation.**— *Cases in 6.5.2.16 due to a transient condition should be assessed as only temporarily unfit.*

6.5.2.17 Cases presenting any signs of organic disease of the kidney shall be assessed as unfit; those due to a transient condition may be assessed as temporarily unfit. The urine shall contain no abnormal element considered by the medical examiner to be of pathological significance. Cases of affections of the urinary passages and of the genital organs shall be assessed as unfit; those due to a transient condition may be assessed as temporarily unfit.

6.5.2.18 Any sequelae of disease or surgical procedures on the kidneys and the urinary tract liable to cause incapacity, in particular any obstructions due to stricture or compression, shall be assessed as unfit. Compensated nephrectomy without hypertension or uraemia may be assessed as fit.

6.5.2.19 An applicant for the first issue of a licence who has a personal history of syphilis shall be required to furnish evidence, satisfactory to the medical examiner, that the applicant has undergone adequate treatment.

6.5.2.20 Applicants who have a history of severe menstrual disturbances that have proved unamenable to treatment and that are likely to interfere with the safe exercise of the applicant's licence privileges shall be assessed as unfit.

6.5.2.21 Any active disease of the bones, joints, muscles or tendons and all serious functional sequelae of congenital or acquired disease shall be assessed as unfit. Functional after-effects of lesion affecting the bones, joints, muscles or tendons and certain anatomical defects compatible with the safe exercise of the applicant's licence privileges may be assessed as fit.

6.5.2.22 There shall be:

a) no active pathological process, acute or chronic, of the internal ear or of the middle ear;

b) no permanent disturbances of the vestibular apparatus. Transient conditions may be assessed as temporarily unfit.

Note.— The details of the hearing requirements are set out in 6.5.4.

6.5.2.23 There shall be no serious malformation nor serious, acute or chronic affection of the buccal cavity or upper respiratory tract. Cases of speech defects and stuttering shall be assessed as unfit.

6.5.3 Visual requirements

The medical examination shall be based on the following requirements.

6.5.3.1 The function of the eyes and their adnexae shall be normal. There shall be no active pathological condition, acute or chronic, of either eye or adnexae which is likely to interfere with its proper function to an extent that would interfere with the safe exercise of the applicant's licence privileges.

6.5.3.2 The applicant shall be required to have normal fields of vision.

6.5.3.3 The applicant shall be required to have a distant visual acuity of not less than 6/9 (20/30, 0.7) in each eye separately, with or without the use of correcting lenses. Where this standard of visual acuity can be obtained only with correcting lenses, the applicant may be assessed as fit provided that:

a) the applicant possesses a visual acuity without correction in each eye separately, not less than 6/60 (20/200, 0.1) or the refractive error falls within the range of ±3 dioptres (equivalent spherical error);

b) such correcting lenses are worn when exercising the privileges of the licence or rating applied for or held; and

c) a spare set of suitable correcting lenses shall be readily available when exercising the privileges of the applicant's licence.

Note.— An applicant accepted as meeting those provisions of 6.5.3.3. a) which refer to refractive error is deemed to continue to do so unless there is reason to suspect otherwise, in which case refraction is repeated at the discretion of the Licensing Authority. The uncorrected visual acuity is measured and recorded at each re-examination. Conditions which indicate a need to redetermine the refractive error include: a refractive state close to the limit of acceptability, a substantial decrease in the uncorrected visual acuity, and the occurrence of eye disease, eye injury or eye surgery.

6.5.3.4 The applicant shall have the ability to read the N5 chart or its equivalent at a distance selected by that applicant in the range of 30 to 50 cm and the ability to read the N14 chart or its equivalent at a distance of 100 cm. If this requirement is met only by the use of correcting lenses, the applicant may be assessed as fit provided that such lenses are available for immediate use when exercising the privileges of the licence. No more than one pair of correcting lenses shall be used in demonstrating compliance with this visual requirement.

Note 1.— N5 and N14 refer to "Times Roman" type-face.

Note 2.— Single-vision near correction may be acceptable for certain air traffic control duties. However, it should be realized that single-vision near correction (full lenses of one power only, appropriate to reading) significantly reduces distant visual acuity. Whenever there is a requirement to obtain or renew correcting lenses, an applicant is expected to advise the refractionist of reading distances for the air traffic duties the applicant is likely to perform.

6.5.3.4.1 **Recommendation.—** *An applicant should have a near point of accommodation of 30 cm while wearing the correcting lenses, if any, required by 6.5.3.3. An applicant who does not meet this provision may nevertheless be assessed as fit if able to produce evidence, satisfactory to the Licensing Authority, of having been fitted with correction for near and intermediate-range vision, or of not requiring such correction at present. Such an applicant should be required to wear the correction needed for near and intermediate-range vision, in addition to any correction required by 6.5.3.3, while exercising the privileges of the licence.*

6.5.4 Hearing requirements

The medical examination shall be based on the following requirements.

6.5.4.1 The applicant, tested on a pure-tone audiometer at first issue of licence, not less than once every five years up to the age of 40 years, and thereafter not less than once every three years, shall not have a hearing loss, in either ear separately, of more than 35 dB at any of the frequencies 500, 1 000 or 2 000 Hz, or more than 50 dB at 3 000 Hz. However, an applicant with a hearing loss greater than the above may be declared fit provided that:

a) the applicant has a hearing performance in each ear separately equivalent to that of a normal person, against a background noise that will simulate that experienced in a typical air traffic control working environment; and

b) the applicant has the ability to hear an average conversational voice in a quiet room, using both ears, at a distance of 2 m from the examiner, with the back turned to the examiner.

6.5.4.1.1 Alternatively, other methcds providing equivalent results to those specified in 6.5.4.1 shall be used.

ATTACHMENT TO ANNEX 1

Editorial Note: This attachment reproduces in a four-column format the Standards and Recommended Practices contained in 2.3 to 2.10.2 inclusive (pilot licences and instrument ratings for aeroplanes and helicopters). The presentation makes it easier for the reader to compare the provisions of the various levels of licences and the instrument rating within the same category of aircraft.

2.3 Private pilot licence — Aeroplane

Note.— The ICAO Training Manual (Doc 7192), Part B-5, contains guidance material for a course of training for the private pilot licence — aeroplane.

2.3.1 Requirements for the issue of the licence

2.3.1.1 *Age*

The applicant shall be not less than 17 years of age.

2.3.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a private pilot licence — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a private pilot licence — aeroplane; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation of aeroplane powerplants, systems and instruments;

c) operating limitations of aeroplanes and powerplants; relevant operational information from the flight manual or other appropriate document;

2.4 Commercial pilot licence — Aeroplane

Note.— The ICAO Training Manual (Doc 7192), Part B-5, contains guidance material for a course of training for the commercial pilot licence — aeroplane.

2.4.1 Requirements for the issue of the licence

2.4.1.1 *Age*

The applicant shall be not less than 18 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.4.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a commercial pilot licence — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a commercial pilot licence — aeroplane; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation and functioning of aeroplane powerplants, systems and instruments;

c) operating limitations of appropriate aeroplanes and powerplants; relevant operational information from the flight manual or other appropriate document;

2.5 Airline transport pilot licence — Aeroplane

2.5.1 Requirements for the issue of the licence

2.5.1.1 *Age*

The applicant shall be not less than 21 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.5.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an airline transport pilot licence — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of an airline transport pilot licence — aeroplane; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) general characteristics and limitations of electrical, hydraulic, pressurization and other aeroplane systems; flight control systems, including autopilot and stability augmentation;

c) principles of operation, handling procedures and operating limitations of aeroplane powerplants; effects of atmospheric conditions on engine performance; relevant operational information from the flight manual or other appropriate document;

d) operating procedures and limitations of appropriate aeroplanes; effects of atmospheric conditions on aeroplane performance;

2.6 Instrument rating — Aeroplane

Note.— The ICAO Training Manual (Doc 7192), Part B-5, contains guidance material for a course of training for the instrument rating — aeroplane.

2.6.1 Requirements for the issue of the rating

2.6.1.1 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an instrument rating — aeroplane, in at least the following subjects:

Air law

a) rules and regulations relevant to flight under IFR; related air traffic services practices and procedures;

Aircraft general knowledge

b) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of aeroplanes under IFR and in instrument meteorological conditions; use and limitations of autopilot;

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2.3 Private pilot licence — Aeroplane	2.4 Commercial pilot licence — Aeroplane	2.5 Airline transport pilot licence — Aeroplane	2.6 Instrument rating — Aeroplane
	d) use and serviceability checks of equipment and systems of appropriate aeroplanes;	e) use and serviceability checks of equipment and systems of appropriate aeroplanes;	
		f) flight instruments; compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;	c) compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;
	e) maintenance procedures for airframes, systems and powerplants of appropriate aeroplanes;	g) maintenance procedures for airframes, systems and powerplants of appropriate aeroplanes;	
Flight performance and planning	*Flight performance and planning*	*Flight performance and planning*	*Flight performance and planning*
d) effects of loading and mass distribution on flight characteristics; mass and balance calculations;	f) effects of loading and mass distribution on aeroplane handling, flight characteristics and performance; mass and balance calculations;	h) effects of loading and mass distribution on aeroplane handling, flight characteristics and performance; mass and balance calculations;	d) pre-flight preparations and checks appropriate to flight under IFR;
e) use and practical application of take-off, landing and other performance data;	g) use and practical application of take-off, landing and other performance data;	i) use and practical application of take-off, landing and other performance data, including procedures for cruise control;	
f) pre-flight and en-route flight planning appropriate to private operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; position reporting procedures; altimeter setting procedures; operations in areas of high-density traffic;	h) pre-flight and en-route flight planning appropriate to operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;	j) pre-flight and en-route operational flight planning; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;	e) operational flight planning; preparation and filing of air traffic services flight plans under IFR; altimeter setting procedures;
Human performance and limitations	*Human performance and limitations*	*Human performance and limitations*	*Human performance and limitations*
g) human performance and limitations relevant to the private pilot — aeroplane;	i) human performance and limitations relevant to the commercial pilot — aeroplane;	k) human performance and limitations relevant to the airline transport pilot — aeroplane;	f) human performance and limitations relevant to instrument flight in aeroplanes;
Meteorology	*Meteorology*	*Meteorology*	*Meteorology*
h) application of elementary aeronautical meteorology; use of, and procedures for obtaining, meteorological information; altimetry;	j) interpretation and application of aeronautical meteorological reports, charts and forecasts; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;	l) interpretation and application of aeronautical meteorological reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;	g) application of aeronautical meteorology; interpretation and use of reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information; altimetry;
	k) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems, the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions; hazardous weather avoidance;	m) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems; the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions;	

		n) causes, recognition and effects of engine and airframe icing; frontal zone penetration procedures; hazardous weather avoidance;	h) causes, recognition and effects of engine and airframe icing; frontal zone penetration procedures; hazardous weather avoidance;
		o) practical high altitude meteorology, including interpretation and use of weather reports, charts and forecasts; jetstreams;	
Navigation	*Navigation*	*Navigation*	*Navigation*
i) practical aspects of air navigation and dead-reckoning techniques; use of aeronautical charts;	l) air navigation, including the use of aeronautical charts, instruments and navigation aids; an understanding of the principles and characteristics of appropriate navigation systems; operation of airborne equipment;	p) air navigation, including the use of aeronautical charts, radio navigation aids and area navigation systems; specific navigation requirements for long-range flights;	i) practical air navigation using radio navigation aids;
		q) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of aeroplanes;	
		r) use, accuracy and reliability of navigation systems used in departure, en-route, approach and landing phases of flight; identification of radio navigation aids;	j) use, accuracy and reliability of navigation systems used in departure, en-route, approach and landing phases of flight; identification of radio navigation aids;
		s) principles and characteristics of self-contained and external-referenced navigation systems; operation of airborne equipment;	
Operational procedures	*Operational procedures*	*Operational procedures*	*Operational procedures*
j) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;	m) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;	t) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations, and instrument procedure charts for departure, en-route, descent and approach;	k) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations, and instrument procedure charts for departure, en-route, descent and approach;
k) appropriate precautionary and emergency procedures, including action to be taken to avoid hazardous weather, wake turbulence and other operating hazards;	n) appropriate precautionary and emergency procedures;	u) precautionary and emergency procedures; safety practices associated with flight under IFR;	l) precautionary and emergency procedures; safety practices associated with flight under IFR;
	o) operational procedures for carriage of freight; potential hazards associated with dangerous goods;	v) operational procedures for carriage of freight and dangerous goods;	
	p) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from aeroplanes;	w) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from aeroplanes;	

Private pilot licence — Aeroplane (cont.)	Commercial pilot licence — Aeroplane (cont.)	Airline transport pilot licence — Aeroplane (cont.)	Instrument rating — Aeroplane (cont.)
Principles of flight	*Principles of flight*	*Principles of flight*	
l) principles of flight relating to aeroplanes;	q) principles of flight relating to aeroplanes;	x) principles of flight relating to aeroplanes; sub-sonic aerodynamics; compressibility effects, manoeuvre boundary limits, wing design characteristics, effects of supplementary lift and drag devices; relationships between lift, drag and thrust at various airspeeds and in different flight configurations;	
Radiotelephony	*Radiotelephony*	*Radiotelephony*	*Radiotelephony*
m) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.	r) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.	y) radiotelephony procedures and phraseology; action to be taken in case of communication failure.	m) radiotelephony procedures and phraseology as applied to aircraft operations under IFR; action to be taken in case of communication failure.
2.3.1.3 *Experience*	2.4.1.3 *Experience*	2.5.1.3 *Experience*	2.6.1.2 *Experience*
2.3.1.3.1 The applicant shall have completed not less than 40 hours of flight time as a pilot of aeroplanes. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 40 hours. Credit for such experience shall be limited to a maximum of 5 hours.	2.4.1.3.1 The applicant shall have completed not less than 200 hours of flight time, or 150 hours if completed during a course of approved training, as a pilot of aeroplanes. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 200 hours or 150 hours, as the case may be. Credit for such experience shall be limited to a maximum of 10 hours.	2.5.1.3.1 The applicant shall have completed not less than 1 500 hours of flight time as a pilot of aeroplanes. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 1 500 hours. Credit for such experience shall be limited to a maximum of 100 hours, of which not more than 25 hours shall have been acquired in a flight procedure trainer or a basic instrument flight trainer.	2.6.1.2.1 The applicant shall hold a private or commercial pilot licence — aeroplane.
2.3.1.3.1.1 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.3.1.3.1 can be reduced accordingly.			
2.3.1.3.2 The applicant shall have completed in aeroplanes not less than 10 hours of solo flight time under the supervision of an authorized flight instructor, including 5 hours of solo cross-country flight time with at least one cross-country flight totalling not less than 270 km (150 NM) in the course of which full-stop landings at two different aerodromes shall be made.	2.4.1.3.1.1 The applicant shall have completed in aeroplanes not less than: a) 100 hours as pilot-in-command or, in the case of a course of approved training, 70 hours as pilot-in-command;	2.5.1.3.1.1 The applicant shall have completed in aeroplanes not less than: a) 250 hours, either as pilot-in-command, or made up by not less than 100 hours as pilot-in-command and the necessary additional flight time as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;	2.6.1.2.2 The applicant shall have completed not less than:

2.3.1.4 *Flight instruction*

2.3.1.4.1 The applicant shall have received dual instruction in aeroplanes from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the private pilot:

a) pre-flight operations, including mass and balance determination, aeroplane inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the aeroplane by external visual reference;

b) 20 hours of cross-country flight time as pilot-in-command including a cross-country flight totalling not less than 540 km (300 NM) in the course of which full-stop landings at two different aerodromes shall be made;

c) 10 hours of instrument instruction time of which not more than 5 hours may be instrument ground time; and

d) if the privileges of the licence are to be exercised at night, 5 hours of night flight time including 5 take-offs and 5 landings as pilot-in-command.

2.4.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.4.1.3.1 can be reduced accordingly.

2.4.1.4 *Flight instruction*

2.4.1.4.1 The applicant shall have received dual instruction in aeroplanes from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the commercial pilot:

a) pre-flight operations, including mass and balance determination, aeroplane inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the aeroplane by external visual reference;

b) 200 hours of cross-country flight time, of which not less than 100 hours shall be as pilot-in-command or as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;

c) 75 hours of instrument time, of which not more than 30 hours may be instrument ground time; and

d) 100 hours of night flight as pilot-in-command or as co-pilot.

2.5.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.5.1.3.1 can be reduced accordingly.

2.5.1.4 *Flight instruction*

The applicant shall have received the dual flight instruction required for the issue of the commercial pilot licence — aeroplane (2.4.1.4) and for the issue of the instrument rating — aeroplane (2.6.1.3).

a) 50 hours of cross-country flight time as pilot-in-command of aircraft in categories acceptable to the Licensing Authority, of which not less than 10 hours shall be in aeroplanes; and

b) 40 hours of instrument time in aeroplanes or helicopters of which not more than 20 hours, or 30 hours where a flight simulator is used, may be instrument ground time. The ground time shall be under the supervision of an authorized instructor.

2.6.1.3 *Flight instruction*

2.6.1.3.1 The applicant shall have gained not less than 10 hours of the instrument flight time required in 2.6.1.2.2 b) while receiving dual instrument flight instruction in aeroplanes from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the holder of an instrument rating:

a) pre-flight procedures, including the use of the flight manual or equivalent document, and appropriate air traffic services documents in the preparation of an IFR flight plan;

b) pre-flight inspection, use of checklists, taxiing and pre-take-off checks;

c) procedures and manoeuvres for IFR operation under normal, abnormal and emergency conditions covering at least:

Private pilot licence — Aeroplane (cont.)

d) flight at critically slow airspeeds; recognition of, and recovery from, incipient and full stalls;

e) flight at critically high airspeeds; recognition of, and recovery from, spiral dives;

f) normal and cross-wind take-offs and landings;

g) maximum performance (short field and obstacle clearance) take-offs; short-field landings;

h) flight by reference solely to instruments, including the completion of a level 180° turn;

i) cross-country flying using visual reference, dead-reckoning and, where available, radio navigation aids;

j) emergency operations, including simulated aeroplane equipment malfunctions; and

k) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

2.3.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in aeroplanes in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.3.1.4.1 h) and the night flying experience specified in 2.3.1.4.2 do not entitle the holder of a private pilot licence — aeroplane to pilot aeroplanes under IFR.

2.3.1.5 *Skill*

Commercial pilot licence — Aeroplane (cont.)

d) flight at critically slow airspeeds; spin avoidance; recognition of, and recovery from, incipient and full stalls;

e) flight at critically high airspeeds; recognition of, and recovery from, spiral dives;

f) normal and cross-wind take-offs and landings;

g) maximum performance (short field and obstacle clearance) take-offs; short-field landings;

h) basic flight manoeuvres and recovery from unusual attitudes by reference solely to basic flight instruments;

i) cross-country flying using visual reference, dead-reckoning and radio navigation aids; diversion procedures;

j) abnormal and emergency procedures and manoeuvres; and

k) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

2.4.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in aeroplanes in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.4.1.3.1.1 c) and 2.4.1.4.1 h) and the night flying experience specified in 2.4.1.3.1.1 d) and 2.4.1.4.2 do not entitle the holder of a commercial pilot licence — aeroplane to pilot aeroplanes under IFR.

2.4.1.5 *Skill*

Airline transport pilot licence — Aeroplane (cont.)

2.5.1.5 *Skill*

2.5.1.5.1 The applicant shall have demonstrated the ability to perform, as pilot-in-command of a multi-engined aeroplane required to be operated with a co-pilot, the following procedures and manoeuvres:

a) pre-flight procedures, including the preparation of the operational flight plan and filing of the air traffic services flight plan;

Instrument rating — Aeroplane (cont.)

— transition to instrument flight on take-off

— standard instrument departures and arrivals

— en-route IFR procedures

— holding procedures

— instrument approaches to specified minima

— missed approach procedures

— landings from instrument approaches

d) in-flight manoeuvres and particular flight characteristics.

2.6.1.3.2 If the privileges of the instrument rating are to be exercised on multi-engined aeroplanes, the applicant shall have received dual instrument flight instruction in such an aeroplane from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in the operation of the aeroplane solely by reference to instruments with one engine inoperative or simulated inoperative.

2.6.1.4 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of an aeroplane, the procedures and manoeuvres described in 2.3.1.4 with a degree of competency appropriate to the privileges granted to the holder of a private pilot licence — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

The applicant shall have demonstrated the ability to perform as pilot-in-command of an aeroplane, the procedures and manoeuvres described in 2.4.1.4 with a degree of competency appropriate to the privileges granted to the holder of a commercial pilot licence — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

b) normal flight procedures and manoeuvres during all phases of flight;

c) procedures and manoeuvres for IFR operations under normal, abnormal and emergency conditions, including simulated engine failure, and covering at least the following:

— transition to instrument flight on take-off

— standard instrument departures and arrivals

— en-route IFR procedures and navigation

— holding procedures

— instrument approaches to specified minima

— missed approach procedures

— landings from instrument approaches

d) abnormal and emergency procedures and manoeuvres related to failures and malfunctions of equipment, such as powerplant, systems and airframe; and

e) procedures for crew incapacitation and crew co-ordination, including allocation of pilot tasks, crew co-operation and use of checklists.

2.5.1.5.1.1 The applicant shall have demonstrated the ability to perform the procedures and manoeuvres described in 2.5.1.5.1 with a degree of competency appropriate to the privileges granted to the holder of an airline transport pilot licence — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge;

2.6.1.4.1 The applicant shall have demonstrated the ability to perform the procedures and manoeuvres described in 2.6.1.3.1 with a degree of competency appropriate to the privileges granted to the holder of an instrument rating — aeroplane, and to:

a) operate the aeroplane within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

Private pilot licence — Aeroplane (cont.)	Commercial pilot licence — Aeroplane (cont.)	Airline transport pilot licence — Aeroplane (cont.)	Instrument rating — Aeroplane (cont.)
e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.	e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.	e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never in doubt; f) understand and apply crew co-ordination and incapacitation procedures; and g) communicate effectively with the other flight crew members.	e) maintain control of the aeroplane at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.
			2.6.1.4.1.1 The applicant shall have demonstrated the ability to operate multi-engined aeroplanes solely by reference to instruments with one engine inoperative, or simulated inoperative, if the privileges of the instrument rating are to be exercised on such aeroplanes. *Note.— Attention is called to 2.1.6 on the use of synthetic flight trainers for demonstrations of skill.*
2.3.1.6 *Medical fitness* The applicant shall hold a current Class 2 Medical Assessment. *Note.— Attention is called to 2.6.1.5 on the medical fitness requirements for private pilot licence holders seeking an instrument rating.*	2.4.1.6 *Medical fitness* The applicant shall hold a current Class 1 Medical Assessment.	2.5.1.6 *Medical fitness* The applicant shall hold a current Class 1 Medical Assessment.	2.6.1.5 *Medical fitness* 2.6.1.5.1 Applicants who hold a private pilot licence shall have established their hearing acuity on the basis of compliance with the hearing requirements for the issue of a Class 1 Medical Assessment. 2.6.1.5.2 **Recommendation.**— *Contracting States should consider requiring the holder of a private pilot licence to comply with the physical and mental, and visual requirements for the issue of a Class 1 Medical Assessment.*
2.3.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges 2.3.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a private pilot licence — aeroplane shall be to act, but not for remuneration, as pilot-in-command or co-pilot of any aeroplane engaged in non-revenue flights.	2.4.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges 2.4.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a commercial pilot licence — aeroplane shall be: a) to exercise all the privileges of the holder of a private pilot licence — aeroplane; b) to act as pilot-in-command in any aeroplane engaged in operations other than commercial air transportation;	2.5.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an airline transport pilot licence — aeroplane shall be: a) to exercise all the privileges of the holder of a private and commercial pilot licence — aeroplane and of an instrument rating — aeroplane; and b) to act as pilot-in-command and co-pilot in aeroplanes in air transportation.	2.6.2 Privileges of the holder of the rating and the conditions to be observed in exercising such privileges 2.6.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an instrument rating — aeroplane shall be to pilot aeroplanes under IFR. 2.6.2.2 Before exercising the privileges on multi-engined aeroplanes, the holder of the rating shall have complied with the requirements of 2.6.1.4.1.1. *Note.— Attention is called to 2.10.3 on the exercise of joint privileges of the*

2.3.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.3.1.4.2.

2.7 Private pilot licence — Helicopter

2.7.1 Requirements for the issue of the licence

2.7.1.1 *Age*

The applicant shall be not less than 17 years of age.

2.7.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a private pilot licence — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a private pilot licence — helicopter; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation of helicopter powerplants, transmission (power-trains), systems and instruments;

c) to act as pilot-in-command in commercial air transportation in any aeroplane certificated for single-pilot operation; and

d) to act as co-pilot in commercial air transportation in aeroplanes required to be operated with a co-pilot.

2.4.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.4.1.3.1.1 d) and 2.4.1.4.2.

2.8 Commercial pilot licence — Helicopter

2.8.1 Requirements for the issue of the licence

2.8.1.1 *Age*

The applicant shall be not less than 18 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.8.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of a commercial pilot licence — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of a commercial pilot licence — helicopter; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) principles of operation and functioning of helicopter powerplants, transmission (power-trains), systems and instruments;

2.9 Airline transport pilot licence — Helicopter

2.9.1 Requirements for the issue of the licence

2.9.1.1 *Age*

The applicant shall be not less than 21 years of age.

Note.— Certain privileges of the licence are curtailed by 2.1.10 for licence holders who have attained their 60th birthday.

2.9.1.2 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an airline transport pilot licence — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to the holder of an airline transport pilot licence — helicopter; rules of the air; appropriate air traffic services practices and procedures;

Aircraft general knowledge

b) general characteristics and limitations of electrical, hydraulic, and other helicopter systems; flight control systems, including autopilot and stability augmentation;

instrument rating — aeroplane and of the instrument rating — helicopter.

2.10 Instrument rating — Helicopter

2.10.1 Requirements for the issue of the rating

2.10.1.1 *Knowledge*

The applicant shall have demonstrated a level of knowledge appropriate to the privileges granted to the holder of an instrument rating — helicopter, in at least the following subjects:

Air law

a) rules and regulations relevant to flight under IFR; related air traffic services practices and procedures;

Aircraft general knowledge

b) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of helicopters under IFR and in instrument meteorological conditions; use and limitations of autopilot;

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Private pilot licence — Aeroplane (cont.)	Commercial pilot licence — Aeroplane (cont.)	Airline transport pilot licence — Aeroplane (cont.)	Instrument rating — Aeroplane (cont.)
c) operating limitations of helicopters and powerplants; relevant operational information from the flight manual;	c) operating limitations of appropriate helicopters and powerplants; relevant operational information from the flight manual;	c) principles of operation, handling procedures and operating limitations of helicopter powerplants; transmission (power-trains); effects of atmospheric conditions on engine performance; relevant operational information from the flight manual;	
		d) operating procedures and limitations of appropriate helicopters; effects of atmospheric conditions on helicopter performance; relevant operational information from the flight manual;	
	d) use and serviceability checks of equipment and systems of appropriate helicopters;	e) use and serviceability checks of equipment and systems of appropriate helicopters;	
		f) flight instruments; compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;	c) compasses, turning and acceleration errors; gyroscopic instruments, operational limits and precession effects; practices and procedures in the event of malfunctions of various flight instruments;
	e) maintenance procedures for airframes, systems and powerplants of appropriate helicopters;	g) maintenance procedures for airframes, systems and powerplants of appropriate helicopters;	
Flight performance and planning	*Flight performance and planning*	*Flight performance and planning*	*Flight performance and planning*
d) effects of loading and mass distribution on flight characteristics; mass and balance calculations;	f) effects of loading and mass distribution, including external loads, on helicopter handling, flight characteristics and performance; mass and balance calculations;	h) effects of loading and mass distribution, including external loads, on helicopter handling, flight characteristics and performance; mass and balance calculations;	
e) use and practical application of take-off, landing and other performance data;	g) use and practical application of take-off, landing and other performance data;	i) use and practical application of take-off, landing and other performance data, including procedures for cruise control;	d) pre-flight preparations and checks appropriate to flight under IFR;
f) pre-flight and en-route flight planning appropriate to private operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; position reporting procedures; altimeter setting procedures; operations in areas of high-density traffic;	h) pre-flight and en-route flight planning appropriate to operations under VFR; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;	j) pre-flight and en-route operational flight planning; preparation and filing of air traffic services flight plans; appropriate air traffic services procedures; altimeter setting procedures;	e) operational flight planning; preparation and filing of air traffic services flight plans under IFR; altimeter setting procedures;
Human performance and limitations	*Human performance and limitations*	*Human performance and limitations*	*Human performance and limitations*
g) human performance and limitations relevant to the private pilot — helicopter;	i) human performance and limitations relevant to the commercial pilot — helicopter;	k) human performance and limitations relevant to the airline transport pilot — helicopter;	f) human performance and limitations relevant to instrument flight in helicopters;

Meteorology	*Meteorology*	*Meteorology*	*Meteorology*
h) application of elementary aeronautical meteorology; use of, and procedures for obtaining, meteorological information; altimetry;	j) interpretation and application of aeronautical meteorological reports, charts and forecasts; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;	l) interpretation and application of aeronautical meteorological reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information, pre-flight and in-flight; altimetry;	g) application of aeronautical meteorology; interpretation and use of reports, charts and forecasts; codes and abbreviations; use of, and procedures for obtaining, meteorological information; altimetry;
	k) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems, the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions; hazardous weather avoidance;	m) aeronautical meteorology; climatology of relevant areas in respect of the elements having an effect upon aviation; the movement of pressure systems, the structure of fronts, and the origin and characteristics of significant weather phenomena which affect take-off, en-route and landing conditions;	
		n) causes, recognition and effects of engine, airframe and rotor icing; hazardous weather avoidance;	h) causes, recognition and effects of engine, airframe and rotor icing; frontal zone penetration procedures; hazardous weather avoidance;
Navigation	*Navigation*	*Navigation*	*Navigation*
i) practical aspects of air navigation and dead-reckoning techniques; use of aeronautical charts;	l) air navigation, including the use of aeronautical charts, instruments and navigation aids; an understanding of the principles and characteristics of appropriate navigation systems; operation of airborne equipment;	o) air navigation, including the use of aeronautical charts, radio navigation aids and area navigation systems; specific navigation requirements for long-range flights;	i) practical air navigation using radio navigation aids;
		p) use, limitation and serviceability of avionics and instruments necessary for the control and navigation of helicopters;	
		q) use, accuracy and reliability of navigation systems; identification of radio navigation aids;	j) use, accuracy and reliability of navigation systems used in departure, en-route, approach and landing phases of flight; identification of radio navigation aids;
		r) principles and characteristics of self-contained and external-referenced navigation systems; operation of airborne equipment;	
Operational procedures	*Operational procedures*	*Operational procedures*	*Operational procedures*
j) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;	m) use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;	s) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations;	k) interpretation and use of aeronautical documentation such as AIP, NOTAM, aeronautical codes and abbreviations, and instrument procedure charts for departure, en – route, descent and approach;

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Private pilot licence — Helicopter (cont.)	Commercial pilot licence — Helicopter (cont.)	Airline transport pilot licence — Helicopter (cont.)	Instrument rating — Helicopter (cont.)
k) appropriate precautionary and emergency procedures, including action to be taken to avoid hazardous weather and wake turbulence; settling with power, ground resonance, roll-over and other operating hazards;	n) appropriate precautionary and emergency procedures; settling with power, ground resonance, roll-over and other operating hazards;	t) precautionary and emergency procedures; settling with power, ground resonance, retreating blade stall, dynamic roll-over and other operating hazards; safety practices associated with flight under VFR;	l) precautionary and emergency procedures; safety practices associated with flight under IFR;
	o) operational procedures for carriage of freight, including external loads; potential hazards associated with dangerous goods;	u) operational procedures for carriage of freight, including external loads, and dangerous goods;	
	p) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from helicopters;	v) requirements and practices for safety briefing to passengers, including precautions to be observed when embarking and disembarking from helicopters;	
Principles of flight	*Principles of flight*	*Principles of flight*	
l) principles of flight relating to helicopters;	q) principles of flight relating to helicopters;	w) principles of flight relating to helicopters;	
Radiotelephony	*Radiotelephony*	*Radiotelephony*	*Radiotelephony*
m) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.	r) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.	x) radiotelephony procedures and phraseology as applied to VFR operations; action to be taken in case of communication failure.	m) radiotelephony procedures and phraseology as applied to aircraft operations under IFR; action to be taken in case of communication failure.
2.7.1.3 *Experience*	2.8.1.3 *Experience*	2.9.1.3 *Experience*	2.10.1.2 *Experience*
2.7.1.3.1 The applicant shall have completed not less than 40 hours of flight time as a pilot of helicopters. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 40 hours. Credit for such experience shall be limited to a maximum of 5 hours.	2.8.1.3.1 The applicant shall have completed not less than 150 hours of flight time, or 100 hours if completed during a course of approved training, as a pilot of helicopters. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 150 hours or 100 hours, as the case may be. Credit for such experience shall be limited to a maximum of 10 hours.	2.9.1.3.1 The applicant shall have completed not less than 1 000 hours of flight time as a pilot of helicopters. The Licensing Authority shall determine whether experience as a pilot under instruction in a synthetic flight trainer, which it has approved, is acceptable as part of the total flight time of 1 000 hours. Credit for such experience shall be limited to a maximum of 100 hours, of which not more than 25 hours shall have been acquired in a flight procedure trainer or a basic instrument flight trainer.	2.10.1.2.1 The applicant shall hold a private, commercial or airline transport pilot licence — helicopter.
2.7.1.3.1.1 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.7.1.3.1 can be reduced accordingly.			

2.7.1.3.2 The applicant shall have completed in helicopters not less than 10 hours of solo flight time under the supervision of an authorized flight instructor, including 5 hours of solo cross-country flight time with at least one cross-country flight totalling not less than 180 km (100 NM) in the course of which landings at two different points shall be made.

2.7.1.4 *Flight instruction*

2.7.1.4.1 The applicant shall have received not less than 20 hours of dual instruction time in helicopters from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the private pilot:

2.8.1.3.1.1 The applicant shall have completed in helicopters not less than:

a) 35 hours as pilot-in-command;

b) 10 hours of cross-country flight time as pilot-in-command including a cross-country flight in the course of which landings at two different points shall be made;

c) 10 hours of instrument instruction time of which not more than 5 hours may be instrument ground time; and

d) if the privileges of the licence are to be exercised at night, 5 hours of night flight time including 5 take-offs and 5 landing patterns as pilot-in-command.

2.8.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.8.1.3.1 can be reduced accordingly.

2.8.1.4 *Flight instruction*

2.8.1.4.1 The applicant shall have received dual instruction in helicopters from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas to the level of performance required for the commercial pilot:

2.9.1.3.1.1 The applicant shall have completed in helicopters not less than:

a) 250 hours, either as pilot-in-command, or made up by not less than 100 hours as pilot-in-command and the necessary additional flight time as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;

b) 200 hours of cross-country flight time, of which not less than 100 hours shall be as pilot-in-command or as co-pilot performing, under the supervision of the pilot-in-command, the duties and functions of a pilot-in-command, provided that the method of supervision employed is acceptable to the Licensing Authority;

c) 30 hours of instrument time, of which not more than 10 hours may be instrument ground time; and

d) 50 hours of night flight as pilot-in-command or as co-pilot.

2.9.1.3.2 When the applicant has flight time as a pilot of aircraft in other categories, the Licensing Authority shall determine whether such experience is acceptable and, if so, the extent to which the flight time requirements of 2.9.1.3.1 can be reduced accordingly.

2.9.1.4 *Flight instruction*

The applicant shall have received the flight instruction required for the issue of the commercial pilot licence — helicopter (2.8.1.4).

Note.— The instrument time specified in 2.9.1.3.1.1 c) and the night flying time specified in 2.9.1.3.1.1 d) do not entitle the holder of the airline transport pilot licence — helicopter to pilot helicopters under IFR.

2.10.1.2.2 The applicant shall have completed not less than:

a) 50 hours of cross-country flight time as pilot-in-command of aircraft in categories acceptable to the Licensing Authority, of which not less than 10 hours shall be in helicopters; and

b) 40 hours of instrument time in helicopters or aeroplanes of which not more than 20 hours, or 30 hours where a flight simulator is used, may be instrument ground time. The ground time shall be under the supervision of an authorized instructor.

2.10.1.3 *Flight instruction*

The applicant shall have gained not less than 10 hours of the instrument flight time required in 2.10.1.2.2 b) while receiving dual instrument flight instruction in helicopters from an authorized flight instructor. The instructor shall ensure that the applicant has operational experience in at least the following areas and to the level of performance required for the holder of an instrument rating:

Private pilot licence — Helicopter (cont.)

a) pre-flight operations, including mass and balance determination, helicopter inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the helicopter by external visual reference;

d) recovery at the incipient stage from settling with power; recovery techniques from low-rotor rpm within the normal range of engine rpm;

e) ground manoeuvring and run-ups; hovering; take-offs and landings — normal, out of wind and sloping ground;

f) take-offs and landings with minimum necessary power; maximum performance take-off and landing techniques; restricted site operations; quick stops;

g) cross-country flying using visual reference, dead reckoning and, where available, radio navigation aids, including a flight of at least one hour;

h) emergency operations, including simulated helicopter equipment malfunctions; autorotative approach and landing; and

i) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

2.7.1.4.1.1 **Recommendation.—** *The applicant should have received dual instrument flight instruction from an authorized flight instructor. The instructor should ensure that the applicant has operational experience in flight solely by reference to instruments, including the completion of a level 180° turn, in a suitably instrumented helicopter.*

Commercial pilot licence — Helicopter (cont.)

a) pre-flight operations, including mass and balance determination, helicopter inspection and servicing;

b) aerodrome and traffic pattern operations, collision avoidance precautions and procedures;

c) control of the helicopter by external visual reference;

d) recovery at the incipient stage from settling with power; recovery techniques from low-rotor rpm within the normal range of engine rpm;

e) ground manoeuvring and run-ups; hovering; take-offs and landings — normal, out of wind and sloping ground; steep approaches;

f) take-offs and landings with minimum necessary power; maximum performance take-off and landing techniques; restricted site operations; quick stops;

g) hovering out of ground effect; operations with external load, if applicable; flight at high altitude;

h) basic flight manoeuvres and recovery from unusual attitudes by reference solely to basic flight instruments;

i) cross-country flying using visual reference, dead-reckoning and radio navigation aids; diversion procedures;

j) abnormal and emergency procedures, including simulated helicopter equipment malfunctions, autorotative approach and landing; and

k) operations to, from and transitting controlled aerodromes, compliance with air traffic services procedures, radiotelephony procedures and phraseology.

Airline transport pilot licence — Helicopter (cont.)

Instrument rating — Helicopter (cont.)

a) **pre-flight procedures, including the use of the flight manual or equivalent document, and appropriate air traffic services documents in the preparation of an IFR flight plan;**

b) **pre-flight inspection, use of checklists, taxiing and pre-take-off checks;**

c) **procedures and manoeuvres for IFR operation under normal, abnormal and emergency conditions covering at least:**

— transition to instrument flight on take-off

— standard instrument departures and arrivals

— en-route IFR procedures

— holding procedures

— instrument approaches to specified minima

— missed approach procedures

— landings from instrument approaches

d) **in-flight manoeuvres and particular flight characteristics; and**

e) **if appropriate, operation of a multi-engined helicopter solely by reference to instruments with one engine inoperative or simulated inoperative.**

2.7.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in helicopters in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.7.1.4.1.1 and the night flying experience specified in 2.7.1.4.2 do not entitle the holder of a private pilot licence — helicopter to pilot helicopters under IFR.

2.7.1.5 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of a helicopter, the procedures and manoeuvres described in 2.7.1.4 with a degree of competency appropriate to the privileges granted to the holder of a private pilot licence — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

2.8.1.4.2 If the privileges of the licence are to be exercised at night, the applicant shall have received dual instruction in helicopters in night flying, including take-offs, landings and navigation.

Note.— The instrument experience specified in 2.8.1.3.1.1 c) and 2.8.1.4.1 h) and the night flying experience specified in 2.8.1.3.1.1 d) and 2.8.1.4.2 do not entitle the holder of a commercial pilot licence — helicopter to pilot helicopters under IFR.

2.8.1.5 *Skill*

The applicant shall have demonstrated the ability to perform as pilot-in-command of a helicopter, the procedures and manoeuvres described in 2.8.1.4 with a degree of competency appropriate to the privileges granted to the holder of a commercial pilot licence — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

2.9.1.5 *Skill*

2.9.1.5.1 The applicant shall have demonstrated the ability to perform, as pilot-in-command of a helicopter required to be operated with a co-pilot, the following procedures and manoeuvres:

a) pre-flight procedures, including the preparation of the operational flight plan and filing of the air traffic services flight plan;

b) normal flight procedures and manoeuvres during all phases of flight;

c) abnormal and emergency procedures and manoeuvres related to failures and malfunctions of equipment, such as powerplant, systems and airframe; and

d) procedures for crew incapacitation and crew co-ordination including allocation of pilot tasks, crew co-operation and use of checklists.

2.9.1.5.1.1 The applicant shall have demonstrated the ability to perform the procedures and manoeuvres described in 2.9.1.5.1 with a degree of competency appropriate to the privileges granted to the holder of an airline transport pilot licence — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge;

2.10.1.4 *Skill*

The applicant shall have demonstrated the ability to perform the procedures and manoeuvres specified in 2.10.1.3 with a degree of competency appropriate to the privileges granted to the holder of an instrument rating — helicopter, and to:

a) operate the helicopter within its limitations;

b) complete all manoeuvres with smoothness and accuracy;

c) exercise good judgement and airmanship;

d) apply aeronautical knowledge; and

Private pilot licence — Helicopter (cont.)	Commercial pilot licence — Helicopter (cont.)	Airline transport pilot licence — Helicopter (cont.)	Instrument rating — Helicopter (cont.)
e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.	e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt.	e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never in doubt; f) understand and apply crew co-ordination and incapacitation procedures; and g) communicate effectively with the other flight crew members.	e) maintain control of the helicopter at all times in a manner such that the successful outcome of a procedure or manoeuvre is never seriously in doubt. *Note.— Attention is called to 2.1.6 on the use of synthetic flight trainers for demonstrations of skill.*
2.7.1.6 *Medical fitness* The applicant shall hold a current Class 2 Medical Assessment. *Note.— Attention is called to 2.10.1.5 on the medical fitness requirements for private pilot licence holders seeking an instrument rating.*	2.8.1.6 *Medical fitness* The applicant shall hold a current Class 1 Medical Assessment.	2.9.1.6 *Medical fitness* The applicant shall hold a current Class 1 Medical Assessment.	2.10.1.5 *Medical fitness* 2.10.1.5.1 Applicants who hold a private pilot licence shall have established their hearing acuity on the basis of compliance with the hearing requirements for the issue of a Class 1 Medical Assessment. 2.10.1.5.2 **Recommendation.—** *Contracting States should consider requiring the holder of a private pilot licence to comply with the physical and mental, and visual requirements for the issue of a Class 1 Medical Assessment.*
2.7.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges 2.7.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a private pilot licence — helicopter shall be to act, but not for remuneration, as pilot-in-command or co-pilot of any helicopter engaged in non-revenue flights.	2.8.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges 2.8.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a commercial pilot licence — helicopter shall be: a) to exercise all the privileges of the holder of a private pilot licence — helicopter; b) to act as pilot-in-command in any helicopter engaged in operations other than commercial air transportation; c) to act as pilot-in-command in commercial air transportation in any helicopter certificated for single-pilot operation; and	2.9.2 Privileges of the holder of the licence and the conditions to be observed in exercising such privileges Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an airline transport pilot licence — helicopter shall be: a) to exercise all the privileges of the holder of a private and commercial pilot licence — helicopter; and b) to act as pilot-in-command and co-pilot in helicopters in air transportation.	2.10.2 Privileges of the holder of the rating and the conditions to be observed in exercising such privileges Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of an instrument rating helicopter shall be to pilot helicopters under IFR.

2.7.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.7.1.4.2.

d) to act as co-pilot in commercial air transportation in helicopters required to be operated with a co-pilot.

2.8.2.2 Before exercising the privileges at night, the licence holder shall have complied with the requirements specified in 2.8.1.3.1.1 d) and 2.8.1.4.2.

— END —

Transmittal Note

SUPPLEMENT TO

ANNEX 1 — PERSONNEL LICENSING

(Eighth Edition)

1. The attached Supplement supersedes all previous Supplements to Annex 1 and includes differences notified by Contracting States up to 19 July 1995.

2. This Supplement should be inserted at the end of Annex 1, Eighth Edition. Additional differences and revised comments received from Contracting States will be issued at intervals as amendments to this Supplement.

SUPPLEMENT TO ANNEX 1 — EIGHTH EDITION

PERSONNEL LICENSING

Differences between the national regulations and practices of States and the corresponding International Standards contained in Annex 1, as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

JULY 1995

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT

No.	Date	Entered by

No.	Date	Entered by

AMENDMENTS TO ANNEX 1 ADOPTED OR APPROVED BY THE COUNCIL SUBSEQUENT TO THE EIGHTH EDITION ISSUED JULY 1988

No.	Date of adoption or approval	Date applicable
160	24/3/93	10/11/94

No.	Date of adoption or approval	Date applicable

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards of Annex 1, Eighth Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
Argentina	18/7/95	1-2	19/7/95
Australia	16/3/93	1-2	19/7/95
Barbados	14/11/94	1	19/7/95
Belgium	19/12/94	1	19/7/95
Canada	14/10/93	1-3	19/7/95
Côte d'Ivoire	25/11/94	1	19/7/95
Czech Republic	8/2/91	1	19/7/95
Denmark	17/10/94	1	19/7/95
Egypt	30/8/93	1	19/7/95
France	5/10/94	1-2	19/7/95
Germany	28/9/94	1	19/7/95
Greece	30/11/94	1	19/7/95
Iran, Islamic Republic of	16/6/89	1	19/7/95
Ireland	23/6/94	1	19/7/95
Jordan	8/1/95	1	19/7/95
Luxembourg	23/8/93	1	19/7/95
Malaysia	15/7/95	1	19/7/95
Namibia	12/7/93	1	19/7/95
Nepal	11/4/95	1	19/7/95
Netherlands, Kingdom of the	2/11/94	1	19/7/95
Norway	10/10/94	1	19/7/95
Pakistan	26/7/93	1	19/7/95
Peru	19/1/94	1	19/7/95
Republic of Korea	26/9/94	1	19/7/95
Russian Federation	7/10/93	1-2	19/7/95
South Africa	30/5/95	1	19/7/95
Spain	29/11/94	1	19/7/95
Thailand	20/9/93	1	19/7/95
Turkey	23/7/93	1	19/7/95
United Kingdom	4/10/94	1	19/7/95
United States	7/10/94	1-3	19/7/95
Uruguay	20/12/93	1	19/7/95

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2. Contracting States which have notified ICAO that no differences exist

State	*Date of notification*	*State*	*Date of notification*
Bahrain	26/5/93	Morocco	15/11/94
Chile	26/10/93	Oman	23/1/94
Costa Rica	24/9/93	Portugal	12/1/94
Cyprus	7/10/93	Saudi Arabia	25/7/93
Fiji	13/7/93	Sweden	5/10/94
Finland	5/10/94	United Arab Emirates	16/5/93

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3. Contracting States from which no information has been received

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Armenia
Austria
Azerbaijan
Bahamas
Bangladesh
Belarus
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Colombia
Comoros
Congo
Cook Islands
Croatia
Cuba
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Ecuador
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Gabon
Gambia
Georgia
Ghana
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
Iceland
India
Indonesia
Iraq
Israel
Italy
Jamaica
Japan
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Lithuania
Madagascar
Malawi
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Micronesia, Federated States of
Monaco
Mongolia
Mozambique
Myanmar
Nauru
New Zealand
Nicaragua
Niger
Nigeria
Panama
Papua New Guinea
Paraguay
Philippines
Poland
Qatar
Republic of Moldova
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
Singapore
Slovakia
Slovenia
Solomon Islands
Somalia
Sri Lanka
Sudan
Suriname
Swaziland
Switzerland
Syrian Arab Republic
Tajikistan
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkmenistan
Uganda
Ukraine
United Republic of Tanzania
Uzbekistan
Vanuatu
Venezuela
Viet Nam
Yemen
Zaire
Zambia
Zimbabwe

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4. Paragraphs with respect to which differences have been notified

Paragraph	*Differences notified by*
1.2	Canada
	Czech Republic
	Russian Federation
1.2.1	Czech Republic
1.2.4.1	Canada
1.2.5.1.1	Spain
1.2.5.1.1.1	Canada
	Côte d'Ivoire
1.2.5.2	Argentina
	Australia
	Canada
	Czech Republic
	Norway
	United States
1.2.5.2.1	Russian Federation
	United States
1.2.5.2.2	United States
2.1.2	Norway
2.1.2.1	Czech Republic
2.1.3	Norway
2.1.3.1.1	Canada
2.1.3.2	United States
2.1.4.1	United States
2.1.4.1.1	Canada
	United States
2.1.5.2	France
	Malaysia
	United Kingdom
	United States
2.1.9	United States
2.1.9.1	Russian Federation
2.1.9.2	Russian Federation
2.1.9.3	Russian Federation
2.1.10	Australia
	Canada
	France
	Jordan
	Luxembourg
	Russian Federation
	South Africa
	Turkey
	United Kingdom
	Uruguay
2.1.10.1	Argentina
	Canada
	Germany
	Iran, Islamic Republic of
	Peru

Paragraph	*Differences notified by*
2.1.10.2	Argentina
	Canada
	Peru
2.3.1.1	Czech Republic
2.3.1.3.1	Canada
	United States
2.3.1.6	Denmark
2.3.2.1	Argentina
2.4	Russian Federation
2.4.1.2	France
2.4.1.3.1	Argentina
	Canada
2.4.1.3.1.1	Canada
2.4.2.1	Nepal
2.5	Russian Federation
2.5.1.1	Russian Federation
2.5.1.2	France
2.5.1.3.1	Argentina
2.5.1.3.1.1	Czech Republic
2.5.1.5.1	United States
2.6.1.1	France
2.6.1.2.2	Canada
2.6.1.5.1	Canada
	France
2.6.1.5.2	Canada
2.7.1.1	Czech Republic
2.7.1.3	Canada
2.7.1.3.1	Canada
2.7.1.4.1	United States
2.7.1.6	Denmark
2.8.1.2	France
2.8.1.3.1	Canada
2.9	Canada
2.9.1.2	France
2.9.1.3.1.1	United States
2.10.1.1	France
2.10.1.2.2	Canada
2.10.1.5.1	Canada
	France
2.10.1.5.2	Canada
2.11.1	France
2.12.1.3.1	Canada
2.12.1.5	Denmark
	United States
2.13	Argentina
2.13.1.3.1	United States
2.13.1.3.3	United States
2.13.1.5	Denmark
	United States

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Paragraph	Differences notified by
3.2	Norway
3.2.1.1	Canada
3.2.1.3.1	Canada
	Russian Federation
3.2.1.5	Canada
3.3	Canada
	Norway
3.3.1.1	Czech Republic
	United States
3.3.1.3.1	Argentina
	Russian Federation
3.3.1.5	Canada
3.4	Russian Federation
Chapter 4	Belgium
4.1.1.1	Australia
4.2	Argentina
	France
4.2.1.1	Thailand
4.2.1.3	Thailand
4.3	Argentina
	Denmark
	France
4.3.1	Germany
4.3.1.1	Canada
	Thailand
4.3.1.2	Norway
4.3.1.3	Thailand
4.3.1.4	Canada
4.4	Canada
	Netherlands, Kingdom of the
	Norway
	Pakistan
4.4.1.1	Barbados
	Ireland
	United Kingdom
	United States
4.4.1.3	Namibia
	Republic of Korea
	United States
4.4.1.4	Greece
	United States
4.5	Canada
	France
	Netherlands, Kingdom of the
	Norway
4.5.1.1	Egypt
4.5.2.2.	Namibia
	United States

Paragraph	Differences notified by
4.6	Canada
	Netherlands, Kingdom of the
	United Kingdom
4.6.1.1	United States
4.6.1.2	United States
4.6.1.3	Republic of Korea
4.7	Argentina
	Denmark
Chapter 6	Netherlands, Kingdom of the
6.1.1	Australia
	Greece
6.2.2	Greece
6.2.3	Greece
6.2.3.1	Australia
6.2.4.2.1	Australia
6.2.5.1	Australia
6.3.2.2	Canada
6.3.2.5	Greece
6.3.2.5.1	Australia
	United States
6.3.2.8.1	Australia
	United States
6.3.2.9	Australia
6.3.2.10	Australia
6.3.2.11	Australia
6.3.2.13	Australia
6.3.2.18	Australia
6.3.2.21	Australia
6.3.2.23	United States
6.3.2.23.1	Australia
6.3.2.26	Australia
6.3.2.27	Australia
6.3.3	Greece
6.3.3.3	Australia
	Canada
	United States
6.3.4.1	Canada
6.3.4.1.1	Australia
6.4.2.2	Canada
6.4.2.5.1	United States
6.4.2.8.1	United States
6.4.2.22	United States
6.4.2.22.1	Canada
6.5.1	Greece
6.5.4.1	Canada

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CHAPTER 1

1.2.5.2 Twelve months for the private pilot — aeroplane licence, glider pilot licence and private pilot — helicopter licence.

CHAPTER 2

2.1.10.1 Change of legislation in progress.

2.1.10.2* Change of legislation in progress.

2.3.2.1 Subject to compliance with the requirements specified in 1.2.5, 1.2.6 and 2.1, the privileges of the holder of a private pilot licence — should be to act, but not for remuneration:

a) As pilot-in-command of any aeroplane not operated for remuneration. For the carriage of passengers by day he shall have completed 25 hours as pilot from the date on which he obtained his licence and have been checked by a qualified instructor in a flight test lasting at least 30 minutes with three landings.

b) Before undertaking a local night flight he shall have satisfactorily attended a course of approved training for the local night flight rating, which includes:

1) ten hours of instrument flight training or five hours of instrument flight training under hood and five hours of instrument ground training, and

2) ten hours of local night flying, of which five hours shall be dual and five hours solo.

2.4.1.3.1 Satisfactory completion of a course of approved training for the commercial pilot licence plus the following experience:

Not less than 200 flying hours from the date on which he obtained the private pilot — aeroplane licence, including:

— 100 hours as pilot on local flights, 50 hours of which may be as glider pilot.
— 80 hours as pilot on cross-country flights, including not less than one flight of 500 km with two full-stop landings at different points along the route.
— 10 hours of instrument flying (under hood) or five hours of instrument flying (under hood) and five hours of instrument ground training.
— 10 hours of night flying, of which five hours dual and five hours instrument ground training.

2.5.1.3.1 Not less than 1 200 hours flying from the date on which he obtained the private pilot — aeroplane licence, as follows:

a) 1 200 hours flying as pilot or 700 hours as pilot and 500 hours as co-pilot in aircraft which require a co-pilot.

b) of the total quoted in a) above, not less than 100 hours of night flying as pilot, of which not less than 25 hours of cross-country flying.

c) 90 hours of instrument flying, of which 25 hours of flight under actual instrument conditions.

d) at least 200 hours of cross-country flying as pilot.

e) The totals quoted in b), c) and d) above may be accomplished as co-pilot, provided the times are equivalent to the requirement of 1 200 flying hours, with not less than 300 hours as co-pilot.

2.13 Not issued.

CHAPTER 3

3.3.1.3.1 Not less than 50 hours flying under instruction in aircraft which require a flight engineer, under the supervision of a person in possession of a flight engineer licence.

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* Recommended Practice

CHAPTER 4

4.2 and 4.3 An aircraft maintenance mechanic licence is issued on successful completion of a three-year approved training course. Subsequently, three categories of rating are granted in accordance with the duly certified experience of the holder; these ratings authorize him to carry out the following duties:

— Category "A": Inspection and major maintenance of aircraft up to 5 700 kg, their powerplants, equipment and accessories and the issue of the relevant certificates, the work being carried out in aeronautical workshops approved for the relevant category.

  Not less than two years of certified experience as holder of the relevant licence are required to obtain this rating.

— Category "B": Inspection and major maintenance of aircraft weighing more than 5 700 kg and their powerplants, equipment and accessories and the issue of the relevant certificates.

  Not less than one year of certified experience, as holder of the Category "A" rating, for aircraft weighing more than 5 700 kg is required to obtain this rating.

— Category "C": Inspection and major maintenance of aircraft weighing more than 5 700 kg and their powerplants, equipment and accessories and the issue of the relevant certificates.

  Not less than two years of certified experience, as holder of a Category "B" rating, for aircraft weighing more than 5 700 kg is required to obtain this rating.

4.7 Not issued. 19/7/95

AUSTRALIA

CHAPTER 1

1.2.5.2 Interval between medical examinations.
Under age 40:
class 2 = 48 months
Under age 40:
class 1 = 12 months
classes 2 and 3 = 24 months

CHAPTER 2

2.1.10 The following over age 60 requirements apply to the holders of Commercial Pilot Licence — Aeroplane, Helicopter, Gyroplane, Airship and Air Transport Pilot Licence — Aeroplane, Helicopter:

1. A pilot who is at least 60 years old must not fly as pilot in command of an aircraft:
   a) that is engaged in commercial operations; and
   b) that is carrying passengers.
2. Paragraph 1 above does not apply to a pilot if:
   a) the pilot flies an aircraft:
      i) that is fitted with fully functioning dual controls; and
      ii) that has an operating crew that includes a qualified pilot who is not the pilot in command; or
   b) in the case of a pilot who is less than 65 years old — within the period of one year immediately before the day of the proposed flight, the pilot has satisfactorily completed an aircraft proficiency check; or
   c) in the case of a pilot who is at least 65 years old — within the period of six months immediately before the day of the proposed flight, the pilot has satisfactorily completed an aircraft proficiency check.

"Qualified pilot" means a pilot who:

a) holds a command endorsement (type rating) for the aircraft; and 19/7/95

b) if an activity for which a flight crew rating is required is to be carried out during the flight — holds a flight crew rating, or grade of flight crew rating, that authorises him or her to carry out the activity as pilot in command of the aircraft; and

c) either:

i) is less than 60 years old; or

ii) satisfies the requirements of paragraph 2. b) or c).

CHAPTER 4

4.1.1.1 Australian Civil Aviation Regulation 31(4)(a) specifies a minimum age of 21 years.

CHAPTER 6

6.1.1 b) Class 2 medical assessment. Does not apply to glider pilots.

6.2.3.1* Visual Acuity Test. Illumination Levels. Not specified in Australia regulations.

6.2.4.2.1* Colour Perception. Candidates failing pseudiosochromatic plates and colour perception lantern may be given dispensation in class 2, and class 1 commercial level but no higher.

6.2.5.1 Note 3. Choice of speech. Not specified.

6.3.2.5.1 Electrocardiograph on issue and at specified intervals. Not required for class 2.

6.3.2.8.1* Routine chest radiography. Not required.

6.3.2.9 Chest deformities, tuberculosis and emphysema. Not specifically mentioned in Australian regulations.

6.3.2.10* Chest deformities, tuberculosis and emphysema. Not specifically mentioned in Australian regulations.

6.3.2.11 Chest deformities, tuberculosis and emphysema. Not specifically mentioned in Australian regulations.

6.3.2.13 Hernias. Not specifically mentioned.

6.3.2.18 Reticulo-endothelial system. Candidates must not suffer from immune deficiencies likely to interfere with safe operations.

6.3.2.21 Requirement for evidence of satisfactory treatment of syphilis. Not specifically mentioned.

6.3.2.23.1* Pregnancy. No specified period of unfitness.

6.3.2.26 Unhealed perforation of tympanic membrane. Not specifically mentioned.

6.3.2.27 Free nasal air passages. Not specifically mentioned.
Speech defects and stuttering. Not specifically mentioned.

6.3.3.3 Visual acuity. Testing of uncorrected visual acuity at renewal examination is not mandatory if visual correction is worn and tested.

Minimum corrected visual acuity. Classes 1 and 3 = 6/9 each eye and 6/6 binocular, class 2 = 6/12 each eye and 6/9 binocular.

A class 2 applicant who has 6/6 vision in one eye, but whose other eye cannot be corrected to 6/12, may be licensed under waiver.

Refractive error limits are waived if suitable correction is worn.

6.3.4.1.1 Practical hearing test after failing audiogram and speech test.

Available for classes 1 and 3, not required for class 2.

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* Recommended Practice

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BARBADOS

CHAPTER 4

4.4.1.1	The minimum age for the issue of an air traffic controller's licence is 18 years.	19/7/95

BELGIUM

CHAPTER 4	The licences listed in this chapter are not issued in Belgium.	19/7/95

CANADA

CHAPTER 1

1.2	Canada does not issue flight radio operator, flight operations officer or aeronautical station operator licences.
Note 2	In addition, Canada issues Private Pilot Licence — Gyroplane, PPL Ultra-light aeroplane and CPL — Ultra-light aeroplane.
b)	Canada does not issue flight operations officer or aeronautical station operator licences.
1.2.4.1	Canadian medical assessment is recorded on a document entitled a Licence Validation Certificate. Until otherwise advised, Category 3 shall be equivalent to ICAO Class 2 Medical Assessment and Category 2 shall be equivalent to ICAO Class 3 Medical Assessment.
1.2.5.1.1.1	Canada intends to continue to issue the flight instructor rating for gliders and free balloons after November 15, 1994.
1.2.5.2	60 months for the glider pilot licence. 12 months for the air traffic controller licence.

CHAPTER 2

2.1.3.1.1*	Canada does not anticipate establishing a class rating for helicopters.
2.1.4.1.1	Canadian type ratings do not indicate the capacity (pilot or co-pilot).
2.1.10	Canada does not curtail privileges of pilots who have attained their 60th birthday.
2.1.10.1	Canada does not curtail privileges of pilots who have attained their 60th birthday.
2.1.10.2*	Canada does not curtail privileges of pilots who have attained their 60th birthday.
2.3.1.3.1	Canada requires applicants to complete not less than 45 hours flight time of which 5 hours must be instrument time.
2.4.1.3.1	Canada requires 200 hours flight time for CPL-A and does not make concession for approved courses.
2.4.1.3.1.1 c)	Canada requires 20 hours dual instrument flight time of which 10 hours may be instrument ground time.
d)	Canada requires 10 hours night flight time (5 hours dual, 5 hours solo) including 10 take-offs and 10 landings.
2.6.1.2.2 a)	Canada requires applicant to have 150 hours pilot-in-command flight time.
2.6.1.5.1	Holders of instrument ratings do not require Class 1 Medical Assessment.
2.6.1.5.2*	Holders of instrument ratings do not require Class 1 Medical Assessment.

* Recommended Practice

2.7.1.3	45 hours of flight time.
2.7.1.3.1	Canada requires applicants to complete not less than 45 hours of flight time of which 5 hours must be instrument time.
2.8.1.3.1	Canada requires applicants to have completed not less than 100 hours flight time and does not make concessions for approved courses.
2.9	Canada does not issue Airline Transport Pilot Licence (ATPL) — Helicopter.
2.10.1.2.2	Canada requires the applicant to have 150 hours pilot-in-command flight time.
2.10.1.5.1	Holders of instrument ratings do not require Class 1 Medical Assessment.
2.10.1.5.2*	Holders of instrument ratings do not require Class 1 Medical Assessment.
2.12.1.3.1	Canada requires the applicant to have 3 hours of flight time with at least 20 solo take-offs and landings.

CHAPTER 3

3.2.1.1	The applicant shall be not less than 21 years of age.
3.2.1.3.1	Canada requires the applicant to have not less than 50 hours cross-country by night.
3.2.1.5	Canada requires applicant to have Category 1 or 2 medical.
3.3	Not issued.
3.3.1.5	Canada requires applicant to have Category 1 or 2 medical.

CHAPTER 4

4.3.1.1	The applicant shall not be less than 19 years of age.
4.3.1.4	Category 1 or 2 medical.
4.4	Not issued.
4.5	Not issued.
4.6	Not issued.

CHAPTER 6

6.3.2.2 d)	Any personality disorder, particularly if severe enough to have provoked any significant overt act.
6.3.3.3 a)	Canadian regulations require that the applicant possess a visual acuity without correction in each eye separately, of not less than 6/60 (20/200, 0.1) or the refractive error falls within the range of ±3.5 dioptres (equivalent spherical error).
6.3.4.1	The applicant shall be tested on a pure-tone audiometer at the initial examination for a medical Category 1 and at the first medical examination after age 55, unless tested satisfactorily during the five years preceding these dates.
6.4.2.2 d)	Any personality disorder, particularly if severe enough to have provoked any significant overt act.
6.4.2.22.1	In the event of completely normal pregnancy, the applicant may be considered fit up to the end of the seventh month of pregnancy provided there is not physical obstruction to the safe operation of an aircraft.
6.5.4.1	The applicant shall be tested on a pure-tone audiometer at the initial examination for a medical Category 2 and at the first medical examination after age 55, unless tested satisfactorily during the five years preceding these dates.

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Côte d'Ivoire

CHAPTER 1

1.2.5.1.1.1 Pilots issued with the Senior Commercial Pilot Licence in Côte d'Ivoire will be allowed to exercise the privileges of their licence up to 31 March 1995, after which date the new regulations related to the suppression of the licence will be in force.

19/7/95

Czech Republic

CHAPTER 1

1.2 Cabin attendants are licensed with a valid licence for a 24 month interval.

1.2.1 We have additional subparagraph with concrete specifications who can be as licensed member of Czechoslovak Civil Aviation.

1.2.5.2 We have a shorter interval 12 months for the air traffic controller licence:

- in national regulations we have additional licences
- pilot ULA interval 24 months
- cabin attendant — interval 24 months until their 40th birthday and for next activity shall be reduced to 12 months
- aircraft maintenance technician Type I interval 36 months (in case, he will participate in testing flights).

CHAPTER 2

2.1.2.1 We have additional subparagraph for ULA, balloons

2.3.1.1 The applicant shall be not less than 18 years of age.

2.5.1.3.1.1 We have additional subparagraph:

- 500 hours as pilot of a two-engined aeroplane

2.7.1.1 The applicant shall be not less than 18 years of age.

CHAPTER 3

3.3.1.1 The applicant shall be not less than 21 years of age.

We have additional functions — instructor and inspector.

19/7/95

Denmark

CHAPTER 2

2.3.1.6 Defective colour perception acceptable. Licences will be endorsed accordingly.

2.7.1.6 Defective colour perception acceptable. Licences will be endorsed accordingly.

2.12.1.5 Defective colour perception acceptable. Licences will be endorsed accordingly.

2.13.1.5 Defective colour perception acceptable. Licences will be endorsed accordingly.

CHAPTER 4

4.3 Not issued.

4.7 Not issued. The duties are performed by State employees meeting Annex 1 Standards.

19/7/95

EGYPT

CHAPTER 4

4.5.1.1 d) With the exception of approach precision radar control rating, all other ratings exist.

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FRANCE

CHAPTER 2

2.1.5.2 Given the stringent requirements it has set for an airline transport pilot licence, France demands only that applicants for a type rating on a two-pilot aircraft possess those elements of the APL knowledge requirements that the Authority has determined are necessary for the performance of their duties aboard the aircraft type in question.

2.1.10 France does not curtail the privileges of pilots who have attained their 60th birthday. A bill calling for strict application of ICAO Standards and Recommended Practices is to be presented to parliament in the fall of 1994.

2.4.1.2 i) There is thus far no examination for human performance and limitations. Training and examination programmes in this field have been developed and are being adopted. They will be implemented gradually over the period 1995-1998, and will include specific training programmes in the airlines.

2.5.1.2 k) There is thus far no examination for human performance and limitations. Training and examination programmes in this field have been developed and are being adopted. They will be implemented gradually over the period 1995-1998, and will include specific training programmes in the airlines.

2.6.1.1 f) There is thus far no examination for human performance and limitations. Training and examination programmes in this field have been developed and are being adopted. They will be implemented gradually over the period 1995-1998, and will include specific training programmes in the airlines.

2.6.1.5.1 France does not require that private pilot licence holders applying for an aeroplane or helicopter instrument rating meet the Class 1 hearing requirement.

2.8.1.2 i) There is thus far no examination for human performance and limitations. Training and examination programmes in this field have been developed and are being adopted. They will be implemented gradually over the period 1995-1998, and will include specific training programmes in the airlines.

2.9.1.2 k) There is thus far no examination for human performance and limitations. Training and examination programmes in this field have been developed and are being adopted. They will be implemented gradually over the period 1995-1998, and will include specific training programmes in the airlines.

2.10.1.1 f) There is thus far no examination for human performance and limitations. Training and examination programmes in this field have been developed and are being adopted. They will be implemented gradually over the period 1995-1998, and will include specific training programmes in the airlines.

2.10.1.5.1 France does not require that private pilot licence holders applying for an aeroplane or helicopter instrument rating meet the Class 1 hearing requirement.

2.11.1 k) There is thus far no examination for human performance and limitations. Training and examination programmes in this field have been developed and are being adopted. They will be implemented gradually over the period 1995-1998, and will include specific training programmes in the airlines.

CHAPTER 4

4.2 France does not issue individual licences to maintenance technicians/mechanics. The authority issues certificates to maintenance organizations that comply with the standards and procedures contained in the regulations.

4.3 France does not issue individual licences to maintenance technicians/mechanics. The authority issues certificates to maintenance organizations that comply with the standards and procedures contained in the regulations.

4.6 France does not issue a flight operations officer licence. France has adopted a method of operational supervision that meets the specifications of Annex 6 and does not require flight operations officers to hold licences issued by the State.

19/7/95

GERMANY

CHAPTER 2

2.1.10.1 The German Order on the Operation of Aircraft provides for a regulation which merely recommends the aircraft operators not to employ crew members who have attained their 60th birthday.

CHAPTER 4

4.4.1 According to the German regulations, an air traffic controller licence will be issued to an applicant without any controller rating after having passed the final theoretical and practical checks. This initial controller licence will permit the applicant to operate as air traffic controller under supervision only and the licence will expire after 12 months if the applicant has not acquired at least one controller rating.

19/7/95

GREECE

CHAPTER 4

4.4.1.4 Implemented only for applicants for initial issue or renewal of an aerodrome control rating.

CHAPTER 6

6.1.1. c) Implemented only for applicants for the initial issue or renewal of an aerodrome control rating.

6.2.2 Cases of brain tumours (benign or malignant), even if they have been surgically removed, shall be assessed as unfit.

6.2.3 The correction of visual acuity may be by glasses or contact lenses.

6.3.2.5 A by-pass surgical operation or a history of proven coronary insufficiency (angina pectoris) that may be reasonably expected to lead to myocardial infarction shall be disqualifying.

6.3.3 The applicant shall be required to have heterophoria no more than Hyper 1 pd, Eso 10 pd.

6.5.1 Implemented only for applicants for initial issue or renewal of an aerodrome rating.

19/7/95

IRAN, ISLAMIC REPUBLIC OF

CHAPTER 2

2.1.10.1 Any pilot (in-command or co-pilot) of aircraft engaged in scheduled international air services or non-scheduled air transport operations for remuneration or hire if he has attained his 60th birthday could continue to act as pilot-in-command or co-pilot until the age of 61 provided that:

1) he undergoes a medical check at least every four months;
2) the other pilot operating in the same flight is less than 60 years of age;
3) the waiver is cancelled if any operational, physical or mental problem occurs.

19/7/95

IRELAND

CHAPTER 4

4.4.1.1 Air traffic controller shall be not less than 20 years of age.

Applicants for a licence for radar ratings are required to be not less than 21 years of age.

19/7/95

JORDAN

CHAPTER 2

2.1.10 In connection with the curtailment of privileges of pilots who have attained their 60th birthday, the Jordanian Civil Aviation Regulations have been amended as follows:

Commercial pilot privileges and limitations:

a) The holder of a commercial pilot certificate:

1) may act as pilot-in-command of an aircraft carrying persons or property for compensation or hire, provided he shall not after his 60th birthday act as pilot-in-command, or second in command of an aircraft whose:

i) maximum seating capacity exceeds 40 passengers; or

ii) maximum payload exceeds 5 000 kg;

2) shall not at any time after his 65th birthday act as pilot-in-command or second in command (co-pilot) of any aircraft for compensation or hire;

3) may give instruction in free balloon if he holds a free balloon class rating.

General privileges and limitations:

The holder of an airline transport pilot certificate shall not at any time after the age of 60 years act as pilot-in-command of any aircraft for the purpose of hire or compensation if its:

i) maximum seating capacity exceeds 40 seats; or

ii) maximum authorized pay load exceeds 5 000 kg;

The holder of an airline transport pilot certificate shall not at any time after the age of 65 years act as pilot-in-command or second in command of any aircraft for the purpose of compensation or hire.

19/7/95

LUXEMBOURG

CHAPTER 2

2.1.10 Luxembourg does not apply the Annex 1 Standards and Recommended Practices regarding the curtailment of privileges of pilots who have attained their 60th birthday.

Foreign licences are accepted through validation, that is, by issuing a certificate authorizing an individual to pilot aircraft registered in Luxembourg and falling within the categories indicated on the original licence.

There is no age limit.

As long as the original licence has not been withdrawn, the holder can pilot aircraft that fall within the categories described on the licence and are registered in Luxembourg.

19/7/95

MALAYSIA

CHAPTER 2

2.1.5.2 c) Implementation date deferred to 2 August 1996.

19/7/95

NAMIBIA

CHAPTER 4

4.4.1.3 The applicant shall have completed an approved training course and not less than three months' satisfactory service engaged in the actual control of air traffic under the supervision of an appropriately rated air traffic controller with five years experience.

4.5.2.2.1 The applicant shall have:

a) satisfactorily completed an approved training course;

b) provided, satisfactorily, under the supervision of an appropriately rated air traffic controller with five years experience.

19/7/95

NEPAL

CHAPTER 2

2.4.2.1 c) To act as pilot-in-command in commercial air transportation in any aeroplane having a maximum certificated take-off weight of 5 700 kg or less.

19/7/95

NETHERLANDS, KINGDOM OF THE

CHAPTER 4

4.4 Not issued. Duties are performed by State employees meeting Annex 1 Standards.

4.5 Not issued. Duties are performed by State employees meeting Annex 1 Standards.

4.6 Not issued. Duties are performed by State employees meeting Annex 1 Standards.

CHAPTER 6 All Recommendations are applied as Standards.

19/7/95

NORWAY

CHAPTER 1

1.2.5.2 For private pilots under the age of 40, the interval is 60 months, between 40-50 years the interval is 24 months and for private pilots above 50 years the interval is 12 months.

CHAPTER 2

2.1.2 Not issued. The Norwegian CAA has granted the organization "Norsk Aero Klubb" the permission to issue certain documents which entitle the holder to act as crew member on gliders and free balloons in Norwegian airspace.

2.1.3 Not issued. The Norwegian CAA has granted the organization "Norsk Aero Klubb" the permission to issue certain documents which entitle the holder to act as crew member on gliders and free balloons in Norwegian airspace.

CHAPTER 3

3.2 Not issued in Norway.

3.3 Flight engineer licence is issued according to the Standards of Annex 1, 7th edition.

19/7/95

CHAPTER 4

4.3.1.2 b) 1) Not required. Type I licence for complete aircraft is not issued.

c) 1) Not required. Type I licence for complete aircraft is not issued in Norway.

4.4 Air Traffic Controllers in Norway are unlicensed state employees. The Standards of Annex 1, however, apply.

4.5 Not issued in Norway.

19/7/95

PAKISTAN

CHAPTER 4

4.4 Licences to air traffic controllers are not issued.

19/7/95

PERU

CHAPTER 2

2.1.10.1 The age limit for captain of an aeroplane is 63 and for the co-pilot the age limit is 65.

2.1.10.2 The age limit for captain of an aeroplane is 63 and for the co-pilot the age limit is 65.

19/7/95

REPUBLIC OF KOREA

CHAPTER 4

4.4.1.3

1) The applicant shall have recently completed not less than 12 months' satisfactory service as pilot or flight navigator; or

2) completed not less than nine months' satisfactory service engaged in actual control of air traffic under the supervision of an appropriately rated air traffic controller; or

3) satisfactory completed an approved training course and not less than three months' satisfactory service engaged in the actual control of air traffic under the supervision of an appropriately rated air traffic controller.

4.6.1.3 The applicant shall, during the three years immediately preceding the date of his application, have completed two years service in any one or in any combination of the capacities specified in a) to e) inclusive, provided that in any combination of experience the period served in any one of these capacities shall not be less than one year:

1) a pilot member of the crew in air transportation; or

2) a flight navigator in air transportation; or

3) a radio operator in air transportation; or

4) a meteorologist in an organization dispatching aircraft in air transportation; or

5) an air traffic controller, or a technical supervisor or flight operations officers or air transportation flight operations systems;

or

The applicant shall have served as an assistant in the dispatching of air transport for not less than one year within the two years immediately preceding the date of his application;

or

The applicant shall have satisfactorily completed an approved training course.

19/7/95

CHAPTER 1

1.2, Note 2 Russian civil aviation specialists are, depending on the level of theoretical training, practical skills and working experience, issued with licences with the corresponding grade being given:

- — pilots (Grades 3, 2 and 1);
- — flight navigators (Grades 3, 2 and 1);
- — flight engineers (flight mechanics) (Grades 3, 2 and 1);
- — flight radio operators (Grades 3, 2 and 1);
- — traffic controllers (Grades 3, 2 and 1);
- — engineers (technicians) (Grades 3, 2 and 1).

Grade 1 is the highest.

In addition licences are issued to flight attendants, flight operators and parachute service instructors.

The pilot (Grade 1) licence is issued to pilots (Grade 2) provided that established requirements are met and professional knowledge and skills are verified.

1.2.5.2.1 The 12-month interval is not reduced for pilots over 40.

CHAPTER 2

2.1.9.1 When licences are issued or a higher grade is given to pilots, account is taken of the following flying experience:

- — the total accident-free flight time, irrespective of the capacity (pilot-in-command or co-pilot) in which the pilot acted;
- — the total solo flight time as pilot-in-command;
- — the solo flight time as pilot-in-command at night.

2.1.9.2 When licences are issued or a higher grade is given to pilots, account is taken of the following flying experience:

- — the total accident-free flight time, irrespective of the capacity (pilot-in-command or co-pilot) in which the pilot acted;
- — the total solo flight time as pilot-in-command;
- — the solo flight time as pilot-in-command at night.

2.1.9.3 When licences are issued or a higher grade is given to pilots, account is taken of the following flying experience:

- — the total accident-free flight time, irrespective of the capacity (pilot-in-command or co-pilot) in which the pilot acted;
- — the total solo flight time as pilot-in-command;
- — the solo flight time as pilot-in-command at night.

2.1.10 An age limit does not restrict the holder of a licence when acting as the pilot-in-command or co-pilot.

2.4 This corresponds to the pilot Grade 3 licence which is given after completion of flying school. The requirements concerning age, knowledge, experience and skills are no lower than the requirements for the issue of a commercial pilot licence. A rating as to the grade of licence and type and class of aircraft is entered on the licence.

2.5 This corresponds to the classification of pilot Grade 2. Ratings as to the grade given (grade 2) and the type and class of aircraft are entered on the pilot licence. For pilot Grade 1 licence, the requirements concerning experience exceed the requirements for the issue of the airline transport pilot licence.

2.5.1.1 The minimum age is 18 years.

CHAPTER 3

3.2.1.3.1 The applicant, having completed an approved flight navigator training programme at an educational establishment, receives the flight navigator licence.

3.3.1.3.1 The applicant, having completed an approved flight engineer training programme, receives the flight engineer licence.

3.4 Provision is made for the issue of a flight radio operator licence. The requirements for the issue of the licence correspond to the requirements of 3.3 of Annex 1 (Seventh Edition).

A flight radiotelephone operator licence is not issued.

19/7/95

SOUTH AFRICA

CHAPTER 2

2.1.10 The Civil Aviation Authority of the Republic of South Africa shall not permit the holder of a pilot licence, which it has issued, who has attained the age of 60 years, to act as pilot-in-command or co-pilot, as appropriate, of an aircraft engaged in scheduled international air services or non-scheduled international transport operations for remuneration or hire except:

— as a member of a multi-pilot crew and provided that:

— such holder is the only pilot in the flight crew who has attained age 60; and
— the aircraft is fitted with dual controls.

Such pilots shall not act as pilot of an aircraft engaged on scheduled international air services or non-scheduled air transport operations after attaining their 65th birthday.

19/7/95

SPAIN

CHAPTER 1

1.2.5.1.1 The senior commercial pilot licence and the flight radio operator licence will remain in force in Spain beyond 15 November 1994 under the same conditions and with the same privileges as prior to that date.

19/7/95

THAILAND

CHAPTER 4

4.2.1.1 Age. Not less than 22 years of age.

4.2.1.3 Experience.

a) for the issue of a licence with privileges for signing a Maintenance Release (Certificate of Safety for Flight), at least:

1) four years; or

2) one year if the applicant has satisfactorily completed an approved training course which will provide an equivalent level of practical experience.

4.3.1.1 Age. Not less than 22 years of age.

4.3.1.3 Experience.

a) for the issue of a licence with privileges for certifying the airworthiness of aircraft, at least:

1) five years; or

2) two years of the applicant has satisfactorily completed an approved training course that will give an equivalent level of practical experience.

19/7/95

TURKEY

CHAPTER 2

2.1.10 The 63rd birthday rather than the 60th shall be applied.

19/7/95

UNITED KINGDOM

CHAPTER 2

2.1.5.2 c) Holders of a pilot's licence issued by the United Kingdom Civil Aviation Authority may continue, until 2 August 1996, to act as co-pilot of two pilot certificated aircraft without having demonstrated, at airline transport pilot licence level, an extent of knowledge determined by the Licensing Authority.

2.1.10 The United Kingdom has issued an exemption to the Air Navigation Order allowing public transport operations on any weight of aircraft up to the age of 65. The regulation is similar to that proposed within JAR-FCL, but we have added the proviso that the 60-64 year old pilot may not have an "as or with co-pilot limitation" for aircraft above 20 tonnes in weight. It naturally remains a multi-crew operation with the other pilot being under age 60.

CHAPTER 4

4.4.1.1 Minimum age is 20 for aerodrome control, approach control or area control rating, 21 for other ratings.

4.6 No issue of flight operations officer/flight dispatcher licences.

19/7/95

UNITED STATES

CHAPTER 1

1.2.5.2 Persons performing airline transport pilot duties must be medically examined at 6-month intervals, regardless of age or type of aircraft.

Persons performing air traffic control tower duties must be medically examined at 12-month intervals, regardless of age.

1.2.5.2.1 Persons performing airline transport pilot duties must be medically examined at 6-month intervals, regardless of age or type of aircraft.

1.2.5.2.2* Persons performing air traffic control tower duties must be medically examined at 12-month intervals, regardless of age.

CHAPTER 2

2.1.3.2 b) Type ratings for small helicopters (5 700 kg or less) are required for air transport pilot privileges and class ratings are required for all grades of certificates.

2.1.4.1 Not applied to co-pilots.

2.1.4.1.1 Not applied to co-pilots.

2.1.5.2 b) Not applied to co-pilots.

2.1.9 An applicant for an airline transport pilot certificate with an aeroplane rating may credit toward the total flight time requirement all flight time served as co-pilot in aeroplanes required to have more than one pilot by their approved aircraft flight manual or airworthiness certificate. Flight time served as co-pilot of an aeroplane performing the duties and functions of a pilot-in-command under the supervision pilot-in-command may be credited towards the 250 hours of pilot-in-command flight time required for an airline transport pilot certificate with an aeroplane rating (if the aircraft or the operating rule requires a co-pilot).

* Recommended Practice

19/7/95

2.3.1.3.1 If the applicant has satisfactorily completed an approved training course, 35 hours of flight time are required.

2.5.1.5.1 There is no requirement for an applicant to demonstrate skills in a multi-engine aeroplane required to be operated with a co-pilot. Skill demonstration may be performed in a single-engine aircraft or in a small multi-engine aircraft requiring only one pilot. Certificate may be issued with single-engine land or sea class rating, as appropriate.

2.7.1.4.1 Fifteen hours must be flight instruction in helicopters.

2.9.1.3.1.1 Two hundred hours in helicopters, of which 75 hours must be as pilot-in-command.

2.12.1.5 The applicant must certify that he has no known defects that make him unable to pilot a glider. He is not required to hold a medical certificate.

2.13.1.3.1 Ten hours in free balloons and six flight.

2.13.1.3.3 There is no night requirement.

2.13.1.5 The applicant must certify that he has no known defects that make him unable to pilot a balloon. He is not required to hold a medical certificate.

CHAPTER 3

3.3.1.1 Flight engineers must be at least 21 years of age.

CHAPTER 4

4.4.1.1 To be eligible for an air traffic control tower operator certificate, a person must be at least 18 years of age.

4.4.1.3 Each applicant for a facility rating at any air traffic control tower must have satisfactorily served as an air traffic control tower operator at that control tower without a facility rating for at least 6 months, or as an air traffic control tower operator with a facility rating at a different control tower for at least 6 months before the date he applies for the rating. However, an applicant who is a member of an Armed Force of the United States meets these requirements if he has satisfactorily served as an air traffic control tower operator for at least 6 months.

4.4.1.4 No person may act as an air traffic control tower operator in connection with civil aircraft unless he holds at least a second class medical certificate. Exception to this is an individual employed by the Federal Aviation Administration or on active duty with the Department of the Air Force, Army, Navy or Coast Guard.

4.5.2.2.1 b) 1) Six months.

2) Six months.

3) The United States does not specify a minimum number of precision approaches to be completed prior to receiving a rating.

c) The United States does not specify a minimum number of precision approaches to be completed prior to receiving a rating.

4.6.1.1 The applicant must be at least 23 years of age.

4.6.1.2 The United States requires applicants to pass a written test.

CHAPTER 6

6.3.2.5.1 Except for duties requiring an airline transport pilot certificate, electrocardiography is not required. For duties requiring an airline transport pilot certificate, an applicant who has passed his or her 35th birthday, but not the 40th birthday, must submit an electrocardiogram on the first examination after the 35th birthday and annually after the 40th birthday.

6.3.2.8.1* No radiography required.

6.3.2.23 Pregnancy does not prohibit the issue of a medical certificate.

6.3.3.3 Applicants who must wear correcting lenses will not require testing for refractive error.

6.4.2.5.1* No electrocardiography required.

6.4.2.8.1* No radiography required.

6.4.2.22 Pregnancy does not prohibit the issue of a medical certificate.

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* Recommended Practice

19/7/95

URUGUAY

CHAPTER 2

2.1.10 The age limit for airline pilots and co-pilots is set at 63 and 65 years respectively.

19/7/95

INTERNATIONAL STANDARDS

RULES OF THE AIR

ANNEX 2

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

NINTH EDITION — JULY 1990

This edition incorporates all amendments adopted by the Council prior to 13 March 1990 and supersedes, on 14 November 1991, all previous editions of Annex 2.

For information regarding the application of the Standards, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-29	Incorporated in this Edition		
30	11/11/93	—	ICAO
31	10/11/94	—	ICAO

CORRIGENDA			
No.	Date of issue	Date entered	Entered by
1	Incorporated in this Edition		

TABLE OF CONTENTS

FOREWORD

Historical background

In October 1945, the Rules of the Air and Air Traffic Control (RAC) Division at its first session made recommendations for Standards, Practices and Procedures for the Rules of the Air. These were reviewed by the then Air Navigation Committee and approved by the Council on 25 February 1946. They were published as "Recommendations for Standards, Practices and Procedures — Rules of the Air" in the first part of Doc 2010, published in February 1946.

The RAC Division, at its second session in December 1946-January 1947, reviewed Doc 2010 and proposed Standards and Recommended Practices for the Rules of the Air. These were adopted by the Council as Standards and Recommended Practices relating to Rules of the Air on 15 April 1948, pursuant to Article 37 of the Convention on International Civil Aviation (Chicago, 1944) and designated as Annex 2 to the Convention with the title "International Standards and Recommended Practices — Rules of the Air". They became effective on 15 September 1948.

On 27 November 1951, the Council adopted a complete new text of the Annex, which no longer contained Recommended Practices. The Standards of the amended Annex 2 (Amendment 1) became effective on 1 April 1952 and applicable on 1 September 1952.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

The Standards in this document, together with the Standards and Recommended Practices of Annex 11, govern the application of the "Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services" and the "Regional Supplementary Procedures — Rules of the Air and Air Traffic Services", in which latter document will be found subsidiary procedures of regional application.

Flight over the high seas. It should be noted that the Council resolved, in adopting Annex 2 in April 1948 and Amendment 1 to the said Annex in November 1951, that the Annex constitutes *Rules relating to the flight and manoeuvre of aircraft* within the meaning of Article 12 of the Convention. Over the high seas, therefore, these rules apply without exception.

On 15 November 1972, when adopting Amendment 14 to Annex 2 relating to authority over aircraft operating over the high seas, the Council emphasized that the Amendment was intended solely to improve safety of flight and to ensure adequate provision of air traffic services over the high seas. The Amendment in no way affects the legal jurisdiction of States of Registry over their aircraft or the responsibility of Contracting States under Article 12 of the Convention for enforcing the Rules of the Air.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. Contracting States are also invited to notify the Organization of any differences between their national regulations and practices and the special recommendations contained in Attachment A to this Annex. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

Attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between thei national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. Information relating to the applicability of national rules and procedures, and changes thereto, established according to the Standards specified in this Annex shall be notified in accordance with Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1. — *Material comprising the Annex proper:*

a) Standards and Recommended Practices adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interests of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2. — *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note.* There are no *Recommended Practices* in Annex 2.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document which is identified by a number includes all subdivisions of the portion.

Table A. Amendments to Annex 2

Amendment	*Source(s)*	*Subject(s)*	*Adopted/approved Effective Applicable*
1st Edition (1948)	RAC Division, Second Session (1947)	Standards and Recommended Practices — Rules of the Air.	15 April 1948 15 September 1948 —
1 (2nd Edition)	RAC Division Fourth Session (1950)	Complete revision and rearrangement of the Annex.	27 November 1951 1 April 1952 1 September 1952
2	RAC Committee of the European-Mediterranean Region Fourth Special Meeting (1952)	Radiocommunication failure procedures; flight plan.	17 November 1953 1 April 1954 1 September 1954
3 (3rd Edition)	Second Air Navigation Conference (1955)	Definitions and terminology; VFR flight outside controlled airspace; distress and urgency signals; signals for aerodrome traffic; marshalling signals.	11 May 1956 15 September 1956 1 December 1956
4	Air Navigation Commission	Guidance material on the application of the definitions of danger area; prohibited area and restricted area.	14 November 1958 — —
5 (4th Edition)	RAC/SAR Divisions Meeting (1958); Air Navigation Commission	Definitions; prohibition of VFR flights at night within controlled airspace; avoidance of collisions; flight plans; visual and instrument flight rules; SELCAL; marshalling signals.	8 December 1959 1 May 1960 1 August 1960
6	RAC/SAR Divisions Meeting (1958); Airworthiness Committee, Fourth Meeting (1960)	VFR flight; table of cruising levels; aircraft navigation lights.	13 December 1961 1 April 1962 1 July 1962
7	Fourth North Atlantic Regional Air Navigation Meeting (1961)	Application of table of cruising levels in polar areas.	27 June 1962 1 November 1962 1 December 1962
8 (5th Edition)	RAC/OPS Divisional Meeting (1963); Air Navigation Commission	Definitions; provisions regarding flight level and altitudes; submission of flight plans; establishment of a single table of VFR criteria; prohibition of VFR flights at night in uncontrolled airspace and above FL 200; communications for IFR flights outside controlled airspace; replacement of quadrantal table of cruising levels by a semi-circular table; vertical separation above FL 290.	29 November 1965 29 March 1966 25 August 1966
9	Air Navigation Commission	Guidance material; excerpts from the International Regulations for Preventing Collisions at Sea.	29 November 1965 — —
10	Air Traffic Control Automation Panel (ATCAP), Fifth Meeting (1966); Air Navigation Commission	Flight plans; deletion of guidance material regarding the International Regulations for Preventing Collisions at Sea and of the associated application Standard.	7 June 1967 5 October 1967 8 February 1968

Amendment	Source(s)	Subject(s)	Adopted/approved Effective Applicable
11	Fifth Air Navigation Conference (1967)	Air traffic services reporting office; marshalling signals.	23 January 1969 23 May 1969 18 September 1969
12 (6th Edition)	Sixth Air Navigation Conference (1969)	Definitions; minimum heights/levels; controlled VFR flights; new terminology for designating controlled airspace.	25 May 1970 25 September 1970 4 February 1971
13	Limited European-Mediterranean (RAC/COM) Regional Air Navigation Meeting (1969); Air Navigation Commission	Radiocommunication failure procedures; unserviceability markings on manoeuvring areas.	24 March 1972 24 July 1972 7 December 1972
14	Air Navigation Commission	Authority over aircraft operating over the high seas.	15 November 1972 15 March 1973 16 August 1973
15	Air Traffic Control Automation Panel (ATCAP), Fifth Meeting (1966)	Repetitive flight plans.	13 December 1972 13 April 1973 16 August 1973
16	Seventh Air Navigation Conference (1972)	Note relating to SSR Mode C transmission of pressure-altitude.	23 March 1973 — 23 May 1974
17	Council action in pursuance of Assembly Resolutions A17-10 and A18-10	Practices to be followed in the event that an aircraft is being subjected to unlawful interference.	7 December 1973 7 April 1974 23 May 1974
18	Air Navigation Commission	Radiocommunication failure procedures; Note concerning lease, charter and interchange of aircraft.	8 April 1974 8 August 1974 27 February 1975
19	Technical Panel on Supersonic Transport Operations (SSTP), Fourth Meeting (1973); Air Navigation Commission	Action by an aircraft which is being intercepted; visual signals for use in the event of interception; guidance material to assist States in eliminating or reducing interceptions; provision relating to flight at transonic and supersonic speeds; changes to reflect the concept of cruise climbs.	4 February 1975 4 June 1975 9 October 1975
20	Air Navigation Commission	Time-keeping accuracy in ATS units and on board aircraft; use of SSR code 7500 in the event of unlawful interference.	7 April 1976 7 August 1976 30 December 1976
21	Ninth Air Navigation Conference (1976)	Definitions relating to change-over points and transition altitudes; requirement for aircraft to adhere to the centre line of ATS routes and to comply with change-over points; cruising levels; flight plans and position reports; alignment of the definition of flight level with that in Annex 3 and Annex 10, Volume II.	7 December 1977 7 April 1978 10 August 1978

Amendment	*Source(s)*	*Subject(s)*	*Adopted/approved* *Effective* *Applicable*
22	Air Navigation Commission	Unmanned free balloons: estimated time of arrival.	2 March 1981 2 July 1981 26 November 1981
23 (7th Edition)	Air Navigation Commission	Interception of civil aircraft.	1 April 1981 1 August 1981 26 November 1981
24	Air Navigation Commission	Aircraft exterior lights.	19 March 1982 19 July 1982 25 November 1982
25	Air Navigation Commission; AGA Divisional Meeting (1981)	Definitions relating to height, instrument approach procedure, manoeuvring and movement area, taxiing, and taxiway; use of the phrase "HIJACK" in the event of interception of civil aircraft; note regarding lease, charter or interchange of aircraft; provisions related to surface movement of aircraft and taxiing; series 2 signals used by helicopters in the event of interception; units of measurement.	21 March 1983 29 July 1983 24 November 1983
26	ATS Data Acquisition, Processing and Transfer Panel, Third Meeting (1981); Air Navigation Commission	Definitions; contents of flight plans; repetitive flight plans; ATS data interchange; pronunciations to be used by intercepting aircraft; alignment of the radiotelephony urgency signal with Annex 10, Volume II; Co-ordinated Universal Time (UTC).	22 June 1984 22 October 1984 21 November 1985
27 (8th Edition)	Council; Air Navigation Commission	Identification and interception of civil aircraft.	10 March 1986 27 July 1986 20 November 1986
28	Air Navigation Commission	Definition of "apron"; special procedures for use during unlawful interference.	16 March 1987 27 July 1987 19 November 1987
29 (9th Edition)	Visual Flight Rules Operations Panel, Third Meeting (1986); Secretariat; Visual Aids Panel, Eleventh Meeting (1987); Air Navigation Commission; amendments consequential to adoption of amendments to Annex 6	Operation of aircraft in mixed VFR/IFR environments; surface movement of aircraft and surface movement guidance and control; acts of unlawful interference; helicopters as intercepting aircraft.	12 March 1990 30 July 1990 14 November 1991
30	Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel, Fourth Meeting (SICASP/4) (1989)	Definitions; airborne collision avoidance system (ACAS).	26 February 1993 26 July 1993 11 November 1993
31	Review of the General Concept of Separation Panel, Seventh Meeting (1990); Air Navigation Commission; Automatic Dependent Surveillance Panel, Second Meeting (1992)	Definitions; air-taxiing; separation between aircraft; formation flights by civil aircraft in controlled airspace; automatic dependent surveillance	18 March 1994 25 July 1994 10 November 1994

INTERNATIONAL STANDARDS

CHAPTER 1. DEFINITIONS

Note.— Throughout the text of this document the term "service" is used as an abstract noun to designate functions, or service rendered; the term "unit" is used to designate a collective body performing a service.

When the following terms are used in the International Standards for Rules of the Air, they have the following meanings:

Acrobatic flight. Manoeuvres intentionally performed by an aircraft involving an abrupt change in its attitude, an abnormal attitude, or an abnormal variation in speed.

Advisory airspace. An airspace of defined dimensions, or designated route, within which air traffic advisory service is available.

Advisory route. A designated route along which air traffic advisory service is available.

Aerodrome. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome control service. Air traffic control service for aerodrome traffic.

Aerodrome control tower. A unit established to provide air traffic control service to aerodrome traffic.

Aerodrome traffic. All traffic on the manoeuvring area of an aerodrome and all aircraft flying in the vicinity of an aerodrome.

Note.— An aircraft is in the vicinity of an aerodrome when it is in, entering or leaving an aerodrome traffic circuit.

Aerodrome traffic zone. An airspace of defined dimensions established around an aerodrome for the protection of aerodrome traffic.

Aeronautical Information Publication. A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

Aeronautical station. A land station in the aeronautical mobile service. In certain instances, an aeronautical station may be located, for example, on board ship or on a platform at sea.

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Air-ground control radio station. An aeronautical telecommunication station having primary responsibility for handling communications pertaining to the operation and control of aircraft in a given area.

Air-taxiing. Movement of a helicopter/VTOL above the surface of an aerodrome, normally in ground effect and at a ground speed normally less than 37 km/h (20 kt).

Note.— The actual height may vary, and some helicopters may require air-taxiing above 8 m (25 ft) AGL to reduce ground effect turbulence or provide clearance for cargo slingloads.

Air traffic. All aircraft in flight or operating on the manoeuvring area of an aerodrome.

Air traffic advisory service. A service provided within advisory airspace to ensure separation, in so far as practical, between aircraft which are operating on IFR flight plans.

Air traffic control clearance. Authorization for an aircraft to proceed under conditions specified by an air traffic control unit.

Note 1.— For convenience, the term "air traffic control clearance" is frequently abbreviated to "clearance" when used in appropriate contexts.

Note 2.— The abbreviated term "clearance" may be prefixed by the words "taxi", "take-off", "departure", "en route", "approach" or "landing" to indicate the particular portion of flight to which the air traffic control clearance relates.

Air traffic control service. A service provided for the purpose of:

a) preventing collisions:

1) between aircraft, and

2) on the manoeuvring area between aircraft and obstructions, and

b) expediting and maintaining an orderly flow of air traffic.

Air traffic control unit. A generic term meaning variously, area control centre, approach control office or aerodrome control tower.

Air traffic service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Air traffic services airspaces. Airspaces of defined dimensions, alphabetically designated, within which specific types of flights may operate and for which air traffic services and rules of operation are specified.

Note.— ATS airspaces are classified as Class A to G.

Air traffic services reporting office. A unit established for the purpose of receiving reports concerning air traffic services and flight plans submitted before departure.

Note.— An air traffic services reporting office may be established as a separate unit or combined with an existing unit, such as another air traffic services unit, or a unit of the aeronautical information service.

Air traffic services unit. A generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office.

Airborne collision avoidance system (ACAS). An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Airway. A control area or portion thereof established in the form of a corridor equipped with radio navigation aids.

Alerting service. A service provided to notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required.

Alternate aerodrome. An aerodrome to which an aircraft may proceed when it becomes either impossible or inadvisable to proceed to or to land at the aerodrome of intended landing. Alternate aerodromes include the following:

Take-off alternate. An alternate aerodrome at which an aircraft can land should this become necessary shortly after take-off and it is not possible to use the aerodrome of departure.

En-route alternate. An aerodrome at which an aircraft would be able to land after experiencing an abnormal or emergency condition while en route.

Destination alternate. An alternate aerodrome to which an aircraft may proceed should it become impossible or inadvisable to land at the aerodrome of intended landing.

Note.— The aerodrome from which a flight departs may also be an en-route or a destination alternate aerodrome for that flight.

Altitude. The vertical distance of a level, a point or an object considered as a point, measured from mean sea level (MSL).

Approach control office. A unit established to provide air traffic control service to controlled flights arriving at, or departing from, one or more aerodromes.

Approach control service. Air traffic control service for arriving or departing controlled flights.

Appropriate ATS authority. The relevant authority designated by the State responsible for providing air traffic services in the airspace concerned.

Appropriate authority.

a) Regarding flight over the high seas: The relevant authority of the State of Registry.

b) Regarding flight other than over the high seas: The relevant authority of the State having sovereignty over the territory being overflown.

Apron. A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

Area control centre. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

Area control service. Air traffic control service for controlled flights in control areas.

ATS route. A specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services.

Note.— The term "ATS route", is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route, etc.

Ceiling. The height above the ground or water of the base of the lowest layer of cloud below 6 000 metres (20 000 feet) covering more than half the sky.

Change-over point. The point at which an aircraft navigating on an ATS route segment defined by reference to very high frequency omnidirectional radio ranges is expected to transfer its primary navigational reference from the facility behind the aircraft to the next facility ahead of the aircraft.

Note.— Change-over points are established to provide the optimum balance in respect of signal strength and quality between facilities at all levels to be used and to ensure a common source of azimuth guidance for all aircraft operating along the same portion of a route segment.

Clearance limit. The point to which an aircraft is granted an air traffic control clearance.

Control area. A controlled airspace extending upwards from a specified limit above the earth.

Controlled aerodrome. An aerodrome at which air traffic control service is provided to aerodrome traffic.

Note.— The term "controlled aerodrome" indicates that air traffic control service is provided to aerodrome traffic but does not necessarily imply that a control zone exists.

Controlled airspace. An airspace of defined dimensions within which air traffic control service is provided to IFR flights and to VFR flights in accordance with the airspace classification.

Note.— Controlled airspace is a generic term which covers ATS airspace Classes A, B, C, D and E.

Controlled flight. Any flight which is subject to an air traffic control clearance.

Control zone. A controlled airspace extending upwards from the surface of the earth to a specified upper limit.

Cruise climb. An aeroplane cruising technique resulting in a net increase in altitude as the aeroplane mass decreases.

Cruising level. A level maintained during a significant portion of a flight.

Current flight plan. The flight plan, including changes, if any, brought about by subsequent clearances.

Danger area. An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

Estimated off-block time. The estimated time at which the aircraft will commence movement associated with departure.

Estimated time of arrival. For IFR flights, the time at which it is estimated that the aircraft will arrive over that designated point, defined by reference to navigation aids, from which it is intended that an instrument approach procedure will be commenced, or, if no navigation aid is associated with the aerodrome, the time at which the aircraft will arrive over the aerodrome. For VFR flights, the time at which it is estimated that the aircraft will arrive over the aerodrome.

Expected approach time. The time at which ATC expects that an arriving aircraft, following a delay, will leave the holding point to complete its approach for a landing.

Note.— The actual time of leaving the holding point will depend upon the approach clearance.

Filed flight plan. The flight plan as filed with an ATS unit by the pilot or a designated representative, without any subsequent changes.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aircraft during flight time.

Flight information centre. A unit established to provide flight information service and alerting service.

Flight information region. An airspace of defined dimensions within which flight information service and alerting service are provided.

Flight information service. A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Flight level. A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hectopascals (hPa) and is separated from other such surfaces by specific pressure intervals.

Note 1.— A pressure type altimeter calibrated in accordance with the Standard Atmosphere:

a) when set to a QNH altimeter setting, will indicate altitude;

b) when set to a QFE altimeter setting, will indicate height above the QFE reference datum;

c) when set to a pressure of 1 013.2 hectopascals (hPa) may be used to indicate flight levels.

Note 2.— The terms "height" and "altitude" used in Note 1 above, indicate altimetric rather than geometric heights and altitudes.

Flight plan. Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Flight status. An indication of whether a given aircraft requires special handling by air traffic services units or not.

Flight visibility. The visibility forward from the cockpit of an aircraft in flight.

Ground visibility. The visibility at an aerodrome, as reported by an accredited observer.

Heading. The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from North (true, magnetic, compass or grid).

Height. The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

IFR. The symbol used to designate the instrument flight rules.

IFR flight. A flight conducted in accordance with the instrument flight rules.

IMC. The symbol used to designate instrument meteorological conditions.

Instrument approach procedure. A series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply.

Instrument meteorological conditions. Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.

Note.— The specified minima for visual meteorological conditions are contained in Chapter 4.

Landing area. That part of a movement area intended for the landing or take-off of aircraft.

Level. A generic term relating to the vertical position of an aircraft in flight and meaning variously, height, altitude or flight level.

Manoeuvring area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Movement area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Pressure-altitude. An atmospheric pressure expressed in terms of altitude which corresponds to that pressure in the Standard Atmosphere.*

Prohibited area. An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

Repetitive flight plan (RPL). A flight plan related to a series of frequently recurring, regularly operated individual flights with identical basic features, submitted by an operator for retention and repetitive use by ATS units.

Reporting point. A specified geographical location in relation to which the position of an aircraft can be reported.

Restricted area. An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

Runway. A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Signal area. An area on an aerodrome used for the display of ground signals.

Special VFR flight. A VFR flight cleared by air traffic control to operate within a control zone in meteorological conditions below VMC.

Taxiing. Movement of an aircraft on the surface of an aerodrome under its own power, excluding take-off and landing.

Taxiway. A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another; including:

a) *Aircraft stand taxilane.* A portion of an apron designated as a taxiway and intended to provide access to aircraft stands only.

b) *Apron taxiway.* A portion of a taxiway system located on an apron and intended to provide a through taxi route across the apron.

c) *Rapid exit taxiway.* A taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than are achieved on other exit taxiways and thereby minimizing runway occupancy times.

Terminal control area. A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

Total estimated elapsed time. For IFR flights, the estimated time required from take-off to arrive over that designated point, defined by reference to navigation aids, from which it is intended that an instrument approach procedure will be commenced, or, if no navigation aid is associated with the destination aerodrome, to arrive over the destination aerodrome. For VFR flights, the estimated time required from take-off to arrive over the destination aerodrome.

Track. The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic or grid).

Traffic avoidance advice. Advice provided by an air traffic services unit specifying manoeuvres to assist a pilot to avoid a collision.

Traffic information. Information issued by an air traffic services unit to alert a pilot to other known or observed air traffic which may be in proximity to the position or intended route of flight and to help the pilot avoid a collision.

Transition altitude. The altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes.

Unmanned free balloon. A non-power-driven, unmanned, lighter-than-air aircraft in free flight.

Note.— Unmanned free balloons are classified as heavy, medium or light in accordance with specifications contained in Appendix 4.

VFR. The symbol used to designate the visual flight rules.

VFR flight. A flight conducted in accordance with the visual flight rules.

Visibility. The ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night.

Visual meteorological conditions. Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling equal to or better than specified minima.

Note.— The specified minima are contained in Chapter 4.

VMC. The symbol used to designate visual meteorological conditions.

* As defined in Annex 8.

CHAPTER 2. APPLICABILITY OF THE RULES OF THE AIR

2.1 Territorial application of the rules of the air

2.1.1 The rules of the air shall apply to aircraft bearing the nationality and registration marks of a Contracting State, wherever they may be, to the extent that they do not conflict with the rules published by the State having jurisdiction over the territory overflown.

Note.— The Council of the International Civil Aviation Organization resolved, in adopting Annex 2 in April 1948 and Amendment 1 to the said Annex in November 1951, that the Annex constitutes Rules relating to the flight and manoeuvre of aircraft *within the meaning of Article 12 of the Convention. Over the high seas, therefore, these rules apply without exception.*

2.1.2 If, and so long as, a Contracting State has not notified the International Civil Aviation Organization to the contrary, it shall be deemed, as regards aircraft of its registration, to have agreed as follows:

For purposes of flight over those parts of the high seas where a Contracting State has accepted, pursuant to a regional air navigation agreement, the responsibility of providing air traffic services, the "appropriate ATS authority" referred to in this Annex is the relevant authority designated by the State responsible for providing those services.

Note.— The phrase "regional air navigation agreement" refers to an agreement approved by the Council of ICAO normally on the advice of a Regional Air Navigation Meeting.

2.2 Compliance with the rules of the air

The operation of an aircraft either in flight or on the movement area of an aerodrome shall be in compliance with the general rules and, in addition, when in flight, either with:

a) the visual flight rules, or

b) the instrument flight rules.

Note 1.— Information relevant to the services provided to aircraft operating in accordance with both visual flight rules and instrument flight rules in the seven ATS airspace classes is contained in 2.6.1 and 2.6.3 of Annex 11.

Note 2.— A pilot may elect to fly in accordance with instrument flight rules in visual meteorological conditions or may be required to do so by the appropriate ATS authority.

2.3 Responsibility for compliance with the rules of the air

2.3.1 Responsibility of pilot-in-command

The pilot-in-command of an aircraft shall, whether manipulating the controls or not, be responsible for the operation of the aircraft in accordance with the rules of the air, except that the pilot-in-command may depart from these rules in circumstances that render such departure absolutely necessary in the interests of safety.

2.3.2 Pre-flight action

Before beginning a flight, the pilot-in-command of an aircraft shall become familiar with all available information appropriate to the intended operation. Pre-flight action for flights away from the vicinity of an aerodrome, and for all IFR flights, shall include a careful study of available current weather reports and forecasts, taking into consideration fuel requirements and an alternative course of action if the flight cannot be completed as planned.

2.4 Authority of pilot-in-command of an aircraft

The pilot-in-command of an aircraft shall have final authority as to the disposition of the aircraft while in command.

2.5 Use of intoxicating liquor, narcotics or drugs

No person shall pilot an aircraft, or act as a flight crew member of an aircraft, while under the influence of intoxicating liquor or any narcotic or drug, by reason of which that person's capacity to act is impaired.

CHAPTER 3. GENERAL RULES

3.1 Protection of persons and property

3.1.1 Negligent or reckless operation of aircraft

An aircraft shall not be operated in a negligent or reckless manner so as to endanger life or property of others.

3.1.2 Minimum heights

Except when necessary for take-off or landing, or except by permission from the appropriate authority, aircraft shall not be flown over the congested areas of cities, towns or settlements or over an open-air assembly of persons, unless at such a height as will permit, in the event of an emergency arising, a landing to be made without undue hazard to persons or property on the surface.

Note.— See 4.6 for minimum heights for VFR flights and 5.1.2 for minimum levels for IFR flights.

3.1.3 Cruising levels

The cruising levels at which a flight or a portion of a flight is to be conducted shall be in terms of:

a) flight levels, for flights at or above the lowest usable flight level or, where applicable, above the transition altitude;

b) altitudes, for flights below the lowest usable flight level or, where applicable, at or below the transition altitude.

Note.— The system of flight levels is prescribed in the Procedures for Air Navigation Services — Aircraft Operations *(Doc 8168).*

3.1.4 Dropping or spraying

Nothing shall be dropped or sprayed from an aircraft in flight except under conditions prescribed by the appropriate authority and as indicated by relevant information, advice and/or clearance from the appropriate air traffic services unit.

3.1.5 Towing

No aircraft or other object shall be towed by an aircraft, except in accordance with requirements prescribed by the appropriate authority and as indicated by relevant information, advice and/or clearance from the appropriate air traffic services unit.

3.1.6 Parachute descents

Parachute descents, other than emergency descents, shall not be made except under conditions prescribed by the appropriate authority and as indicated by relevant information, advice and/or clearance from the appropriate air traffic services unit.

3.1.7 Acrobatic flight

No aircraft shall be flown acrobatically except under conditions prescribed by the appropriate authority and as indicated by relevant information, advice and/or clearance from the appropriate air traffic services unit.

3.1.8 Formation flights

Aircraft shall not be flown in formation except by pre-arrangement among the pilots-in-command of the aircraft taking part in the flight and, for formation flight in controlled airspace, in accordance with the conditions prescribed by the appropriate ATS authority(ies). These conditions shall include the following:

a) the formation operates as a single aircraft with regard to navigation and position reporting;

b) separation between aircraft in the flight shall be the responsibility of the flight leader and the pilots-in-command of the other aircraft in the flight and shall include periods of transition when aircraft are manoeuvring to attain their own separation within the formation and during join-up and break-away; and

c) a distance not exceeding 1 km (0.5 NM) laterally and longitudinally and 30 m (100 ft) vertically from the flight leader shall be maintained by each aircraft.

3.1.9 Unmanned free balloons

An unmanned free balloon shall be operated in such a manner as to minimize hazards to persons, property or other aircraft and in accordance with the conditions specified in Appendix 4.

3.1.10 Prohibited areas and restricted areas

Aircraft shall not be flown in a prohibited area, or in a restricted area, the particulars of which have been duly published, except in accordance with the conditions of the restrictions or by permission of the State over whose territory the areas are established.

3.2 Avoidance of collisions

Note.— It is important that vigilance for the purpose of detecting potential collisions be not relaxed on board an aircraft in flight, regardless of the type of flight or the class of airspace in which the aircraft is operating, and while operating on the movement area of an aerodrome.

3.2.1 Proximity

An aircraft shall not be operated in such proximity to other aircraft as to create a collision hazard.

3.2.2 Right-of-way

The aircraft that has the right-of-way shall maintain its heading and speed, but nothing in these rules shall relieve the pilot-in-command of an aircraft from the responsibility of taking such action, including collision avoidance manoeuvres based on resolution advisories provided by ACAS equipment, as will best avert collision.

Note 1.— Operating procedures for use of ACAS are contained in PANS-OPS (Doc 8168), Volume I, Part VIII, Chapter 3.

Note 2.— There are currently no ICAO provisions concerning mandatory carriage of ACAS equipment.

3.2.2.1 An aircraft that is obliged by the following rules to keep out of the way of another shall avoid passing over, under or in front of the other, unless it passes well clear and takes into account the effect of aircraft wake turbulence.

3.2.2.2 *Approaching head-on.* When two aircraft are approaching head-on or approximately so and there is danger of collision, each shall alter its heading to the right.

3.2.2.3 *Converging.* When two aircraft are converging at approximately the same level, the aircraft that has the other on its right shall give way, except as follows:

a) power-driven heavier-than-air aircraft shall give way to airships, gliders and balloons;

b) airships shall give way to gliders and balloons;

c) gliders shall give way to balloons;

d) power-driven aircraft shall give way to aircraft which are seen to be towing other aircraft or objects.

3.2.2.4 *Overtaking.* An overtaking aircraft is an aircraft that approaches another from the rear on a line forming an angle of less than 70 degrees with the plane of symmetry of the latter, i.e. is in such a position with reference to the other aircraft that at night it should be unable to see either of the aircraft's left (port) or right (starboard) navigation lights. An aircraft that is being overtaken has the right-of-way and the overtaking aircraft, whether climbing, descending or in horizontal flight, shall keep out of the way of the other aircraft by altering its heading to the right, and no subsequent change in the relative positions of the two aircraft shall absolve the overtaking aircraft from this obligation until it is entirely past and clear.

3.2.2.5 *Landing*

3.2.2.5.1 An aircraft in flight, or operating on the ground or water, shall give way to aircraft landing or in the final stages of an approach to land.

3.2.2.5.2 When two or more heavier-than-air aircraft are approaching an aerodrome for the purpose of landing, aircraft at the higher level shall give way to aircraft at the lower level, but the latter shall not take advantage of this rule to cut in in front of another which is in the final stages of an approach to land, or to overtake that aircraft. Nevertheless, power-driven heavier-than-air aircraft shall give way to gliders.

3.2.2.5.3 *Emergency landing.* An aircraft that is aware that another is compelled to land shall give way to that aircraft.

3.2.2.6 *Taking off.* An aircraft taxiing on the manoeuvring area of an aerodrome shall give way to aircraft taking off or about to take off.

3.2.2.7 *Surface movement of aircraft*

3.2.2.7.1 In case of danger of collision between two aircraft taxiing on the movement area of an aerodrome the following shall apply:

a) when two aircraft are approaching head on, or approximately so, each shall stop or where practicable alter its course to the right so as to keep well clear;

b) when two aircraft are on a converging course, the one which has the other on its right shall give way;

c) an aircraft which is being overtaken by another aircraft shall have the right-of-way and the overtaking aircraft shall keep well clear of the other aircraft.

Note.— For the description of an overtaking aircraft see 3.2.2.4.

3.2.2.7.2 An aircraft taxiing on the manoeuvring area shall stop and hold at all taxi-holding positions unless otherwise authorized by the aerodrome control tower.

Note.— For taxi-holding position markings and related signs, see Annex 14, Volume I, 5.2.9 and 5.4.2.

3.2.2.7.3 An aircraft taxiing on the manoeuvring area shall stop and hold at all lighted stop bars and may proceed further when the lights are switched off.

3.2.3 Lights to be displayed by aircraft

Note 1.— The characteristics of lights intended to meet the requirements of 3.2.3 for aeroplanes are specified in Annex 8. Specifications for navigation lights for aeroplanes are contained in the Appendices to Parts I and II of Annex 6. Detailed technical specifications for lights for aeroplanes are contained in Part III of the Airworthiness Technical Manual *(Doc 9051) and for helicopters in Part IV of that document.*

Note 2.— In the context of 3.2.3.2 c) and 3.2.3.4 a) an aircraft is understood to be operating when it is taxiing or being towed or is stopped temporarily during the course of taxiing or being towed.

Note 3.— For aircraft on the water see 3.2.6.2.

3.2.3.1 Except as provided by 3.2.3.5, from sunset to sunrise or during any other period which may be prescribed by the appropriate authority all aircraft in flight shall display:

a) anti-collision lights intended to attract attention to the aircraft; and

b) navigation lights intended to indicate the relative path of the aircraft to an observer and other lights shall not be displayed if they are likely to be mistaken for these lights.

Note.— Lights fitted for other purposes, such as landing lights and airframe floodlights, may be used in addition to the anti-collision lights specified in the Airworthiness Technical Manual *(Doc 9051) to enhance aircraft conspicuity.*

3.2.3.2 Except as provided by 3.2.3.5, from sunset to sunrise or during any other period prescribed by the appropriate authority:

a) all aircraft moving on the movement area of an aerodrome shall display navigation lights intended to indicate the relative path of the aircraft to an observer and other lights shall not be displayed if they are likely to be mistaken for these lights;

b) unless stationary and otherwise adequately illuminated, all aircraft on the movement area of an aerodrome shall display lights intended to indicate the extremities of their structure;

c) all aircraft operating on the movement area of an aerodrome shall display lights intended to attract attention to the aircraft; and

d) all aircraft on the movement area of an aerodrome whose engines are running shall display lights which indicate that fact.

Note.— If suitably located on the aircraft, the navigation lights referred to in 3.2.3.1 b) may also meet the requirements of 3.2.3.2 b). Red anti-collision lights fitted to meet the requirements of 3.2.3.1 a) may also meet the requirements of 3.2.3.2 c) and 3.2.3.2 d) provided they do not subject observers to harmful dazzle.

3.2.3.3 Except as provided by 3.2.3.5, all aircraft in flight and fitted with anti-collision lights to meet the requirement of 3.2.3.1 a) shall display such lights also outside the period specified in 3.2.3.1.

3.2.3.4 Except as provided by 3.2.3.5, all aircraft:

a) operating on the movement area of an aerodrome and fitted with anti-collision lights to meet the requirement of 3.2.3.2 c); or

b) on the movement area of an aerodrome and fitted with lights to meet the requirement of 3.2.3.2 d);

shall display such lights also outside the period specified in 3.2.3.2.

3.2.3.5 A pilot shall be permitted to switch off or reduce the intensity of any flashing lights fitted to meet the requirements of 3.2.3.1, 3.2.3.2, 3.2.3.3 and 3.2.3.4 if they do or are likely to:

a) adversely affect the satisfactory performance of duties; or

b) subject an outside observer to harmful dazzle.

3.2.4 Simulated instrument flights

An aircraft shall not be flown under simulated instrument flight conditions unless:

a) fully functioning dual controls are installed in the aircraft; and

b) a qualified pilot occupies a control seat to act as safety pilot for the person who is flying under simulated instrument conditions. The safety pilot shall have adequate vision forward and to each side of the aircraft, or a competent observer in communication with the safety pilot shall occupy a position in the aircraft from which the observer's field of vision adequately supplements that of the safety pilot.

3.2.5 Operation on and in the vicinity of an aerodrome

An aircraft operated on or in the vicinity of an aerodrome shall, whether or not within an aerodrome traffic zone:

a) observe other aerodrome traffic for the purpose of avoiding collision;

b) conform with or avoid the pattern of traffic formed by other aircraft in operation;

c) make all turns to the left, when approaching for a landing and after taking off, unless otherwise instructed;

d) land and take off into the wind unless safety, the runway configuration, or air traffic considerations determine that a different direction is preferable.

Note 1.— See 3.6.5.1.

Note 2.— Additional rules may apply in aerodrome traffic zones.

3.2.6 Water operations

Note.— In addition to the provisions of 3.2.6.1 of this Annex, rules set forth in the International Regulations for Preventing Collisions at Sea, developed by the International Conference on Revision of the International Regulations for Preventing Collisions at Sea (London, 1972) may be applicable in certain cases.

3.2.6.1 When two aircraft or an aircraft and a vessel are approaching one another and there is a risk of collision, the aircraft shall proceed with careful regard to existing circumstances and conditions including the limitations of the respective craft.

3.2.6.1.1 *Converging.* An aircraft which has another aircraft or a vessel on its right shall give way so as to keep well clear.

3.2.6.1.2 *Approaching head-on.* An aircraft approaching another aircraft or a vessel head-on, or approximately so, shall alter its heading to the right to keep well clear.

3.2.6.1.3 *Overtaking.* The aircraft or vessel which is being overtaken has the right of way, and the one overtaking shall alter its heading to keep well clear.

3.2.6.1.4 *Landing and taking off.* Aircraft landing on or taking off from the water shall, in so far as practicable, keep well clear of all vessels and avoid impeding their navigation.

3.2.6.2 *Lights to be displayed by aircraft on the water.* Between sunset and sunrise or such other period between sunset and sunrise as may be prescribed by the appropriate authority, all aircraft on the water shall display lights as required by the International Regulations for Preventing Collisions at Sea (revised 1972) unless it is impractical for them to do so, in which case they shall display lights as closely similar as possible in characteristics and position to those required by the International Regulations.

Note 1.— Specifications for lights to be shown by aeroplanes on the water are contained in the Appendices to Parts I and II of Annex 6.

Note 2.— The International Regulations for Preventing Collisions at Sea specify that the rules concerning lights shall be complied with from sunset to sunrise. Any lesser period between sunset and sunrise established in accordance with 3.2.6.2 cannot, therefore, be applied in areas where the International Regulations for Preventing Collisions at Sea apply, e.g. on the high seas.

3.3 Flight plans

3.3.1 Submission of a flight plan

3.3.1.1 Information relative to an intended flight or portion of a flight, to be provided to air traffic services units, shall be in the form of a flight plan.

3.3.1.2 A flight plan shall be submitted prior to operating:

a) any flight or portion thereof to be provided with air traffic control service;

b) any IFR flight within advisory airspace;

c) any flight within or into designated areas, or along designated routes, when so required by the appropriate ATS authority to facilitate the provision of flight information, alerting and search and rescue services;

d) any flight within or into designated areas, or along designated routes, when so required by the appropriate ATS authority to facilitate co-ordination with appropriate military units or with air traffic services units in adjacent States in order to avoid the possible need for interception for the purpose of identification;

e) any flight across international borders.

Note.— The term "flight plan" is used to mean variously, full information on all items comprised in the flight plan description, covering the whole route of a flight, or limited information required when the purpose is to obtain a clearance for a minor portion of a flight such as to cross an airway, to take off from, or to land at a controlled aerodrome.

3.3.1.3 A flight plan shall be submitted before departure to an air traffic services reporting office or, during flight, transmitted to the appropriate air traffic services unit or air-ground control radio station, unless arrangements have been made for submission of repetitive flight plans.

3.3.1.4 Unless otherwise prescribed by the appropriate ATS authority, a flight plan for a flight to be provided with air traffic control service or air traffic advisory service shall be submitted at least sixty minutes before departure, or, if submitted during flight, at a time which will ensure its receipt by the appropriate air traffic services unit at least ten minutes before the aircraft is estimated to reach:

a) the intended point of entry into a control area or advisory area; or

b) the point of crossing an airway or advisory route.

3.3.2 Contents of a flight plan

A flight plan shall comprise information regarding such of the following items as are considered relevant by the appropriate ATS authority:

— Aircraft identification

— Flight rules and type of flight

— Number and type(s) of aircraft and wake turbulence category

— Equipment

— Departure aerodrome (see Note 1)

— Estimated off-block time (see Note 2)

— Cruising speed(s)

— Cruising level(s)

— Route to be followed

— Destination aerodrome and total estimated elapsed time

— Alternate aerodrome(s)

— Fuel endurance

— Total number of persons on board

— Emergency and survival equipment

— Other information.

Note 1.— For flight plans submitted during flight, the information provided in respect of this item will be an indication of the location from which supplementary information concerning the flight may be obtained, if required.

Note 2.— For flight plans submitted during flight, the information to be provided in respect of this item will be the time over the first point of the route to which the flight plan relates.

Note 3.— The term "aerodrome" where used in the flight plan is intended to cover also sites other than aerodromes which may be used by certain types of aircraft, e.g. helicopters or balloons.

3.3.3 Completion of a flight plan

3.3.3.1 Whatever the purpose for which it is submitted, a flight plan shall contain information, as applicable, on relevant items up to and including "Alternate aerodrome(s)" regarding the whole route or the portion thereof for which the flight plan is submitted.

3.3.3.2 It shall, in addition, contain information, as applicable, on all other items when so prescribed by the appropriate ATS authority or when otherwise deemed necessary by the person submitting the flight plan.

3.3.4 Changes to a flight plan

Subject to the provisions of 3.6.2.2, all changes to a flight plan submitted for an IFR flight, or a VFR flight operated as a controlled flight, shall be reported as soon as practicable to the appropriate air traffic services unit. For other VFR flights, significant changes to a flight plan shall be reported as soon as practicable to the appropriate air traffic services unit.

Note 1.— Information submitted prior to departure regarding fuel endurance or total number of persons carried on board, if incorrect at time of departure, constitutes a significant change to the flight plan and as such must be reported.

Note 2.— Procedures for submission of changes to repetitive flight plans are contained in the PANS-RAC, Part II (Doc 4444).

3.3.5 Closing a flight plan

3.3.5.1 Unless otherwise prescribed by the appropriate ATS authority, a report of arrival shall be made either in person or by radio at the earliest possible moment after landing, to the appropriate air traffic services unit at the arrival aerodrome, by any flight for which a flight plan has been submitted covering the entire flight or the remaining portion of a flight to the destination aerodrome.

3.3.5.2 When a flight plan has been submitted only in respect of a portion of a flight, other than the remaining portion of a flight to destination, it shall, when required, be closed by an appropriate report to the relevant air traffic services unit.

3.3.5.3 When no air traffic services unit exists at the arrival aerodrome, the arrival report, when required, shall be made as soon as practicable after landing and by the quickest means available to the nearest air traffic services unit.

3.3.5.4 When communication facilities at the arrival aerodrome are known to be inadequate and alternate arrangements for the handling of arrival reports on the ground are not available, the following action shall be taken. Immediately prior to landing the aircraft shall, if practicable, transmit by radio to an appropriate air traffic services unit, a message comparable to an arrival report, where such a report is required. Normally, this transmission shall be made to the aeronautical station serving the air traffic services unit in charge of the flight information region in which the aircraft is operated.

3.3.5.5 Arrival reports made by aircraft shall contain the following elements of information:

a) aircraft identification;

b) departure aerodrome;

c) destination aerodrome (only in the case of a diversionary landing);

d) arrival aerodrome;

e) time of arrival.

Note.— Whenever an arrival report is required, failure to comply with these provisions may cause serious disruption in the air traffic services and incur great expense in carrying out unnecessary search and rescue operations.

3.4 Signals

3.4.1 Upon observing or receiving any of the signals given in Appendix 1, aircraft shall take such action as may be required by the interpretation of the signal given in that Appendix.

3.4.2 The signals of Appendix 1 shall, when used, have the meaning indicated therein. They shall be used only for the purpose indicated and no other signals likely to be confused with them shall be used.

3.5 Time

3.5.1 Co-ordinated Universal Time (UTC) shall be used and shall be expressed in hours and minutes of the 24-hour day beginning at midnight.

3.5.2 A time check shall be obtained prior to operating a controlled flight and at such other times during the flight as may be necessary.

Note.— Such time check is normally obtained from an air traffic services unit unless other arrangements have been made by the operator or by the appropriate ATS authority.

3.6 Air traffic control service

3.6.1 Air traffic control clearances

3.6.1.1 An air traffic control clearance shall be obtained prior to operating a controlled flight, or a portion of a flight as a controlled flight. Such clearance shall be requested through the submission of a flight plan to an air traffic control unit.

Note 1.— A flight plan may cover only part of a flight, as necessary, to describe that portion of the flight or those manoeuvres which are subject to air traffic control. A clearance may cover only part of a current flight plan, as indicated in a clearance limit or by reference to specific manoeuvres such as taxiing, landing or taking off.

Note 2.— If an air traffic control clearance is not satisfactory to a pilot-in-command of an aircraft, the pilot-in-command may request and, if practicable, will be issued an amended clearance.

3.6.1.2 Whenever an aircraft has requested a clearance involving priority, a report explaining the necessity for such priority shall be submitted, if requested by the appropriate air traffic control unit.

3.6.1.3 *Potential reclearance in flight.* If prior to departure it is anticipated that depending on fuel endurance and subject to reclearance in flight, a decision may be taken to proceed to a revised destination aerodrome, the appropriate air traffic control units shall be so notified by the insertion in the flight plan of information concerning the revised route (where known) and the revised destination.

Note.— The intent of this provision is to facilitate a reclearance to a revised destination, normally beyond the filed destination aerodrome.

3.6.1.4 An aircraft operated on a controlled aerodrome shall not taxi on the manoeuvring area without clearance from the aerodrome control tower and shall comply with any instructions given by that unit.

3.6.2 Adherence to flight plan

3.6.2.1 Except as provided for in 3.6.2.2 and 3.6.2.4, an aircraft shall adhere to the current flight plan or the applicable portion of a current flight plan submitted for a controlled flight unless a request for a change has been made and clearance obtained from the appropriate air traffic control unit, or unless an emergency situation arises which necessitates immediate action by the aircraft, in which event as soon as circumstances permit, after such emergency authority is exercised, the appropriate air traffic services unit shall be notified of the action taken and that this action has been taken under emergency authority.

3.6.2.1.1 Unless otherwise authorized or directed by the appropriate air traffic control unit, controlled flights shall, in so far as practicable:

a) when on an established ATS route, operate along the defined centre line of that route; or

b) when on any other route, operate directly between the navigation facilities and/or points defining that route.

3.6.2.1.2 Subject to the overriding requirement in 3.6.2.1.1, an aircraft operating along an ATS route segment defined by reference to very high frequency omnidirectional radio ranges shall change over for its primary navigation guidance from the facility behind the aircraft to that ahead of it at, or as close as operationally feasible to, the change-over point, where established.

3.6.2.1.3 Deviation from the requirements in 3.6.2.1.1 shall be notified to the appropriate air traffic services unit.

3.6.2.2 *Inadvertent changes.* In the event that a controlled flight inadvertently deviates from its current flight plan, the following action shall be taken:

a) *Deviation from track:* if the aircraft is off track, action shall be taken forthwith to adjust the heading of the aircraft to regain track as soon as practicable.

b) *Variation in true airspeed:* if the average true airspeed at cruising level between reporting points varies or is expected to vary by plus or minus 5 per cent of the true airspeed, from that given in the flight plan, the appropriate air traffic services unit shall be so informed.

c) *Change in time estimate:* if the time estimate for the next applicable reporting point, flight information region boundary or destination aerodrome, whichever comes first, is found to be in error in excess of three minutes from that notified to air traffic services, or such other period of time as is prescribed by the appropriate ATS authority or on the basis of air navigation regional agreements, a revised estimated time shall be notified as soon as possible to the appropriate air traffic services unit.

3.6.2.3 *Intended changes.* Requests for flight plan changes shall include information as indicated hereunder:

a) *Change of cruising level:* aircraft identification; requested new cruising level and cruising speed at this level, revised time estimates (when applicable) at subsequent flight information region boundaries.

b) *Change of route:*

1) *Destination unchanged:* aircraft identification; flight rules; description of new route of flight including related flight plan data beginning with the position from which requested change of route is to commence; revised time estimates; any other pertinent information.

2) *Destination changed:* aircraft identification; flight rules; description of revised route of flight to revised destination aerodrome including related flight plan data, beginning with the position from which requested change of route is to commence; revised time estimates; alternate aerodrome(s); any other pertinent information.

3.6.2.4 *Weather deterioration below the VMC.* When it becomes evident that flight in VMC in accordance with its current flight plan will not be practicable, a VFR flight operated as a controlled flight shall:

a) request an amended clearance enabling the aircraft to continue in VMC to destination or to an alternative aerodrome, or to leave the airspace within which an ATC clearance is required; or

b) if no clearance in accordance with a) can be obtained, continue to operate in VMC and notify the appropriate ATC unit of the action being taken either to leave the airspace concerned or to land at the nearest suitable aerodrome; or

c) if operated within a control zone, request authorization to operate as a special VFR flight; or

d) request clearance to operate in accordance with the instrument flight rules.

3.6.3 Position reports

Unless exempted by the appropriate ATS authority or by the appropriate air traffic services unit under conditions specified by that authority, a controlled flight shall report to the appropriate air traffic services unit, as soon as possible, the time and level of passing each designated compulsory reporting point, together with any other required information. Position reports shall similarly be made in relation to additional points when requested by the appropriate air traffic services unit. In the absence of designated reporting points, position reports shall be made at intervals prescribed by the appropriate ATS authority or specified by the appropriate air traffic services unit.

Note.— The conditions and circumstances in which SSR Mode C transmission of pressure-altitude satisfies the requirement for level information in position reports are indicated in the PANS-RAC, Part II (Doc 4444).

3.6.4 Termination of control

A controlled flight shall, except when landing at a controlled aerodrome, advise the appropriate ATC unit as soon as it ceases to be subject to air traffic control service.

3.6.5 Communications

3.6.5.1 An aircraft operated as a controlled flight shall maintain continuous listening watch on the appropriate radio frequency of, and establish two-way communication as necessary with, the appropriate air traffic control unit, except as may be prescribed by the appropriate ATS authority in respect of aircraft forming part of aerodrome traffic at a controlled aerodrome.

Note.— SELCAL or similar automatic signalling devices satisfy the requirement to maintain a listening watch.

3.6.5.2 *Communication failure.* If a radio failure precludes compliance with 3.6.5.1, the aircraft shall comply with the radiocommunication failure procedures of Annex 10, Volume II, and with such of the following procedures as are appropriate. In addition, the aircraft, when forming part of the aerodrome traffic at a controlled aerodrome, shall keep a watch for such instructions as may be issued by visual signals.

3.6.5.2.1 If in visual meteorological conditions, the aircraft shall:

a) continue to fly in visual meteorological conditions;

b) land at the nearest suitable aerodrome; and

c) report its arrival by the most expeditious means to the appropriate air traffic control unit.

3.6.5.2.2 If in instrument meteorological conditions or when weather conditions are such that it does not appear feasible to complete the flight in accordance with 3.6.5.2.1 (see Note 1), the aircraft shall:

a) proceed according to the current flight plan to the appropriate designated navigation aid serving the destination aerodrome (see Note 2) and, when required to ensure compliance with b) below, hold over this aid until commencement of descent;

b) commence descent from the navigation aid specified in a) at, or as close as possible to, the expected approach time last received and acknowledged; or, if no expected approach time has been received and acknowledged, at, or as close as possible to, the estimated time of arrival resulting from the current flight plan;

c) complete a normal instrument approach procedure as specified for the designated navigation aid; and

d) land, if possible, within thirty minutes after the estimated time of arrival specified in b) or the last acknowledged expected approach time, whichever is later.

Note 1.— As evidenced by the meteorological conditions prescribed therein, 3.6.5.2.1 relates to all controlled flights, whereas 3.6.5.2.2 relates only to IFR flights.

Note 2.— If the clearance for the levels covers only part of the route, the aircraft is expected to maintain the last assigned and acknowledged cruising level(s) to the point(s) specified in the clearance and thereafter the cruising level(s) in the current flight plan.

Note 3.— The provision of air traffic control service to other flights operating in the airspace concerned will be based on the assumption that an aircraft experiencing radio failure will comply with the rules in 3.6.5.2.2.

3.7 Unlawful interference

An aircraft which is being subjected to unlawful interference shall endeavour to notify the appropriate ATS unit of this fact, any significant circumstances associated therewith and any deviation from the current flight plan necessitated by the circumstances, in order to enable the ATS unit to give priority to the aircraft and to minimize conflict with other aircraft.

Note 1.— Responsibility of ATS units in situations of unlawful interference is contained in Annex 11.

Note 2.— Guidance material for use when unlawful interference occurs and the aircraft is unable to notify an ATS unit of this fact is contained in Attachment B to this Annex.

Note 3.— Action to be taken by SSR equipped aircraft which are being subjected to unlawful interference is contained in Annex 11, the PANS-RAC (Doc 4444) and the PANS-OPS (Doc 8168).

3.8 Interception

Note.— The word "interception" in this context does not include intercept and escort service provided, on request, to an aircraft in distress, in accordance with the Search and Rescue Manual *(Doc 7333).*

3.8.1 Interception of civil aircraft shall be governed by appropriate regulations and administrative directives issued by Contracting States in compliance with the Convention on International Civil Aviation, and in particular Article 3(d) under which Contracting States undertake, when issuing regulations for their State aircraft, to have due regard for the safety of navigation of civil aircraft. Accordingly, in drafting appropriate regulations and administrative directives due regard shall be had to the provisions of Appendix 1, Section 2 and Appendix 2, Section 1.

Note.— Recognizing that it is essential for the safety of flight that any visual signals employed in the event of an interception which should be undertaken only as a last resort be correctly employed and understood by civil and military aircraft throughout the world, the Council of the International Civil Aviation Organization, when adopting the visual signals in Appendix 1 to this Annex, urged Contracting States to ensure that they be strictly adhered to by their State aircraft. As interceptions of civil aircraft are, in all cases, potentially hazardous, the Council has also formulated special recommendations which Contracting States are urged to apply in a uniform manner. These special recommendations are contained in Attachment A.

3.8.2 The pilot-in-command of a civil aircraft, when intercepted, shall comply with the Standards in Appendix 2, Sections 2 and 3, interpreting and responding to visual signals as specified in Appendix 1, Section 2.

Note.— See also 2.1.1 and 3.4.

CHAPTER 4. VISUAL FLIGHT RULES

4.1 Except when operating as a special VFR flight, VFR flights shall be conducted so that the aircraft is flown in conditions of visibility and distance from clouds equal to or greater than those specified in Table 4-1.

4.2 Except when a clearance is obtained from an air traffic control unit, VFR flights shall not take off or land at an aerodrome within a control zone, or enter the aerodrome traffic zone or traffic pattern:

a) when the ceiling is less than 450 m (1 500 ft); or

b) when the ground visibility is less than 5 km.

4.3 VFR flights between sunset and sunrise, or such other period between sunset and sunrise as may be prescribed by the appropriate ATS authority, shall be operated in accordance with the conditions prescribed by such authority.

4.4 Unless authorized by the appropriate ATS authority, VFR flights shall not be operated:

a) above FL 200;

b) at transonic and supersonic speeds.

4.5 Authorization for VFR flights to operate above FL 290 shall not be granted in areas where a vertical separation minimum of 300 m (1 000 ft) is applied above FL 290.

Table 4-1*
(see 4.1)

Airspace class	B	C D E	F G	
			ABOVE 900 m (3 000 ft) AMSL or above 300 m (1 000 ft) above terrain, whichever is the higher	At and below 900 m (3 000 ft) AMSL or 300 m (1 000 ft) above terrain, whichever is the higher
Distance from cloud	Clear of cloud	1 500 m horizontally 300 m (1 000 ft) vertically		Clear of cloud and in sight of the surface
Flight visibility	8 km at and above 3 050 m (10 000 ft) AMSL 5 km below 3 050 m (10 000 ft) AMSL			5 km**

* When the height of the transition altitude is lower than 3 050 m (10 000 ft) AMSL, FL 100 should be used in lieu of 10 000 ft.

** When so prescribed by the appropriate ATS authority:

a) lower flight visibilities to 1 500 m may be permitted for flights operating:

1) at speeds that, in the prevailing visibility, will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision; or

2) in circumstances in which the probability of encounters with other traffic would normally be low, e.g. in areas of low volume traffic and for aerial work at low levels.

b) HELICOPTERS may be permitted to operate *in less than 1 500 m* flight visibility, if manoeuvred at a speed that will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision.

4.6 Except when necessary for take-off or landing, or except by permission from the appropriate authority, a VFR flight shall not be flown:

a) over the congested areas of cities, towns or settlements or over an open-air assembly of persons at a height less than 300 m (1 000 ft) above the highest obstacle within a radius of 600 m from the aircraft;

b) elsewhere than as specified in 4.6 a), at a height less than 150 m (500 ft) above the ground or water.

Note.— See also 3.1.2.

4.7 Except where otherwise indicated in air traffic control clearances or specified by the appropriate ATS authority, VFR flights in level cruising flight when operated above 900 m (3 000 ft) from the ground or water, or a higher datum as specified by the appropriate ATS authority, shall be conducted at a flight level appropriate to the track as specified in the Tables of cruising levels in Appendix 3.

4.8 VFR flights shall comply with the provisions of 3.6:

a) when operated within Classes B, C and D airspace;

b) when forming part of aerodrome traffic at controlled aerodromes; or

c) when operated as special VFR flights.

4.9 A VFR flight operating within or into areas, or along routes, designated by the appropriate ATS authority in accordance with 3.3.1.2 c) or d), shall maintain continuous listening watch on the appropriate radio frequency of, and report its position as necessary to, the air traffic services unit providing flight information service.

Note.— See Note following 3.6.5.1.

4.10 An aircraft operated in accordance with the visual flight rules which wishes to change to compliance with the instrument flight rules shall:

a) if a flight plan was submitted, communicate the necessary changes to be effected to its current flight plan, or

b) when so required by 3.3.1.2, submit a flight plan to the appropriate air traffic services unit and obtain a clearance prior to proceeding IFR when in controlled airspace.

CHAPTER 5. INSTRUMENT FLIGHT RULES

5.1 Rules applicable to all IFR flights

5.1.1 Aircraft equipment

Aircraft shall be equipped with suitable instruments and with navigation equipment appropriate to the route to be flown.

5.1.2 Minimum levels

Except when necessary for take-off or landing, or except when specifically authorized by the appropriate authority, an IFR flight shall be flown at a level which is not below the minimum flight altitude established by the State whose territory is overflown, or, where no such minimum flight altitude has been established:

a) over high terrain or in mountainous areas, at a level which is at least 600 m (2 000 ft) above the highest obstacle located within 8 km of the estimated position of the aircraft;

b) elsewhere than as specified in a), at a level which is at least 300 m (1 000 ft) above the highest obstacle located within 8 km of the estimated position of the aircraft.

Note 1.— The estimated position of the aircraft will take account of the navigational accuracy which can be achieved on the relevant route segment, having regard to the navigational facilities available on the ground and in the aircraft.

Note 2.— See also 3.1.2.

5.1.3 Change from IFR flight to VFR flight

5.1.3.1 An aircraft electing to change the conduct of its flight from compliance with the instrument flight rules to compliance with the visual flight rules shall, if a flight plan was submitted, notify the appropriate air traffic services unit specifically that the IFR flight is cancelled and communicate thereto the changes to be made to its current flight plan.

5.1.3.2 When an aircraft operating under the instrument flight rules is flown in or encounters visual meteorological conditions it shall not cancel its IFR flight unless it is anticipated, and intended, that the flight will be continued for a reasonable period of time in uninterrupted visual meteorological conditions.

5.2 Rules applicable to IFR flights within controlled airspace

5.2.1 IFR flights shall comply with the provisions of 3.6 when operated in controlled airspace.

5.2.2 An IFR flight operating in cruising flight in controlled airspace shall be flown at a cruising level, or, if authorized to employ cruise climb techniques, between two levels or above a level, selected from:

a) the Tables of cruising levels in Appendix 3, or

b) a modified table of cruising levels, when so prescribed in accordance with Appendix 3 for flight above FL 410,

except that the correlation of levels to track prescribed therein shall not apply whenever otherwise indicated in air traffic control clearances or specified by the appropriate ATS authority in Aeronautical Information Publications.

5.3 Rules applicable to IFR flights outside controlled airspace

5.3.1 Cruising levels

An IFR flight operating in level cruising flight outside of controlled airspace shall be flown at a cruising level appropriate to its track as specified in:

a) the Tables of cruising levels in Appendix 3, except when otherwise specified by the appropriate ATS authority for flight at or below 900 m (3 000 ft) above mean sea level; or

b) a modified table of cruising levels, when so prescribed in accordance with Appendix 3 for flight above FL 410.

Note.— This provision does not preclude the use of cruise climb techniques by aircraft in supersonic flight.

5.3.2 Communications

An IFR flight operating outside controlled airspace but within or into areas, or along routes, designated by the appropriate ATS authority in accordance with 3.3.1.2 c) or d), shall maintain a listening watch on the appropriate radio frequency and establish two-way communication, as necessary, with the air traffic services unit providing flight information service.

Note.— See Note following 3.6.5.1.

5.3.3 Position reports

An IFR flight operating outside controlled airspace and required by the appropriate ATS authority to:

— submit a flight plan,

— maintain a listening watch on the appropriate radio frequency and establish two-way communication, as necessary, with the air traffic services unit providing flight information service,

shall report position as specified in 3.6.3 for controlled flights.

Note.— Aircraft electing to use the air traffic advisory service whilst operating IFR within specified advisory airspace are expected to comply with the provisions of 3.6, except that the flight plan and changes thereto are not subjected to clearances and that two-way communication will be maintained with the unit providing the air traffic advisory service.

APPENDIX 1. SIGNALS

(Note.— See Chapter 3, 3.4 of the Annex)

1. DISTRESS AND URGENCY SIGNALS

Note 1.— None of the provisions in this section shall prevent the use, by an aircraft in distress, of any means at its disposal to attract attention, make known its position and obtain help.

Note 2.— For full details of telecommunication transmission procedures for the distress and urgency signals, see Annex 10, Volume II, Chapter 5.

Note 3.— For details of the search and rescue visual signals, see Annex 12.

1.1 Distress signals

The following signals, used either together or separately, mean that grave and imminent danger threatens, and immediate assistance is requested:

a) a signal made by radiotelegraphy or by any other signalling method consisting of the group SOS (· · · — — — · · · in the Morse Code);

b) a signal sent by radiotelephony consisting of the spoken word MAYDAY;

c) rockets or shells throwing red lights, fired one at a time at short intervals;

d) a parachute flare showing a red light.

Note.— Article 41 of the ITU Radio Regulations (Nos. 3268, 3270 and 3271 refer) provides information on the alarm signals for actuating radiotelegraph and radiotelephone auto-alarm systems:

3268 The radiotelegraph alarm signal consists of a series of twelve dashes sent in one minute, the duration of each dash being four seconds and the duration of the interval between consecutive dashes one second. It may be transmitted by hand but its transmission by means of an automatic instrument is recommended.

3270 The radiotelephone alarm signal consists of two substantially sinusoidal audio frequency tones transmitted alternately. One tone shall have a frequency of 2 200 Hz and the other a frequency of 1 300 Hz, the duration of each tone being 250 milliseconds.

3271 The radiotelephone alarm signal, when generated by automatic means, shall be sent continuously for a period of at least thirty seconds but not exceeding one minute; when generated by other means, the signal shall be sent as continuously as practicable over a period of approximately one minute.

1.2 Urgency signals

1.2.1 The following signals, used either together or separately, mean that an aircraft wishes to give notice of difficulties which compel it to land without requiring immediate assistance:

a) the repeated switching on and off of the landing lights; or

b) the repeated switching on and off of the navigation lights in such manner as to be distinct from flashing navigation lights.

1.2.2 The following signals, used either together or separately, mean that an aircraft has a very urgent message to transmit concerning the safety of a ship, aircraft or other vehicle, or of some person on board or within sight:

a) a signal made by radiotelegraphy or by any other signalling method consisting of the group XXX;

b) a signal sent by radiotelephony consisting of the spoken words PAN, PAN.

2. SIGNALS FOR USE IN THE EVENT OF INTERCEPTION

2.1 Signals initiated by intercepting aircraft and responses by intercepted aircraft

Series	*INTERCEPTING Aircraft Signals*	*Meaning*	*INTERCEPTED Aircraft Responds*	*Meaning*
1	DAY or NIGHT — Rocking aircraft and flashing navigational lights at irregular intervals (and landing lights in the case of a helicopter) from a position slightly above and ahead of, and normally to the left of, the intercepted aircraft (or to the right if the intercepted aircraft is a helicopter) and, after acknowledgement, a slow level turn, normally to the left, (or to the right in the case of a helicopter) on the desired heading. *Note 1.— Meteorological conditions or terrain may require the intercepting aircraft to reverse the positions and direction of turn given above in Series 1.* *Note 2.— If the intercepted aircraft is not able to keep pace with the intercepting aircraft, the latter is expected to fly a series of race-track patterns and to rock the aircraft each time it passes the intercepted aircraft.*	You have been intercepted. Follow me.	DAY or NIGHT — Rocking aircraft, flashing navigational lights at irregular intervals and following. *Note.— Additional action required to be taken by intercepted aircraft is prescribed in Chapter 3, 3.8.*	Understood, will comply.
2	DAY or NIGHT — An abrupt break-away manoeuvre from the intercepted aircraft consisting of a climbing turn of 90 degrees or more without crossing the line of flight of the intercepted aircraft.	You may proceed.	DAY or NIGHT — Rocking the aircraft.	Understood, will comply.
3	DAY or NIGHT — Lowering landing gear (if fitted), showing steady landing lights and overflying runway in use or, if the intercepted aircraft is a helicopter, overflying the helicopter landing area. In the case of helicopters, the intercepting helicopter makes a landing approach, coming to hover near to the landing area.	Land at this aerodrome.	DAY or NIGHT — Lowering landing gear, (if fitted), showing steady landing lights and following the intercepting aircraft and, if, after overflying the runway in use or helicopter landing area, landing is considered safe, proceeding to land.	Understood; will comply.

2.2 Signals initiated by intercepted aircraft and responses by intercepting aircraft

Series	*INTERCEPTED Aircraft Signals*	*Meaning*	*INTERCEPTING Aircraft Responds*	*Meaning*
4	DAY or NIGHT — Raising landing gear (if fitted) and flashing landing lights while passing over runway in use or helicopter landing area at a height exceeding 300 m (1 000 ft) but not exceeding 600 m (2 000 ft) (in the case of a helicopter, at a height exceeding 50 m (170 ft) but not exceeding 100 m (330 ft)) above the aerodrome level, and continuing to circle runway in use or helicopter landing area. If unable to flash landing lights, flash any other lights available.	Aerodrome you have designated is inadequate.	DAY or NIGHT — If it is desired that the intercepted aircraft follow the intercepting aircraft to an alternate aerodrome, the intercepting aircraft raises its landing gear (if fitted) and uses the Series 1 signals prescribed for intercepting aircraft. If it is decided to release the intercepted aircraft, the intercepting aircraft uses the Series 2 signals prescribed for intercepting aircraft.	Understood, follow me. Understood, you may proceed.
5	DAY or NIGHT — Regular switching on and off of all available lights but in such a manner as to be distinct from flashing lights.	Cannot comply.	DAY or NIGHT — Use Series 2 signals prescribed for intercepting aircraft.	Understood.
6	DAY or NIGHT — Irregular flashing of all available lights.	In distress.	DAY or NIGHT — Use Series 2 signals prescribed for intercepting aircraft.	Understood.

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3. VISUAL SIGNALS USED TO WARN AN UNAUTHORIZED AIRCRAFT FLYING IN, OR ABOUT TO ENTER A RESTRICTED, PROHIBITED OR DANGER AREA

By day and by night, a series of projectiles discharged from the ground at intervals of 10 seconds, each showing, on bursting, red and green lights or stars will indicate to an unauthorized aircraft that it is flying in or about to enter a restricted, prohibited or danger area, and that the aircraft is to take such remedial action as may be necessary.

4. SIGNALS FOR AERODROME TRAFFIC

4.1 Light and pyrotechnic signals

4.1.1 Instructions

	Light	*From Aerodrome Control to:*	
		Aircraft in flight	*Aircraft on the ground*
Directed towards aircraft concerned (see Figure 1.1)	Steady green	Cleared to land	Cleared for take-off
	Steady red	Give way to other aircraft and continue circling	Stop
	Series of green flashes	Return for landing*	Cleared to taxi
	Series of red flashes	Aerodrome unsafe, do not land	Taxi clear of landing area in use
	Series of white flashes	Land at this aerodrome and proceed to apron*	Return to starting point on the aerodrome
	Red pyrotechnic	Notwithstanding any previous instructions, do not land for the time being	

* *Clearances to land and to taxi will be given in due course.*

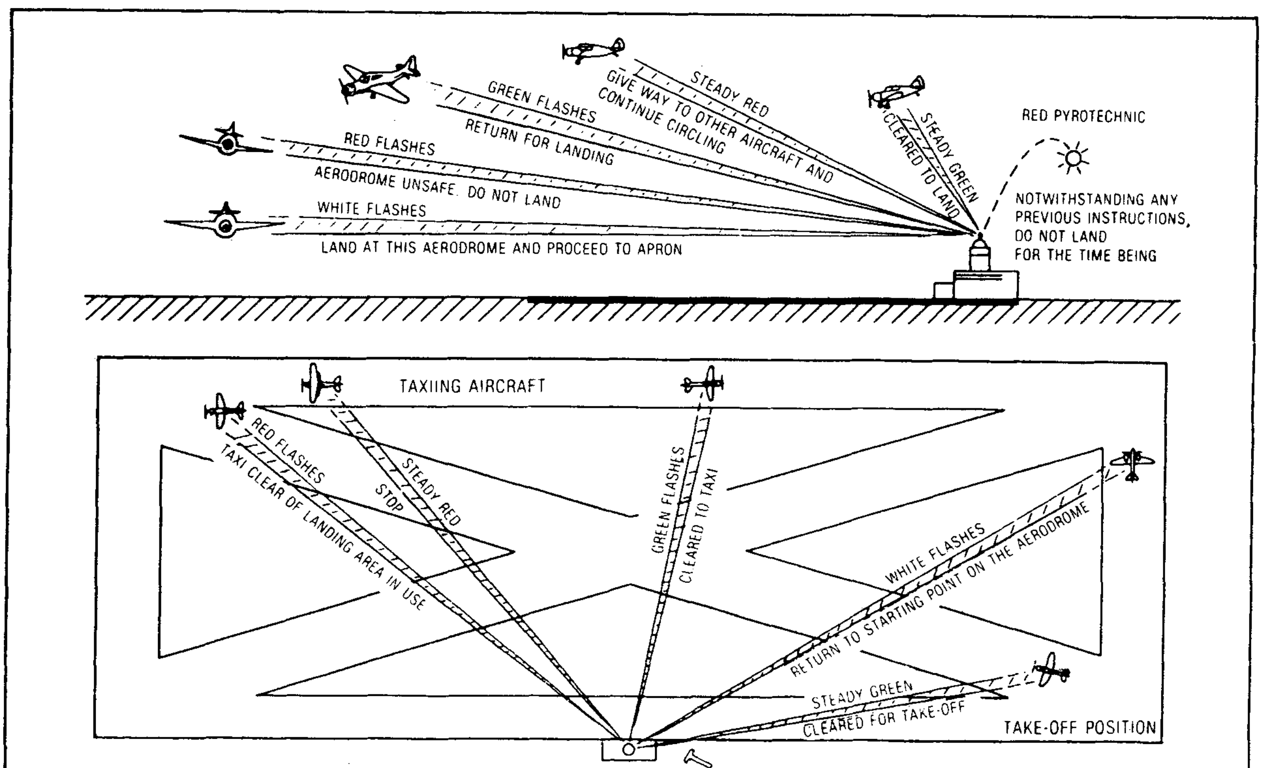


Figure 1.1 (see 4.1.1)

4.1.2 Acknowledgement by an aircraft

a) *When in flight:*

1) during the hours of daylight:

— by rocking the aircraft's wings;

Note.— This signal should not be expected on the base and final legs of the approach.

2) during the hours of darkness:

— by flashing on and off twice the aircraft's landing lights or, if not so equipped, by switching on and off twice its navigation lights.

b) *When on the ground:*

1) during the hours of daylight:

— by moving the aircraft's ailerons or rudder;

2) during the hours of darkness:

— by flashing on and off twice the aircraft's landing lights or, if not so equipped, by switching on and off twice its navigation lights.

4.2 Visual ground signals

Note.— For details of visual ground aids, see Annex 14.

4.2.1 Prohibition of landing

A horizontal red square panel with yellow diagonals (Figure 1.2) when displayed in a signal area indicates that landings are prohibited and that the prohibition is liable to be prolonged.

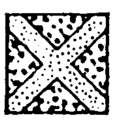


Figure 1.2

4.2.2 Need for special precautions while approaching or landing

A horizontal red square panel with one yellow diagonal (Figure 1.3) when displayed in a signal area indicates that owing to the bad state of the manoeuvring area, or for any other reason, special precautions must be observed in approaching to land or in landing.

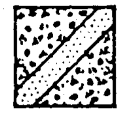


Figure 1.3

4.2.3 Use of runways and taxiways

4.2.3.1 A horizontal white dumb-bell (Figure 1.4) when displayed in a signal area indicates that aircraft are required to land, take off and taxi on runways and taxiways only.

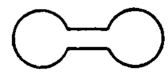


Figure 1.4

4.2.3.2 The same horizontal white dumb-bell as in 4.2.3.1 but with a black bar placed perpendicular to the shaft across each circular portion of the dumb-bell (Figure 1.5) when displayed in a signal area indicates that aircraft are required to land and take off on runways only, but other manoeuvres need not be confined to runways and taxiways.

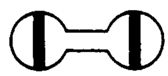


Figure 1.5

4.2.4 Closed runways or taxiways

Crosses of a single contrasting colour, yellow or white (Figure 1.6), displayed horizontally on runways and taxiways or parts thereof indicate an area unfit for movement of aircraft.

Figure 1.6

4.2.5 Directions for landing or take-off

4.2.5.1 A horizontal white or orange landing T (Figure 1.7) indicates the direction to be used by aircraft for landing and take-off, which shall be in a direction parallel to the shaft of the T towards the cross arm.

Note.— When used at night, the landing T is either illuminated or outlined in white coloured lights.

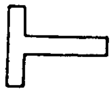


Figure 1.7

4.2.5.2 A set of two digits (Figure 1.8) displayed vertically at or near the aerodrome control tower indicates to aircraft on the manoeuvring area the direction for take-off, expressed in units of 10 degrees to the nearest 10 degrees of the magnetic compass.

09

Figure 1.8

4.2.6 Right-hand traffic

When displayed in a signal area, or horizontally at the end of the runway or strip in use, a right-hand arrow of conspicuous colour (Figure 1.9) indicates that turns are to be made to the right before landing and after take-off.

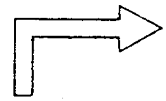


Figure 1.9

4.2.7 Air traffic services reporting office

The letter C displayed vertically in black against a yellow background (Figure 1.10) indicates the location of the air traffic services reporting office.

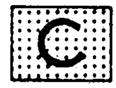


Figure 1.10

4.2.8 Glider flights in operation

A double white cross displayed horizontally (Figure 1.11) in the signal area indicates that the aerodrome is being used by gliders and that glider flights are being performed.

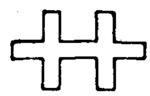


Figure 1.11

5. MARSHALLING SIGNALS

5.1 From a signalman to an aircraft

Note 1.— These signals are designed for use by the signalman, with hands illuminated as necessary to facilitate observation by the pilot, and facing the aircraft in a position:

a) for fixed-wing aircraft, *forward of the left-wing tip within view of the pilot; and*

b) for helicopters, *where the signalman can best be seen by the pilot.*

Note 2.— The meaning of the relevant signals remains the same if bats, illuminated wands or torchlights are held.

Note 3.— The aircraft engines are numbered, for the signalman facing the aircraft, from right to left (i.e. No. 1 engine being the port outer engine).

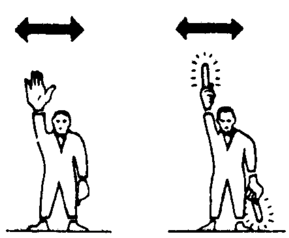
Note 4.— Signals marked with an asterisk are designed for use to hovering helicopters.

5.1.1 Prior to using the following signals, the signalman shall ascertain that the area within which an aircraft is to be guided is clear of objects which the aircraft, in complying with 3.4.1, might otherwise strike.

Note.— The design of many aircraft is such that the path of the wing tips, engines and other extremities cannot always be monitored visually from the flight deck while the aircraft is being manoeuvred on the ground.

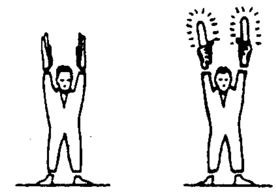
1. To proceed under further guidance by signalman

Signalman directs pilot if traffic conditions on aerodrome require this action.



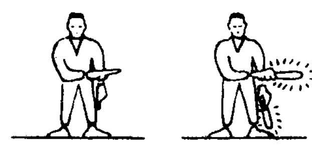
2. This bay

Arms above head in vertical position with palms facing inward.



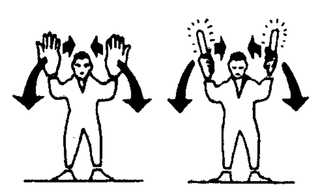
3. Proceed to next signalman

Right or left arm down, other arm moved across the body and extended to indicate direction of next signalman.



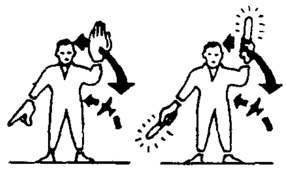
4. Move ahead

Arms a little aside, palms facing backward and repeatedly moved upward-backward from shoulder height.

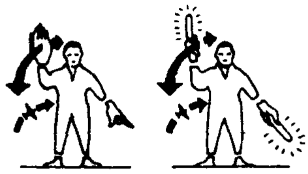


5. Turn

a) *Turn to your left:* right arm downward, left arm repeatedly moved upward-backward. Speed of arm movement indicating rate of turn.

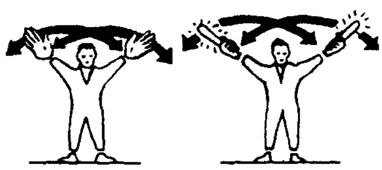


b) *Turn to your right:* left arm downward, right arm repeatedly moved upward-backward. Speed of arm movement indicating rate of turn.



6. Stop

Arms repeatedly crossed above head (the rapidity of the arm movement should be related to the urgency of the stop, i.e. the faster the movement the quicker the stop).



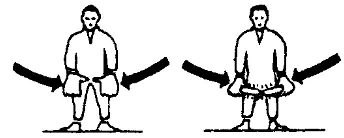
7. Brakes

a) *Engage brakes:* raise arm and hand, with fingers extended, horizontally in front of body, then clench fist.

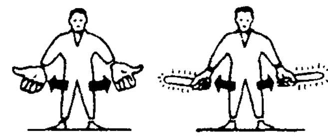
b) *Release brakes:* raise arm, with fist clenched, horizontally in front of body, then extend fingers.

8. Chocks

a) *Chocks inserted:* arms down, palms facing inwards, move arms from extended position inwards.



b) *Chocks removed:* arms down, palms facing outwards, move arms outwards.

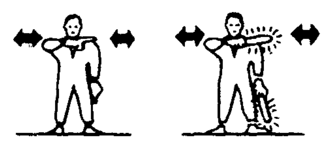


9. Start engine(s)

Left hand overhead with appropriate number of fingers extended, to indicate the number of the engine to be started, and circular motion of right hand at head level.

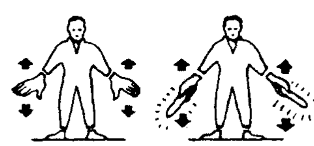
10. Cut engines

Either arm and hand level with shoulder, hand across throat, palm downward. The hand is moved sideways with the arm remaining bent.



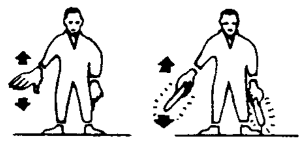
11. Slow down

Arms down with palms toward ground, then moved up and down several times.



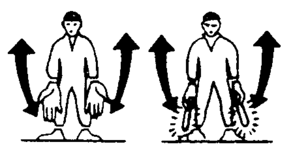
12. Slow down engine(s) on indicated side

Arms down with palms toward ground, then either *right* or *left* hand waved up and down indicating the *left* or *right* side engine(s) respectively should be slowed down.



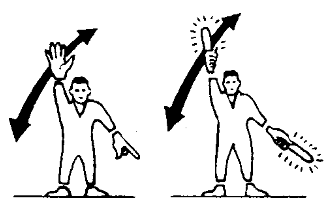
13. Move back

Arms by sides, palms facing forward, swept forward and upward repeatedly to shoulder height.

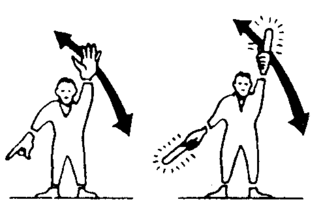


14. Turns while backing

a) *For tail to starboard:* point left arm down, and right arm brought from overhead, vertical position to horizontal forward position, repeating right arm movement.

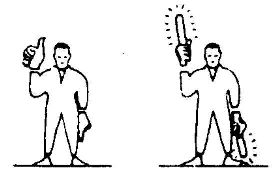


b) *For tail to port:* point right arm down, and left arm brought from overhead, vertical position to horizontal forward position, repeating left arm movement.



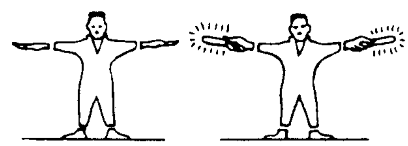
15. All clear

Right arm raised at elbow with thumb erect.



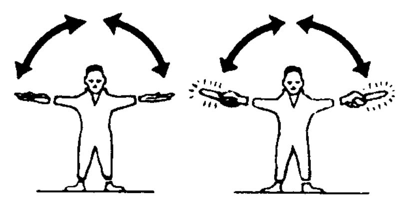
*16. Hover

Arms extended horizontally sideways.



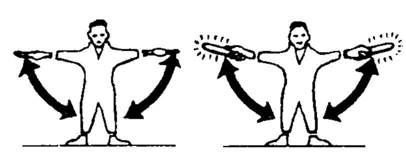
*17. Move upwards

Arms extended horizontally to the side beckoning upwards, with palms turned up. Speed of movement indicates rate of ascent.



*18. Move downwards

Arms extended horizontally to the side beckoning downwards, with palms turned down. Speed of movement indicates rate of descent.



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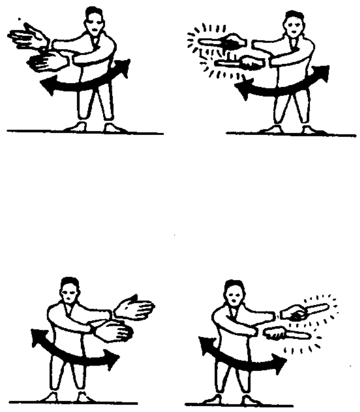
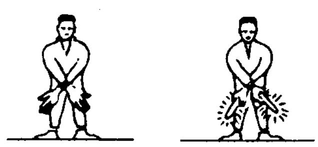
***19. Move horizontally**

Appropriate arm extended horizontally sideways in direction of movement and other arm moved in front of body in same direction, in a repeating movement.



***20. Land**

Arms crossed and extended downwards in front of the body.



5.2 From the pilot of an aircraft to a signalman

Note 1.— These signals are designed for use by a pilot in the cockpit with hands plainly visible to the signalman, and illuminated as necessary to facilitate observation by the signalman.

Note 2.— The aircraft engines are numbered in relation to the signalman facing the aircraft, from right to left (i.e. No. 1 engine being the port outer engine).

5.2.1 Brakes

Note.— The moment the fist is clenched or the fingers are extended indicates, respectively, the moment of brake engagement or release.

a) *Brakes engaged:* raise arm and hand, with fingers extended, horizontally in front of face, then clench fist.

b) *Brakes released:* raise arm, with fist clenched, horizontally in front of face, then extend fingers.

5.2.2 Chocks

a) *Insert chocks:* arms extended, palms outwards, move hands inwards to cross in front of face.

b) *Remove chocks:* hands crossed in front of face, palms outwards, move arms outwards.

5.2.3 Ready to start engine(s)

Raise the appropriate number of fingers on one hand indicating the number of the engine to be started.

APPENDIX 2. INTERCEPTION OF CIVIL AIRCRAFT

(Note.— See Chapter 3, 3.8 of the Annex)

1. Principles to be observed by States

1.1 To achieve the uniformity in regulations which is necessary for the safety of navigation of civil aircraft due regard shall be had by Contracting States to the following principles when developing regulations and administrative directives:

a) interception of civil aircraft will be undertaken only as a last resort;

b) if undertaken, an interception will be limited to determining the identity of the aircraft, unless it is necessary to return the aircraft to its planned track, direct it beyond the boundaries of national airspace, guide it away from a prohibited, restricted or danger area or instruct it to effect a landing at a designated aerodrome;

c) practice interception of civil aircraft will not be undertaken;

d) navigational guidance and related information will be given to an intercepted aircraft by radiotelephony, whenever radio contact can be established; and

e) in the case where an intercepted civil aircraft is required to land in the territory overflown, the aerodrome designated for the landing is to be suitable for the safe landing of the aircraft type concerned.

Note.— In the unanimous adoption by the 25th Session (Extraordinary) of the ICAO Assembly on 10 May 1984 of Article 3 bis to the Convention on International Civil Aviation, the Contracting States have recognized that "every State must refrain from resorting to the use of weapons against civil aircraft in flight."

1.2 Contracting States shall publish a standard method that has been established for the manoeuvring of aircraft intercepting a civil aircraft. Such method shall be designed to avoid any hazard for the intercepted aircraft.

Note.— Special recommendations regarding a method for the manoeuvring are contained in Attachment A, Section 3.

1.3 Contracting States shall ensure that provision is made for the use of secondary surveillance radar, where available, to identify civil aircraft in areas where they may be subject to interception.

2. Action by intercepted aircraft

2.1 An aircraft which is intercepted by another aircraft shall immediately:

a) follow the instructions given by the intercepting aircraft, interpreting and responding to visual signals in accordance with the specifications in Appendix 1;

b) notify, if possible, the appropriate air traffic services unit;

c) attempt to establish radiocommunication with the intercepting aircraft or with the appropriate intercept control unit, by making a general call on the emergency frequency 121.5 MHz, giving the identity of the intercepted aircraft and the nature of the flight; and if no contact has been established and if practicable, repeating this call on the emergency frequency 243 MHz;

d) if equipped with SSR transponder, select Mode A, Code 7700, unless otherwise instructed by the appropriate air traffic services unit.

2.2 If any instructions received by radio from any sources conflict with those given by the intercepting aircraft by visual signals, the intercepted aircraft shall request immediate clarification while continuing to comply with the visual instructions given by the intercepting aircraft.

2.3 If any instructions received by radio from any sources conflict with those given by the intercepting aircraft by radio, the intercepted aircraft shall request immediate clarification while continuing to comply with the radio instructions given by the intercepting aircraft.

3. Radiocommunication during interception

If radio contact is established during interception but communication in a common language is not possible, attempts shall be made to convey instructions, acknowledgement of instructions and essential information by using the phrases and pronunciations in Table 2.1 and transmitting each phrase twice:

Table 2.1

Phrases for use by INTERCEPTING aircraft			*Phrases for use by INTERCEPTED aircraft*		
Phrase	*Pronunciation*[1]	*Meaning*	*Phrase*	*Pronunciation*[1]	*Meaning*
CALL SIGN	KOL SA-IN	What is your call sign?	CALL SIGN (call sign)[2]	KOL SA-IN (call sign)	My call sign is (call sign)
FOLLOW	FOL-LO	Follow me	WILCO	VILL-KO	Understood Will comply
DESCEND	DEE-SEND	Descend for landing	CAN NOT	KANN NOTT	Unable to comply
YOU LAND	YOU LAAND	Land at this aerodrome	REPEAT	REE-PEET	Repeat your instruction
PROCEED	PRO-SEED	You may proceed	AM LOST	AM LOSST	Position unknown
			MAYDAY	MAYDAY	I am in distress
			HIJACK[3]	HI-JACK	I have been hijacked
			LAND (place name)	LAAND (place name)	I request to land at (place name)
			DESCEND	DEE-SEND	I require descent

1. In the second column, syllables to be emphasized are underlined.

2. The call sign required to be given is that used in radiotelephony communications with air traffic services units and corresponding to the aircraft identification in the flight plan.

3. Circumstances may not always permit, nor make desirable, the use of the phrase "HIJACK".

APPENDIX 3. TABLES OF CRUISING LEVELS

The cruising levels to be observed when so required by this Annex are as follows:

a) in areas where, on the basis of regional air navigation agreement and in accordance with conditions specified therein, a vertical separation minimum (VSM) of 300 m (1 000 ft) is applied between FL 290 and FL 410 inclusive:*

TRACK**											
From 000 degrees to 179 degrees***						From 180 degrees to 359 degrees***					
IFR Flights			VFR Flights			IFR Flights			VFR Flights		
	Altitude			Altitude			Altitude			Altitude	
FL	Metres	Feet	FL	Metres	Feet	FL	Metres	Feet	FL	Metres	Feet
-90			–	–	–	0			–	–	–
10	300	1 000	–	–	–	20	600	2 000	–	–	–
30	900	3 000	35	1 050	3 500	40	1 200	4 000	45	1 350	4 500
50	1 500	5 000	55	1 700	5 500	60	1 850	6 000	65	2 000	6 500
70	2 150	7 000	75	2 300	7 500	80	2 450	8 000	85	2 600	8 500
90	2 750	9 000	95	2 900	9 500	100	3 050	10 000	105	3 200	10 500
110	3 350	11 000	115	3 500	11 500	120	3 650	12 000	125	3 800	12 500
130	3 950	13 000	135	4 100	13 500	140	4 250	14 000	145	4 400	14 500
150	4 550	15 000	155	4 700	15 500	160	4 900	16 000	165	5 050	16 500
170	5 200	17 000	175	5 350	17 500	180	5 500	18 000	185	5 650	18 500
190	5 800	19 000	195	5 950	19 500	200	6 100	20 000	205	6 250	20 500
210	6 400	21 000	215	6 550	21 500	220	6 700	22 000	225	6 850	22 500
230	7 000	23 000	235	7 150	23 500	240	7 300	24 000	245	7 450	24 500
250	7 600	25 000	255	7 750	25 500	260	7 900	26 000	265	8 100	26 500
270	8 250	27 000	275	8 400	27 500	280	8 550	28 000	285	8 700	28 500
290	8 850	29 000				300	9 150	30 000			
310	9 450	31 000				320	9 750	32 000			
330	10 050	33 000				340	10 350	34 000			
350	10 650	35 000				360	10 950	36 000			
370	11 300	37 000				380	11 600	38 000			
390	11 900	39 000				400	12 200	40 000			
410	12 500	41 000				430	13 100	43 000			
450	13 700	45 000				470	14 350	47 000			
490	14 950	49 000				510	15 550	51 000			
etc.	etc.	etc.				etc.	etc.	etc.			

* Except when, on the basis of regional air navigation agreements, a modified table of cruising levels based on a nominal vertical separation minimum of 300 m (1 000 ft) is prescribed for use, under specified conditions, by aircraft operating above FL 410 within designated portions of the airspace.

** Magnetic track, or in polar areas at latitudes higher than 70 degrees and within such extensions to those areas as may be prescribed by the appropriate ATS authorities, grid tracks as determined by a network of lines parallel to the Greenwich Meridian superimposed on a polar stereographic chart in which the direction towards the North Pole is employed as the Grid North.

*** Except where, on the basis of regional air navigation agreements, from 090 to 269 degrees and from 270 to 089 degrees is prescribed to accommodate predominant traffic directions and appropriate transition procedures to be associated therewith are specified.

Note.— Guidance material relating to vertical separation is contained in the *Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive* (Doc 9574).

b) in other areas:

TRACK*											
From 000 degrees to 179 degrees**						From 180 degrees to 359 degrees**					
IFR Flights			VFR Flights			IFR Flights			VFR Flights		
	Altitude			Altitude			Altitude			Altitude	
FL	Metres	Feet	FL	Metres	Feet	FL	Metres	Feet	FL	Metres	Feet
-90			–	–	–	0			–	–	–
10	300	1 000	–	–	–	20	600	2 000	–	–	–
30	900	3 000	35	1 050	3 500	40	1 200	4 000	45	1 350	4 500
50	1 500	5 000	55	1 700	5 500	60	1 850	6 000	65	2 000	6 500
70	2 150	7 000	75	2 300	7 500	80	2 450	8 000	85	2 600	8 500
90	2 750	9 000	95	2 900	9 500	100	3 050	10 000	105	3 200	10 500
110	3 350	11 000	115	3 500	11 500	120	3 650	12 000	125	3 800	12 500
130	3 950	13 000	135	4 100	13 500	140	4 250	14 000	145	4 400	14 500
150	4 550	15 000	155	4 700	15 500	160	4 900	16 000	165	5 050	16 500
170	5 200	17 000	175	5 350	17 500	180	5 500	18 000	185	5 650	18 500
190	5 800	19 000	195	5 950	19 500	200	6 100	20 000	205	6 250	20 500
210	6 400	21 000	215	6 550	21 500	220	6 700	22 000	225	6 850	22 500
230	7 000	23 000	235	7 150	23 500	240	7 300	24 000	245	7 450	24 500
250	7 600	25 000	255	7 750	25 500	260	7 900	26 000	265	8 100	26 500
270	8 250	27 000	275	8 400	27 500	280	8 550	28 000	285	8 700	28 500
290	8 850	29 000	300	9 150	30 000	310	9 450	31 000	320	9 750	32 000
330	10 050	33 000	340	10 350	34 000	350	10 650	35 000	360	10 950	36 000
370	11 300	37 000	380	11 600	38 000	390	11 900	39 000	400	12 200	40 000
410	12 500	41 000	420	12 800	42 000	430	13 100	43 000	440	13 400	44 000
450	13 700	45 000	460	14 000	46 000	470	14 350	47 000	480	14 650	48 000
490	14 950	49 000	500	15 250	50 000	510	15 550	51 000	520	15 850	52 000
etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.

* Magnetic track, or in polar areas at latitudes higher than 70 degrees and within such extensions to those areas as may be prescribed by the appropriate ATS authorities, grid tracks as determined by a network of lines parallel to the Greenwich Meridian superimposed on a polar stereographic chart in which the direction towards the North Pole is employed as the Grid North.

** Except where, on the basis of regional air navigation agreements, from 090 to 269 degrees and from 270 to 089 degrees is prescribed to accommodate predominant traffic directions and appropriate transition procedures to be associated therewith are specified.

Note.— Guidance material relating to vertical separation is contained in the *Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive* (Doc 9574).

APPENDIX 4. UNMANNED FREE BALLOONS

(Note.— See Chapter 3, 3.1.9 of the Annex)

1. Classification of unmanned free balloons

Unmanned free balloons shall be classified as:

a) *light:* an unmanned free balloon which carries a payload of one or more packages with a combined mass of less than 4 kg, unless qualifying as a heavy balloon in accordance with c) 2), 3) or 4) below; or

b) *medium:* an unmanned free balloon which carries a payload of two or more packages with a combined mass of 4 kg or more, but less than 6 kg, unless qualifying as a heavy balloon in accordance with c) 2), 3) or 4) below; or

c) *heavy:* an unmanned free balloon which carries a payload which:

1) has a combined mass of 6 kg or more; or

2) includes a package of 3 kg or more; or

3) includes a package of 2 kg or more with an area density of more than 13 g per square centimetre; or

4) uses a rope or other device for suspension of the payload that requires an impact force of 230 N or more to separate the suspended payload from the balloon.

Note 1.— The area density referred to in c) 3) is determined by dividing the total mass in grams of the payload package by the area in square centimetres of its smallest surface.

Note 2.— See Figure 4.1.

2. General operating rules

2.1 An unmanned free balloon shall not be operated without appropriate authorization from the State from which the launch is made.

2.2 An unmanned free balloon, other than a light balloon used exclusively for meteorological purposes and operated in the manner prescribed by the appropriate authority, shall not be operated across the territory of another State without appropriate authorization from the other State concerned.

2.3 The authorization referred to in 2.2 shall be obtained prior to the launching of the balloon if there is reasonable expectation, when planning the operation, that the balloon may drift into airspace over the territory of another State. Such authorization may be obtained for a series of balloon flights or for a particular type of recurring flight, e.g. atmospheric research balloon flights.

2.4 An unmanned free balloon shall be operated in accordance with conditions specified by the State of Registry and the State(s) expected to be overflown.

2.5 An unmanned free balloon shall not be operated in such a manner that impact of the balloon, or any part thereof, including its payload, with the surface of the earth, creates a hazard to persons or property not associated with the operation.

2.6 A heavy unmanned free balloon shall not be operated over the high seas without prior co-ordination with the appropriate ATS authority.

3. Operating limitations and equipment requirements

3.1 A heavy unmanned free balloon shall not be operated without authorization from the appropriate ATS authority at or through any level below 18 000 m (60 000 ft) pressure-altitude at which:

a) there are clouds or obscuring phenomena of more than four oktas coverage; or

b) the horizontal visibility is less than 8 km.

3.2 A heavy or medium unmanned free balloon shall not be released in a manner that will cause it to fly lower than 300 m (1 000 ft) over the congested areas of cities, towns or settlements or an open-air assembly of persons not associated with the operation.

3.3 A heavy unmanned free balloon shall not be operated unless:

a) it is equipped with at least two payload flight-termination devices or systems, whether automatic or operated by telecommand, that operate independently of each other;

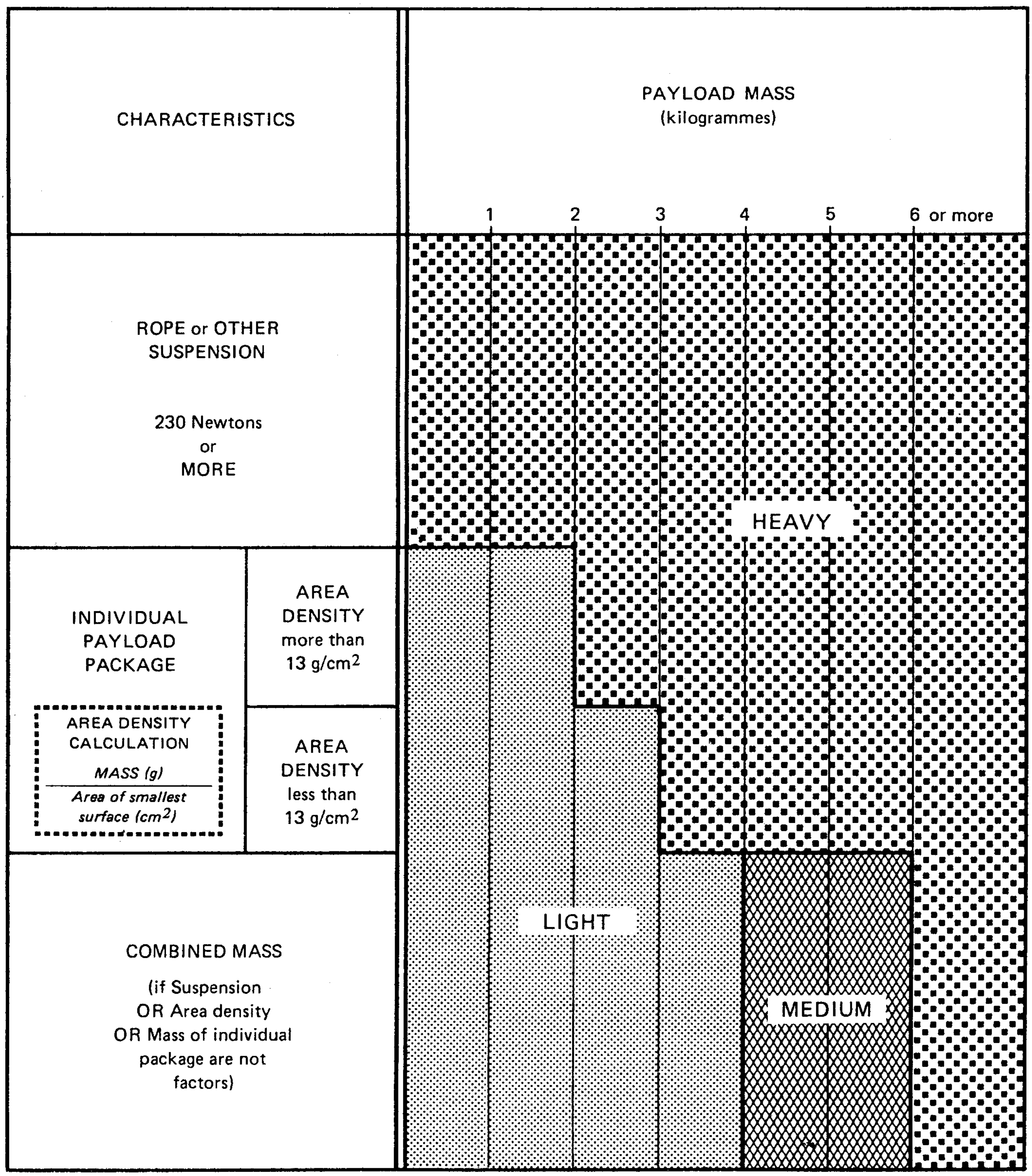


Figure 4.1 Classification of unmanned free balloons

b) for polyethylene zero-pressure balloons, at least two methods, systems, devices, or combinations thereof, that function independently of each other are employed for terminating the flight of the balloon envelope;

Note.— Superpressure balloons do not require these devices as they quickly rise after payload discharge and burst without the need for a device or system designed to puncture the balloon envelope. In this context a superpressure balloon is a simple non-extensible envelope capable of withstanding a differential of pressure, higher inside than out. It is inflated so that the smaller night-time pressure of the gas still fully extends the envelope. Such a superpressure balloon will keep essentially constant level until too much gas diffuses out of it.

c) the balloon envelope is equipped with either a radar reflective device(s) or radar reflective material that will present an echo to surface radar operating in the 200 MHz to 2 700 MHz frequency range, and/or the balloon is equipped with such other devices as will permit continuous tracking by the operator beyond the range of ground-based radar.

3.4 A heavy unmanned free balloon shall not be operated in an area where ground-based SSR equipment is in use, unless it is equipped with a secondary surveillance radar transponder, with altitude reporting capability, which is continuously operating on an assigned code, or which can be turned on when necessary by the tracking station.

3.5 An unmanned free balloon that is equipped with a trailing antenna that requires a force of more than 230 N to break it at any point, shall not be operated unless the antenna has coloured pennants or streamers that are attached at not more than 15 m intervals.

3.6 A heavy unmanned free balloon shall not be operated below 18 000 m (60 000 ft) pressure-altitude between sunset and sunrise or such other period between sunset and sunrise (corrected to the altitude of operation) as may be prescribed by the appropriate ATS authority, unless the balloon and its attachments and payload, whether or not they become separated during the operation, are lighted.

3.7 A heavy unmanned free balloon that is equipped with a suspension device (other than a highly conspicuously coloured open parachute) more than 15 m long, shall not be operated between sunrise and sunset below 18 000 m (60 000 ft) pressure-altitude unless the suspension device is coloured in alternate bands of high conspicuity colours or has coloured pennants attached.

4. Termination

The operator of a heavy unmanned free balloon shall activate the appropriate termination devices required by 3.3 a) and b) above:

a) when it becomes known that weather conditions are less than those prescribed for the operation;

b) if a malfunction or any other reason makes further operation hazardous to air traffic or to persons or property on the surface; or

c) prior to unauthorized entry into the airspace over another State's territory.

5. Flight notification

5.1 Pre-flight notification

5.1.1 Early notification of the intended flight of an unmanned free balloon in the medium or heavy category, shall be made to the appropriate air traffic services unit not less than seven days before the date of the intended flight.

5.1.2 Notification of the intended flight shall include such of the following information as may be required by the appropriate air traffic services unit:

a) balloon flight identification or project code name;

b) balloon classification and description;

c) SSR code or NDB frequency as applicable;

d) operator's name and telephone number;

e) launch site;

f) estimated time of launch (or time of commencement and completion of multiple launches);

g) number of balloons to be launched and the scheduled interval between launches (if multiple launches);

h) expected direction of ascent;

i) cruising level(s) (pressure-altitude);

j) the estimated elapsed time to pass 18 000 m (60 000 ft) pressure-altitude or to reach cruising level if at or below 18 000 m (60 000 ft), together with the estimated location;

Note.— If the operation consists of continuous launchings, the time to be included is the estimated time at which the first and the last in the series will reach the appropriate level (e.g. 122136Z-130330Z).

k) the estimated date and time of termination of the flight and the planned location of the impact/recovery area. In the case of balloons carrying out flights of long duration, as a result of which the date and time of termination of the flight and the location of impact cannot be forecast with accuracy, the term "long duration" shall be used.

Note.— If there is to be more than one location of impact/recovery, each location is to be listed together with the appropriate estimated time of impact. If there is to be a series of continuous impacts, the time to be included is the estimated time of the first and the last in the series (e.g. 070330Z-072300Z).

5.1.3 Any changes in the pre-launch information notified in accordance with 5.1.2 above shall be forwarded to the air traffic services unit concerned not less than 6 hours before the estimated time of launch, or in the case of solar or cosmic disturbance investigations involving a critical time element, not less than 30 minutes before the estimated time of the commencement of the operation.

5.2 Notification of launch

Immediately after a medium or heavy unmanned free balloon is launched the operator shall notify the appropriate air traffic services unit of the following:

a) balloon flight identification;

b) launch site;

c) actual time of launch;

d) estimated time at which 18 000 m (60 000 ft) pressure-altitude will be passed, or the estimated time at which the cruising level will be reached if at or below 18 000 m (60 000 ft), and the estimated location; and

e) any changes to the information previously notified in accordance with 5.1.2 g) and h).

5.3 Notification of cancellation

The operator shall notify the appropriate air traffic services unit immediately it is known that the intended flight of a medium or heavy unmanned free balloon, previously notified in accordance with 5.1, has been cancelled.

6. Position recording and reports

6.1 The operator of a heavy unmanned free balloon operating at or below 18 000 m (60 000 ft) pressure-altitude shall monitor the flight path of the balloon and forward reports of the balloon's position as requested by air traffic services. Unless air traffic services require reports of the balloon's position at more frequent intervals, the operator shall record the position every 2 hours.

6.2 The operator of a heavy unmanned free balloon operating above 18 000 m (60 000 ft) pressure-altitude shall monitor the flight progress of the balloon and forward reports of the balloon's position as requested by air traffic services. Unless air traffic services require reports of the balloon's position at more frequent intervals, the operator shall record the position every 24 hours.

6.3 If a position cannot be recorded in accordance with 6.1 and 6.2, the operator shall immediately notify the appropriate air traffic services unit. This notification shall include the last recorded position. The appropriate air traffic services unit shall be notified immediately when tracking of the balloon is re-established.

6.4 One hour before the beginning of planned descent of a heavy unmanned free balloon, the operator shall forward to the appropriate ATS unit the following information regarding the balloon:

a) the current geographical position;

b) the current level (pressure-altitude);

c) the forecast time of penetration of 18 000 m (60 000 ft) pressure-altitude, if applicable;

d) the forecast time and location of ground impact.

6.5 The operator of a heavy or medium unmanned free balloon shall notify the appropriate air traffic services unit when the operation is ended.

ATTACHMENT A. INTERCEPTION OF CIVIL AIRCRAFT

(Note.— See Chapter 3, 3.8 of the Annex and associated Note)

Note.— In the interest of completeness, the substance of the provisions in Appendix 2 to the Annex is incorporated in this Attachment.

1. In accordance with Article 3 d) of the Convention on International Civil Aviation the Contracting States of ICAO "undertake, when issuing regulations for their state aircraft, that they will have due regard for the safety of navigation of civil aircraft". As interceptions of civil aircraft are, in all cases, potentially hazardous, the Council of ICAO has formulated the following special recommendations which Contracting States are urged to implement through appropriate regulatory and administrative action. The uniform application by all concerned is considered essential in the interest of safety of civil aircraft and their occupants. For this reason the Council of ICAO invites Contracting States to notify ICAO of any differences which may exist between their national regulations or practices and the special recommendations hereunder.

2. General

2.1 Interception of civil aircraft should be avoided and should be undertaken only as a last resort. If undertaken, the interception should be limited to determining the identity of the aircraft, unless it is necessary to return the aircraft to its planned track, direct it beyond the boundaries of national airspace, guide it away from a prohibited, restricted or danger area or instruct it to effect a landing at a designated aerodrome. Practice interception of civil aircraft is not to be undertaken.

2.2 To eliminate or reduce the need for interception of civil aircraft, it is important that:

a) all possible efforts be made by intercept control units to secure identification of any aircraft which may be a civil aircraft, and to issue any necessary instructions or advice to such aircraft, through the appropriate air traffic services units. To this end, it is essential that means of rapid and reliable communications between intercept control units and air traffic services units be established and that agreements be formulated concerning exchanges of information between such units on the movements of civil aircraft, in accordance with the provisions of Annex 11;

b) areas prohibited to all civil flights and areas in which civil flight is not permitted without special authorization by the State be clearly promulgated in aeronautical information publications (AIP) in accordance with the provisions of Annex 15, together with the risk, if any, of interception in the event of penetration of such areas. When delineating such areas in close proximity to promulgated ATS routes, or other frequently used tracks, States should take into account the availability and over-all systems accuracy of the navigation systems to be used by civil aircraft and their ability to remain clear of the delineated areas;

c) the establishment of additional navigation aids be considered where necessary to ensure that civil aircraft are able safely to circumnavigate prohibited or, as required, restricted areas.

2.3 To eliminate or reduce the hazards inherent in interceptions undertaken as a last resort, all possible efforts should be made to ensure co-ordinated actions by the pilots and ground units concerned. To this end, it is essential that Contracting States take steps to ensure that:

a) all pilots of civil aircraft be made fully aware of the actions to be taken by them and the visual signals to be used, as specified in Chapter 3 and Appendix 1 of this Annex;

b) operators or pilots-in-command of civil aircraft implement the provisions in Annex 6, Parts I, II and III regarding the capability of aircraft to communicate on 121.5 MHz and the availability of interception procedures and visual signals on board aircraft;

c) all air traffic services personnel be made fully aware of the actions to be taken by them in accordance with the provisions of Annex 11, Chapter 2 and the PANS-RAC (Doc 4444);

d) all pilots-in-command of intercepting aircraft be made aware of the general performance limitations of civil aircraft and of the possibility that intercepted civil aircraft may be in a state of emergency due to technical difficulties or unlawful interference;

e) clear and unambiguous instructions be issued to intercept control units and to pilots-in-command of potential intercepting aircraft, covering interception manoeuvres, guidance of intercepted aircraft, action by intercepted aircraft, air-to-air visual signals, radiocommunication with intercepted aircraft, and the need to refrain from resorting to the use of weapons;

Note.— See paragraphs 3 to 8.

f) intercept control units and intercepting aircraft be provided with radiotelephony equipment compatible with the technical specifications of Annex 10, Volume I so as to enable them to communicate with intercepted aircraft on the emergency frequency 121.5 MHz;

g) secondary surveillance radar facilities be made available to the extent possible to permit intercept control units to identify civil aircraft in areas where they might otherwise be intercepted. Such facilities should permit recognition of discrete four-digit codes in Mode A, including immediate recognition of Mode A, Codes 7500, 7600 and 7700.

3. Interception manoeuvres

3.1 A standard method should be established for the manoeuvring of aircraft intercepting a civil aircraft in order to avoid any hazard for the intercepted aircraft. Such method should take due account of the performance limitations of civil aircraft, the need to avoid flying in such proximity to the intercepted aircraft that a collision hazard may be created and the need to avoid crossing the aircraft's flight path or to perform any other manoeuvre in such a manner that the wake turbulence may be hazardous, particularly if the intercepted aircraft is a light aircraft.

3.2 Manoeuvres for visual identification

The following method is recommended for the manoeuvring of intercepting aircraft for the purpose of visually identifying a civil aircraft:

Phase I

The intercepting aircraft should approach the intercepted aircraft from astern. The element leader, or the single intercepting aircraft, should normally take up a position on the left (port) side, slightly above and ahead of the intercepted aircraft, within the field of view of the pilot of the intercepted aircraft, and initially not closer to the aircraft than 300 m. Any other participating aircraft should stay well clear of the intercepted aircraft, preferably above and behind. After speed and position have been established, the aircraft should, if necessary, proceed with Phase II of the procedure.

Phase II

The element leader, or the single intercepting aircraft, should begin closing in gently on the intercepted aircraft, at the same level, until no closer than absolutely necessary to obtain the information needed. The element leader, or the single intercepting aircraft, should use caution to avoid startling the flight crew or the passengers of the intercepted aircraft, keeping constantly in mind the fact that manoeuvres considered normal to an intercepting aircraft may be considered hazardous to passengers and crews of civil aircraft. Any other participating aircraft should continue to stay well clear of the intercepted aircraft. Upon completion of identification, the intercepting aircraft should withdraw from the vicinity of the intercepted aircraft as outlined in Phase III.

Phase III

The element leader, or the single intercepting aircraft, should break gently away from the intercepted aircraft in a shallow dive. Any other participating aircraft should stay well clear of the intercepted aircraft and rejoin their leader.

3.3 Manoeuvres for navigational guidance

3.3.1 If, following the identification manoeuvres in Phase I and Phase II above, it is considered necessary to intervene in the navigation of the intercepted aircraft, the element leader, or the single intercepting aircraft, should normally take up a position on the left (port) side, slightly above and ahead of the intercepted aircraft, to enable the pilot-in-command of the latter aircraft to see the visual signals given.

3.3.2 It is indispensable that the pilot-in-command of the intercepting aircraft be satisfied that the pilot-in-command of the intercepted aircraft is aware of the interception and acknowledges the signals given. If repeated attempts to attract the attention of the pilot-in-command of the intercepted aircraft by use of the Series 1 signal in Appendix 1, Section 2 are unsuccessful, other methods of signalling may be used for this purpose, including as a last resort the visual effect of the reheat/afterburner, provided that no hazard is created for the intercepted aircraft.

3.4 It is recognized that meteorological conditions or terrain may occasionally make it necessary for the element leader, or the single intercepting aircraft, to take up a position on the right (starboard) side, slightly above and ahead of the intercepted aircraft. In such case, the pilot-in-command of the intercepting aircraft must take particular care that the intercepting aircraft is clearly visible at all times to the pilot-in-command of the intercepted aircraft.

4. Guidance of an intercepted aircraft

4.1 Navigational guidance and related information should be given to an intercepted aircraft by radiotelephony, whenever radio contact can be established.

4.2 When navigational guidance is given to an intercepted aircraft, care must be taken that the aircraft is not led into conditions where the visibility may be reduced below that required to maintain flight in visual meteorological conditions and that the manoeuvres demanded of the intercepted aircraft do not add to already existing hazards in the event that the operating efficiency of the aircraft is impaired.

4.3 In the exceptional case where an intercepted civil aircraft is required to land in the territory overflown, care must also be taken that:

a) the designated aerodrome is suitable for the safe landing of the aircraft type concerned, especially if the aerodrome is not normally used for civil air transport operations;

b) the surrounding terrain is suitable for circling, approach and missed approach manoeuvres;

c) the intercepted aircraft has sufficient fuel remaining to reach the aerodrome;

d) if the intercepted aircraft is a civil transport aircraft, the designated aerodrome has a runway with a length equivalent to at least 2 500 m at mean sea level and a bearing strength sufficient to support the aircraft; and

e) whenever possible, the designated aerodrome is one that is described in detail in the relevant aeronautical information publication.

4.4 When requiring a civil aircraft to land at an unfamiliar aerodrome, it is essential that sufficient time be allowed it to prepare for a landing, bearing in mind that only the pilot-in-command of the civil aircraft can judge the safety of the landing operation in relation to runway length and aircraft mass at the time.

4.5 It is particularly important that all information necessary to facilitate a safe approach and landing be given to the intercepted aircraft by radiotelephony.

5. Action by intercepted aircraft

The Standards in Appendix 2, Section 2 specify as follows:

"2.1 An aircraft which is intercepted by another aircraft shall immediately:

a) follow the instructions given by the intercepting aircraft, interpreting and responding to visual signals in accordance with the specifications in Appendix 1;

b) notify, if possible, the appropriate air traffic services unit;

c) attempt to establish radiocommunication with the intercepting aircraft or with the appropriate intercept control unit, by making a general call on the emergency frequency 121.5 MHz, giving the identity of the intercepted aircraft and the nature of the flight; and if no contact has been established and if practicable, repeating this call on the emergency frequency 243 MHz;

d) if equipped with SSR transponder, select Mode A, Code 7700, unless otherwise instructed by the appropriate air traffic services unit.

"2.2 If any instructions received by radio from any sources conflict with those given by the intercepting aircraft by visual signals, the intercepted aircraft shall request immediate clarification while continuing to comply with the visual instructions given by the intercepting aircraft.

"2.3 If any instructions received by radio from any sources conflict with those given by the intercepting aircraft by radio, the intercepted aircraft shall request immediate clarification while continuing to comply with the radio instructions given by the intercepting aircraft."

6. Air-to-air visual signals

The visual signals to be used by intercepting and intercepted aircraft are those set forth in Appendix 1 to this Annex. It is essential that intercepting and intercepted aircraft adhere strictly to those signals and interpret correctly the signals given by the other aircraft, and that the intercepting aircraft pay particular attention to any signals given by the intercepted aircraft to indicate that it is in a state of distress or urgency.

7. Radiocommunication between the intercept control unit or the intercepting aircraft and the intercepted aircraft

7.1 When an interception is being made, the intercept control unit and the intercepting aircraft should:

a) first attempt to establish two-way communication with the intercepted aircraft in a common language on the emergency frequency 121.5 MHz, using the call signs "INTERCEPT CONTROL", "INTERCEPTOR (call sign)" and "INTERCEPTED AIRCRAFT" respectively; and

b) failing this, attempt to establish two-way communication with the intercepted aircraft on such other frequency or frequencies as may have been prescribed by the appropriate ATS authority, or to establish contact through the appropriate ATS unit(s).

7.2 If radio contact is established during interception but communication in a common language is not possible, attempts must be made to convey instructions, acknowledgement of instructions and essential information by using the phrases and pronunciations in Table A-1 and transmitting each phrase twice.

8. Refraining from the use of weapons

Note.— In the unanimous adoption by the 25th Session (Extraordinary) of the ICAO Assembly on 10 May 1984 of

Article 3 bis *to the Convention on International Civil Aviation, the Contracting States have recognized that "every State must refrain from resorting to the use of weapons against civil aircraft in flight."*

The use of tracer bullets to attract attention is hazardous, and it is expected that measures will be taken to avoid their use so that the lives of persons on board and the safety of aircraft will not be endangered.

9. Co-ordination between intercept control units and air traffic services units

It is essential that close co-ordination be maintained between an intercept control unit and the appropriate air traffic services unit during all phases of an interception of an aircraft which is, or might be, a civil aircraft, in order that the air traffic services unit is kept fully informed of the developments and of the action required of the intercepted aircraft.

Table A-1

Phrases for use by INTERCEPTING aircraft			*Phrases for use by INTERCEPTED aircraft*		
Phrase	*Pronunciation*[1]	*Meaning*	*Phrase*	*Pronunciation*[1]	*Meaning*
CALL SIGN	KOL SA-IN	What is your call sign?	CALL SIGN (call sign)[2]	KOL SA-IN (call sign)	My call sign is (call sign)
FOLLOW	FOL-LO	Follow me	WILCO	VILL-KO	Understood Will comply
DESCEND	DEE-SEND	Descend for landing	CAN NOT	KANN NOTT	Unable to comply
YOU LAND	YOU LAAND	Land at this aerodrome	REPEAT	REE-PEET	Repeat your instruction
PROCEED	PRO-SEED	You may proceed	AM LOST	AM LOSST	Position unknown
			MAYDAY	MAYDAY	I am in distress
			HIJACK[3]	HI-JACK	I have been hijacked
			LAND (place name)	LAAND (place name)	I request to land at (place name)
			DESCEND	DEE-SEND	I require descent

1. In the second column, syllables to be emphasized are underlined.

2. The call sign required to be given is that used in radiotelephony communications with air traffic services units and corresponding to the aircraft identification in the flight plan.

3. Circumstances may not always permit, nor make desirable, the use of the phrase "HIJACK".

ATTACHMENT B. UNLAWFUL INTERFERENCE

1. General

The following procedures are intended as guidance for use by aircraft when unlawful interference occurs and the aircraft is unable to notify an ATS unit of this fact.

2. Procedures

2.1 Unless considerations aboard the aircraft dictate otherwise, the pilot-in-command should attempt to continue flying on the assigned track and at the assigned cruising level at least until able to notify an ATS unit or within radar coverage.

2.2 When an aircraft subjected to an act of unlawful interference must depart from its assigned track or its assigned cruising level without being able to make radiotelephony contact with ATS, the pilot-in-command should, whenever possible:

a) attempt to broadcast warnings on the VHF emergency frequency and other appropriate frequencies, unless considerations aboard the aircraft dictate otherwise. Other equipment such as on-board transponders, data links, etc., should also be used when it is advantageous to do so and circumstances permit; and

b) proceed in accordance with applicable special procedures for in-flight contingencies, where such procedures have been established and promulgated in Doc 7030 — *Regional Supplementary Procedures*; or

c) if no applicable regional procedures have been established, proceed at a level which differs from the cruising levels normally used for IFR flight in the area by 300 m (1 000 ft) if above FL 290 or by 150 m (500 ft) if below FL 290.

Note. — Action to be taken by an aircraft which is intercepted while being subject to an act of unlawful interference is prescribed in 3.8 of this Annex.

— END —

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

METEOROLOGICAL SERVICE FOR INTERNATIONAL AIR NAVIGATION

ANNEX 3

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

TWELFTH EDITION — JULY 1995

This edition incorporates all amendments adopted by the Council prior to 18 March 1995 and supersedes, on 1 January 1996, all previous editions of Annex 3.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Annex 3
Corrigendum
25/9/95

CORRIGENDUM

1. To incorporate this corrigendum, please make the following correction by hand:
   on page 4319, paragraph 4.13.2 c), *insert* the word «no» before the word «weather».
2. Record the entry of this corrigendum on page 4291.

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-70	Incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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FOREWORD

Historical background

Standards and Recommended Practices relating to meteorology were first adopted by the Council on 16 April 1948, pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago, 1944), and designated as Annex 3 to the Convention with the title *Standards and Recommended Practices — Meteorological Codes*. The Standards and Recommended Practices were based on recommendations of the Special Session of the Meteorology Division, held in September 1947.

Table A shows the origin of subsequent amendments, together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted or approved by the Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each Amendment to this Annex.

Attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as is practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that are important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices* which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

Any reference to a portion of this document, which is identified by a number, includes all subdivisions of the portion.

Applicability

The Standards and Recommended Practices in this document govern the application of the *Regional Supplementary Procedures* (Doc 7030, Part 3 — Meteorology), in which document will be found statements of regional choices, where such options are permitted by this Annex.

Responsibility

In accordance with a similar provision in the Foreword to Annex 6, Part II, the responsibility which devolves upon an operator, in accordance with the provisions of Annex 3, falls upon the pilot-in-command in the case of international general aviation.

Relation to corresponding WMO publications

The regulatory material contained in Annex 3 is, except for a few minor editorial differences, identical with that appearing in the Technical Regulations (Chapter C.3.1) of the World Meteorological Organization (WMO).

The aeronautical meteorological code forms referred to in Annex 3 are developed by the World Meteorological Organization on the basis of aeronautical requirements contained in this Annex, or stated from time to time by the Council. The aeronautical meteorological code forms are promulgated by WMO in its Publication No. 306 — *Manual on Codes*, Volume I.

Table A. Amendments to Annex 3

Amendment(s)	*Source(s)*	*Subject(s)*	*Adopted/approved* *Effective* *Applicable*
1st Edition	Second Session of the Meteorology Division	Meteorological codes for the transmission of meteorological information for aeronautical purposes.	16 April 1948 15 September 1948 1 January 1949
1 to 21	Special Session of the Meteorology Division	Updating and improvement of meteorological codes.	17 September 1948 23 December 1948 1 January 1949
22 to 37	Third Session of the Meteorology Division	Use of plain language and a simplified code for flight conditions in air-reports.	28 May 1951 1 October 1951 1 January 1952
38	First Air Navigation Conference	Introduction of the radiotelephony or radiotelegraphy AIREP form of air-report.	15 December 1953 1 August 1954 1 September 1954
39	First Air Navigation Conference	Revised radiotelegraphy form of POMAR Code for air-reports.	18 May 1954 20 August 1954 1 September 1954
40	World Meteorological Organization	New aeronautical meteorological figure codes in an Attachment, replacing those (except the POMAR code) hitherto appearing in the SARPs.	28 September 1954 1 January 1955 1 January 1955
41	Fourth Session of the Meteorology Division	Introduction of Standards and Recommended Practices governing the obligations of Contracting States relating to the establishment of meteorological organization in each State, adequate to satisfy Articles 28 and 37 of the Convention; consequential change of title of Annex 3 to read *International Standards and Recommended Practices — Meteorology.*	1 April 1955 1 August 1955 1 January 1956
42	Second Air Navigation Conference	Simplification of the detailed specifications for the method of determining the position in the AIREP and POMAR forms of air-report.	8 May 1956 1 September 1956 1 December 1956
43	Third Air Navigation Conference	Introduction of the term "SIGMET information" to replace the terms "advisory message" and "warning message"; amendment of the table for "State of Sea" in the POMAR code.	13 June 1957 1 October 1957 1 December 1957
44	Rules of the Air and Air Traffic Services/ Search and Rescue Divisions	Changes in the list of elements in Section 1 (Position report) of the AIREP form of air-report — deletion of the element "Flight conditions" and amendment of the last element in the Section to read "Next position and time over".	18 February 1960 1 May 1960 1 August 1960
45	Rules of the Air and Air Traffic Services/ Search and Rescue Divisions	Amendment of model AIREP and POMAR forms of air-report consequential to Amendment 44.	18 February 1960 — 1 August 1960
46	World Meteorological Organization	Updating of aeronautical meteorological figure codes, introduced by WMO, as of 1 January 1960.	8 June 1960 — 8 June 1960
47	Fifth Session of the Meteorology Division	Amendment to the procedures for aircraft meteorological observations and reports, modifying those for special observations and introducing requirements for additional observations; deletion of the POMAR form of air-report; elimination of flight meteorological watch and the introduction of en-route forecast service to supplement area meteorological watch; amendment to the provisions concerning meteorological conditions along the route to an alternate aerodrome.	2 December 1960 1 April 1961 1 July 1961

Amendment(s)	Source(s)	Subject(s)	Adopted/approved Effective Applicable
48	Fifth Session of the Meteorology Division	Amendment to model AIREP form of air-report to reflect changes in procedures for aircraft meteorological observations and reports, consequential to an amendment to the PANS-RAC.	2 December 1960 — 1 July 1961
49	Fifth Session of the Meteorology Division	Introduction of definition of "D-value".	8 April 1963 1 August 1963 1 November 1963
50	World Meteorological Organization	Updating of aeronautical meteorological figure codes, introduced by WMO, as of 1 January 1964.	18 March 1964 — 18 March 1964
51	Meteorology and Operations Divisional Meeting	Introduction of a requirement for observations to be made at locations where they will be representative of the area for which they are primarily required; extension of the criteria for special air-reports to cover phenomena likely to affect efficiency as well as safety, and deleting the requirement for "additional aircraft observations" according to regionally agreed criteria; deletion from the AIREP form of air-report of D-value, weather and cloud as standard items; introduction of a modified model AIREP form; changes to the provisions relating to forms of meteorological messages and providing for the exchange of information in pictorial form; introduction of definition of "plain language".	31 May 1965 1 October 1965 10 March 1966
52	World Meteorological Organization	Updating of aeronautical meteorological figure codes, introduced by WMO, as of 10 March 1966.	12 December 1966 — 12 December 1966
53	Meteorology and Operations Divisional Meeting	Permitting regional air navigation agreement on the use of a pictorial form of message for the dissemination of forecasts; replacement of the term "symbolic form of message" by a more specific description of the form of message to which this expression was intended to refer.	12 December 1966 12 April 1967 24 August 1967
54	World Meteorological Organization	Updating of aeronautical meteorological figure codes, introduced by WMO, as of 1 January 1968.	13 June 1967 — 1 January 1968
55	France	Permitting changes to be made to air-reports before their ground-to-ground dissemination.	16 December 1968 16 April 1969 18 September 1969
56	Sixth Air Navigation Conference	Introduction of: specifications for area forecast centres; simplified specifications for meteorological offices to reflect increasing centralization; extended coverage of aircraft reports to include adverse weather conditions encountered during initial climb and final approach; routine reporting by aircraft of "spot" rather than "mean" winds; improved criteria for in-flight reports of the intensity of turbulence; new definition of "air traffic services reporting office" and changes in the definition of "air traffic services unit"; changes to the aeronautical meteorological codes introduced by WMO, as of 18 September 1969.	15 May 1970 15 September 1970 4 February 1971
57	Second Meeting of the Technical Panel on Supersonic Transport Operations	Amendment to the definition of "SIGMET information" to take account of the requirements of SST aircraft operations; introduction of provisions for making and recording special observations whenever moderate turbulence, hail or cumulonimbus clouds are encountered during transonic or supersonic flight.	19 March 1971 6 September 1971 6 January 1972
58	World Meteorological Organization	Updating of aeronautical meteorological codes, introduced by WMO, as of 1 January 1972.	19 March 1971 — 6 January 1972
59	Sixth Air Navigation Conference	Permitting the omission of information on "next position and time over" from Section 1 of air-reports exchanged between meteorological offices; introduction of changes to the formats and data conventions in the model form of air-report to make it suitable for direct input into computers.	24 March 1972 24 July 1972 7 December 1972

Amendment(s)	*Source(s)*	*Subject(s)*	*Adopted/approved* *Effective* *Applicable*
60	Sixth Air Navigation Conference. Eighth Air Navigation Conference. Meteorology Divisional Meeting (1974)	Complete revision of Annex 3, incorporating the PANS-MET, the specifications of which were regarded as being suitable for inclusion in Annex 3 as Standards and Recommended Practices; the revision took into account recently approved operational requirements and up-to-date methods of meeting them; introduction of new Standards and Recommended Practices, relating to service for operators and flight crew members, meteorological information for air traffic services and for search and rescue services, together with requirements for communications and their use; the title of Annex 3 was, accordingly, amended to read *Meteorological Service for International Air Navigation.*	26 November 1975 26 March 1976 12 August 1976
61	Ninth Air Navigation Conference. Meteorology Divisional Meeting (1974)	New provisions and revision of existing provisions to improve the co-ordination between meteorological offices/stations and air traffic services units and the supply of meteorological information to the latter; new specifications for observations and reports for take-off and landing; introduction of a note referring to the specifications of Annex 14 for the siting and construction of equipment and installations on operational areas to reduce the hazard to aircraft to a minimum; replacement of the expression "supersonic transport aircraft" by the expression "supersonic aircraft"; updating of Part 2, Appendix 2; revision of definition of "nephanalysis" and deletion of "(29.92 in.)" from definition of "flight level"; deletion of Attachment D — Aeronautical Meteorological Codes.	14 December 1977 14 April 1978 10 August 1978
62	Eighth Air Navigation Conference and ICAO Council	Inclusion in Appendix 1 of model charts and forms developed by WMO on the basis of the operational requirements contained in Annex 3; transfer of the data designators and geographical designators from Appendix 2 to Annex 3 to the *Manual of Aeronautical Meteorological Practice* (Doc 8896).	26 June 1978 26 October 1978 29 November 1979
63	MET Divisional Meeting (1974). ICAO Secretariat. Operational Flight Information Service Panel. Ninth Air Navigation Conference. Doc 9328	Definition for "meteorological bulletin"; correction to shortcomings in ground-to-ground dissemination of air-reports; decrease in SIGMET messages dealing with "active thunderstorm area"; deletion of reference to "reporting lines"; reference to new *Manual of Runway Visual Range Observing and Reporting Practices.*	23 March 1981 23 July 1981 26 November 1981
64	ICAO Secretariat	New provisions and revision of existing provisions to meet operational requirements for observing and reporting of low-level wind shear, including the introduction of wind shear warnings for the climb-out and approach phases of flight.	6 December 1982 6 April 1983 24 November 1983
65	Communications/ Meteorology Divisional Meeting (1982). Third Meeting of the ADAPT Panel	New provisions and revision of existing provisions related to the introduction of the new world area forecast system; methods of exchange of operational meteorological data; improvement of accuracy of runway visual range assessment, and reporting.	10 June 1983 10 October 1983 22 November 1984
66	Communications/ Meteorology Divisional Meeting (1982). Second Asia/ Pacific Regional Air Navigation Meeting. Twenty-second and twenty-third meetings of the European Air Navigation Planning Group. World Meteorological Organization. Recommendations of the ANC relating to the method of reference date/ time and units of measurement. ICAO Secretariat	Amendment of the provisions related to the transmission of wind shear information beyond the aerodrome, criteria for the issuance of selected special reports, inclusion of cloud information in aerodrome forecasts, flight documentation to be provided for short-haul flights, format of the SIGMET message and meteorological bulletin headings; introduction of the definition for "SIGMET information"; alignment of Annex 3 with Annex 5 in respect of units of measurement and the referencing of time.	24 March 1986 27 July 1986 20 November 1986

Amendment(s)	Source(s)	Subject(s)	Adopted/approved Effective Applicable
67	Communications/ Meteorology Divisional Meeting (1982). Twenty-second and twenty-fifth meetings of the European Air Navigation Planning Group. ICAO Secretariat. World Meteorological Organization	Amendment of the provisions related to light intensity settings used for RVR assessment; the identification of selected aerodromes and the deletion of the requirement for temperature circles on WAFS charts; the transmission time of forecasts from regional area forecast centres to users; introduction of provisions for the origination and dissemination of volcanic ash warnings; inclusion of wind speed units in examples of the aviation meteorological figure codes; alignment of Annex 3 with the PANS-RAC in respect of the elements of the air-report; editorial amendment of the example of the SIGMET message.	27 March 1987 27 July 1987 19 November 1987
68	Communications/ Meteorology Divisional Meeting (1982). ICAO Secretariat. World Meteorological Organization	Amendment of the provisions relating to identification of RVR reporting positions; the criteria for the issuance of selected special reports for changes in RVR; RVR values for touchdown zone for all runways available for landing to be included in reports disseminated beyond the aerodrome; model charts and forms for flight documentation; issuance and updating of SIGMET messages relating to volcanic ash clouds; explicit provisions regarding the need to provide the aeronautical information services units with MET information; alignment with Annex 10 in respect of definitions for aeronautical fixed telecommunication network and aeronautical mobile service; alignment with PANS-OPS, Volume II, Part III, paragraph 6.3.1 in respect of terminology; editorial amendments to paragraph 3.3.7 to delete the equivalent pressure levels; the example of the SPECI report; the reference in Attachment B, Part 3, paragraph 1.4 b); and the footnote in Attachment C concerning visibility and RVR.	21 March 1989 23 July 1989 16 November 1989
69	Communications/ Meteorology/ Operations Divisional Meeting (1990). ICAO Secretariat	Amendment of the provisions related to the transition to the final phase of the WAFS; aeronautical meteorological codes, and guidance material on the selected criteria applicable to aerodrome reports; aeronautical climatological information; SIGMET information and related guidance material for the issuance of SIGMETs; automatic weather observing stations; meteorological information for helicopter operations; and alignment with Annex 6, Parts I and II in respect of the definition for alternate aerodrome.	23 March 1992 27 July 1992 12 November 1992; 1 July 1993
70	Communications/ Meteorology/ Operations Divisional Meeting (1990). Limited North Atlantic (COM/MET/RAC) Regional Air Navigation Meeting (1992). Third Asia/ Pacific Regional Air Navigation Meeting (1993). Thirty-second meeting of the European Air Navigation Planning Group. ICAO Secretariat	Definitions of AIRMET information, extended range operation, GAMET area forecast, operational control and tropical cyclone; amendment to the provisions concerning horizontal resolution of and the code form in which the upper wind and temperature grid-point forecasts are to be prepared by the world area forecast centres; issuance of special reports for changes in temperature at aerodromes; provisions related to the reporting and forecasting of meteorological information at aerodromes on which the new aeronautical meteorological codes are based and a consequential amendment to Models A1, A2, TA1, TA2 and SN to take account of the updated aeronautical meteorological codes; automated air reporting; provision of information on weather phenomenon hazardous to low-level flights; introduction of the minimum threshold value for the maximum surface wind speed for which SIGMETs for tropical cyclones should be issued; observation and reporting of wind shear to take account of new technology in ground-based wind shear observing equipment; interregional exchange of METARs and SPECIs to support extended range operations and long-haul flights conducted under centralized operational control; editorial amendments to replace the term "line squall" by "squall line"; editorial amendments to Models SWL and SN, to align the depiction of freezing level, and editorial corrections to Model A2; inclusion in Model SN of symbols for "volcanic eruptions", "state of the sea" and "sea surface temperature"; updating operationally desirable accuracy of measurement or observation and the currently attainable accuracy of measurement or observation; introduction of criteria for the inclusion of severe mountain waves in SIGMET information.	17 March 1995 24 July 1995 1 January 1996

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

1.1 Definitions

When the following terms are used in the Standards and Recommended Practices for Meteorological Service for International Air Navigation, they have the following meanings:

Aerodrome. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome climatological summary. Concise summary of specified meteorological elements at an aerodrome, based on statistical data.

Aerodrome climatological table. Table providing statistical data on the observed occurrence of one or more meteorological elements at an aerodrome.

Aerodrome control tower. A unit established to provide air traffic control service to aerodrome traffic.

Aerodrome elevation. The elevation of the highest point of the landing area.

Aerodrome meteorological office. An office, located at an aerodrome, designated to provide meteorological service for international air navigation.

Aeronautical fixed service (AFS). A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.

Aeronautical fixed telecommunication network (AFTN). A world-wide system of aeronautical fixed circuits provided, as part of the aeronautical fixed service, for the exchange of messages and/or digital data between aeronautical fixed stations having the same or compatible communications characteristics.

Aeronautical meteorological station. A station designated to make observations and meteorological reports for use in international air navigation.

Aeronautical mobile service. A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate; emergency position-indicating radiobeacon stations may also participate in this service on designated distress and emergency frequencies.

Aeronautical telecommunication station. A station in the aeronautical telecommunication service.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Aircraft observation. The evaluation of one or more meteorological elements made from an aircraft in flight.

AIRMET information. Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of low-level aircraft operations and which was not already included in the forecast issued for low-level flights in the flight information region concerned or sub-area thereof.

Air-report. A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological information.

Air traffic services unit. A generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office.

Alternate aerodrome. An aerodrome to which an aircraft may proceed when it becomes either impossible or inadvisable to proceed to or to land at the aerodrome of intended landing. Alternate aerodromes include the following:

Take-off alternate. An alternate aerodrome at which an aircraft can land should this become necessary shortly after take-off and it is not possible to use the aerodrome of departure.

En-route alternate. An aerodrome at which an aircraft would be able to land after experiencing an abnormal or emergency condition while en route.

Destination alternate. An alternate aerodrome to which an aircraft may proceed should it become impossible or inadvisable to land at the aerodrome of intended landing.

Note.— The aerodrome from which a flight departs may also be an en-route or a destination alternate aerodrome for that flight.

Altitude. The vertical distance of a level, a point or an object considered as a point, measured from mean sea level (MSL).

Approach control office. A unit established to provide air traffic control service to controlled flights arriving at, or departing from, one or more aerodromes.

Appropriate ATS authority. The relevant authority designated by the State responsible for providing air traffic services in the airspace concerned.

Area control centre. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

Area of coverage (world area forecast system). A geographical area for which a regional area forecast centre supplies forecasts for flights departing from aerodromes in its service area.

Area of responsibility (world area forecast system). A geographical area for which a regional area forecast centre prepares significant weather forecasts.

Briefing. Oral commentary on existing and/or expected meteorological conditions.

Consultation. Discussion with a meteorologist or another qualified person of existing and/or expected meteorological conditions relating to flight operations; a discussion includes answers to questions.

Control area. A controlled airspace extending upwards from a specified limit above the earth.

Cruising level. A level maintained during a significant portion of a flight.

Elevation. The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.

Extended range operation. Any flight by an aeroplane with two turbine power-units where the flight time at the one power-unit inoperative cruise speed (in ISA and still air conditions), from a point on the route to an adequate alternate aerodrome, is greater than the threshold time approved by the State of the Operator.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aircraft during flight time.

Flight documentation. Written or printed documents, including charts or forms, containing meteorological information for a flight.

Flight information centre. A unit established to provide flight information service and alerting service.

Flight information region. An airspace of defined dimensions within which flight information service and alerting service are provided.

Flight level. A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals.

Note 1.— A pressure type altimeter calibrated in accordance with the Standard Atmosphere:

a) when set to a QNH altimeter setting, will indicated altitude;

b) when set to a QFE altimeter setting, will indicate height above the QFE reference datum;

c) when set to a pressure of 1 013.2 hectopascals (hPa) may be used to indicate flight levels.

Note 2.— The terms "height" and "altitude", used in Note 1 above, indicate altimetric rather than geometric heights and altitudes.

Forecast. A statement of expected meteorological conditions for a specified time or period, and for a specified area or portion of airspace.

GAMET area forecast. An area forecast in abbreviated plain language for low-level flights for a flight information region or sub-area thereof, prepared by the meteorological office designated by the meteorological authority concerned and exchanged with meteorological offices in adjacent flight information regions, as agreed between the meteorological authorities concerned.

Grid point data in digital form. Computer processed meteorological data for a set of regularly spaced points on a chart, for transmission from a meteorological computer to another computer in a code form suitable for automated use.

Note.— In most cases such data are transmitted on medium or high speed telecommunications channels.

Grid point data in numerical form. Processed meteorological data for a set of regularly spaced points on a chart, in a code form suitable for manual use.

Note.— In most cases such data are transmitted on low speed telecommunications channels.

Height. The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

Meteorological authority. The authority providing or arranging for the provision of meteorological service for international air navigation on behalf of a Contracting State.

Meteorological bulletin. A text comprising meteorological information preceded by an appropriate heading.

Meteorological information. Meteorological report, analysis, forecast, and any other statement relating to existing or expected meteorological conditions.

Meteorological office. An office designated to provide meteorological service for international air navigation.

Meteorological report. A statement of observed meteorological conditions related to a specified time and location.

Meteorological satellite. An artificial Earth satellite making meteorological observations and transmitting these observations to Earth.

Nephanalysis. The graphical depiction of analysed cloud data on a geographical map.

Observation (meteorological). The evaluation of one or more meteorological elements.

Operational control. The exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of the safety of the aircraft and the regularity and efficiency of the flight.

Operational flight plan. The operator's plan for the safe conduct of the flight based on considerations of aeroplane performance, other operating limitations and relevant expected conditions on the route to be followed and at the aerodromes concerned.

Operational planning. The planning of flight operations by an operator.

Operator. A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Prognostic chart. A forecast of a specified meteorological element(s) for a specified time or period and a specified surface or portion of airspace, depicted graphically on a chart.

Regional air navigation agreement. Agreement approved by the Council of ICAO normally on the advice of a regional air navigation meeting.

Regional area forecast centre (RAFC). A meteorological centre designated to prepare and supply area forecasts for flights departing from aerodromes within its service area and to supply grid point data in digital form for up to world-wide coverage.

Reporting point. A specified geographical location in relation to which the position of an aircraft can be reported.

Rescue co-ordination centre. A unit responsible for promoting efficient organization of search and rescue service and for co-ordinating the conduct of search and rescue operations within a search and rescue region.

Runway. A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Runway visual range (RVR). The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

Search and rescue services unit. A generic term meaning, as the case may be, rescue co-ordination centre, rescue subcentre or alerting post.

Service area (world area forecast system). A geographical area within which a regional area forecast centre is responsible for supplying area forecasts to meteorological authorities and other users.

SIGMET information. Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of aircraft operations.

Standard isobaric surface. An isobaric surface used on a world-wide basis for representing and analysing the conditions in the atmosphere.

Threshold. The beginning of that portion of the runway usable for landing.

Touchdown zone. The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway.

Tropical cyclone. Generic term for a non-frontal synoptic-scale cyclone originating over tropical or sub-tropical waters with organized convection and definite cyclonic surface wind circulation.

Upper-air chart. A meteorological chart relating to a specified upper-air surface or layer of the atmosphere.

VOLMET broadcast. Routine broadcast of meteorological information for aircraft in flight.

World area forecast centre (WAFC). A meteorological centre designated to prepare and supply upper-air forecasts in digital form on a global basis to regional area forecast centres.

World area forecast system (WAFS). A world-wide system by which world and regional area forecast centres provide aeronautical meteorological en-route forecasts in uniform standardized formats.

1.2 Terms used with a limited meaning

For the purpose of this Annex, the following terms are used with a limited meaning as indicated below:

a) to avoid confusion in respect of the term ''service'' between the meteorological service considered as an administrative entity and the service which is provided, ''meteorological authority'' is used for the former and ''service'' for the latter;

b) ''provide'' is used solely in connexion with the provision of service;

c) ''issue'' is used solely in connexion with cases where the obligation specifically extends to sending out the information to a user;

d) ''make available'' is used solely in connexion with cases where the obligation ends with making the information accessible to a user;

e) ''supply'' is used solely in connexion with cases where either c) or d) applies.

CHAPTER 2. GENERAL PROVISIONS

Introductory Note 1.— It is recognized that the provisions of this Annex with respect to meteorological information are subject to the understanding that the obligation of a Contracting State is for the supply, under Article 28 of the Convention, of meteorological information and that the responsibility for the use made of such information is that of the user.

Introductory Note 2.— Although the Convention on International Civil Aviation allocates to the State of Registry certain functions which that State is entitled to discharge, or obligated to discharge, as the case may be, the Assembly recognized, in Resolution A23-13, that the State of Registry may be unable to fulfil its responsibilities adequately in instances where aircraft are leased, chartered or interchanged — in particular without crew — by an operator of another State and that the Convention may not adequately specify the rights and obligations of the State of an operator in such instances until such time as Article 83 bis *of the Convention enters into force. Accordingly, the Council urged that if, in the above-mentioned instances, the State of Registry finds itself unable to discharge adequately the functions allocated to it by the Convention, it delegate to the State of the Operator, subject to acceptance by the latter State, those functions of the State of Registry that can more adequately be discharged by the State of the Operator. It is understood that pending entry into force of Article 83* bis *of the Convention the foregoing action will only be a matter of practical convenience and will not affect either the provisions of the Chicago Convention prescribing the duties of the State of Registry or any third State.*

Introductory Note 3.— In the case of international operations effected jointly with aeroplanes not all of which are registered in the same Contracting State, nothing in this Annex prevents the States concerned entering into an agreement for the joint exercise of the functions placed upon the State of Registry by the provisions of this Annex.

2.1 Objective, determination and provision of meteorological service

2.1.1 The objective of meteorological service for international air navigation shall be to contribute towards the safety, regularity and efficiency of international air navigation.

2.1.2 This objective shall be achieved by supplying operators, flight crew members, air traffic services units, search and rescue services units, airport managements and others concerned with the conduct or development of international air navigation with the meteorological information necessary for the performance of their respective functions.

2.1.3 Each Contracting State shall determine the meteoro-logical service which it will provide to meet the needs of inter-national air navigation. This determination shall be made in accordance with the provisions of this Annex and with due regard to regional air navigation agreements; it shall include the determination of the meteorological service to be provided for international air navigation over international waters and other areas which lie outside the territory of the State concerned.

2.1.4 Each Contracting State shall designate the authority, hereinafter referred to as the meteorological authority, to provide or to arrange for the provision of meteorological service for international air navigation on its behalf.

2.2 Supply and use of meteorological information

2.2.1 Close liaison shall be maintained between those concerned with the supply and those concerned with the use of meteorological information on matters which affect the provision of meteorological service.

2.2.2 The meteorological information supplied to aero-nautical personnel shall be up to date and shall be in forms which require a minimum of interpretation by users, as speci-fied in the following chapters.

2.3 Notifications required from operators

2.3.1 An operator requiring meteorological service or changes in existing meteorological service shall notify, sufficiently in advance, the meteorological authority or the meteorological office(s) concerned. The minimum amount of advance notice required shall be as agreed between the meteorological authority or meteorological office(s) and the operator.

2.3.2 The meteorological authority shall be notified by the operator requiring service when:

a) new routes or new types of operations are planned;

b) changes of a lasting character are to be made in scheduled operations;

c) other changes, affecting the provision of meteorological service, are planned.

Such information shall contain all details necessary for the planning of appropriate arrangements by the meteorological authority.

2.3.3 The aerodrome meteorological office, or the meteorological office concerned, shall be notified by the operator or a flight crew member:

a) of flight schedules;

b) when non-scheduled flights are to be operated;

c) when flights are delayed, advanced or cancelled.

2.3.4 **Recommendation.—** *The notification to the aero-drome meteorological office, or the meteorological office concerned, of individual flights should contain the following information except that, in the case of scheduled flights, the requirement for some or all of this information may be waived by agreement between the meteorological office and the operator:*

a) aerodrome of departure and estimated time of departure;

b) destination and estimated time of arrival;

c) route to be flown and estimated times of arrival at, and departure from, any intermediate aerodrome(s);

d) alternate aerodromes needed to complete the oper-ational flight plan and taken from the relevant list contained in the regional air navigation plan;

e) cruising level;

f) for supersonic flights, the alternative subsonic cruising level and the locations of the transonic acceleration and deceleration areas and of the subsonic climb and descent paths;

g) type of flight, whether under the visual or the instrument flight rules;

h) type of meteorological information requested for a flight crew member, whether flight documentation and/or briefing or consultation;

i) time(s) at which briefing, consultation and/or flight documentation are required.

CHAPTER 3. WORLD AREA FORECAST SYSTEM AND METEOROLOGICAL OFFICES

3.1 Objectives of the world area forecast system

The objectives of the world area forecast system shall be:

a) to supply meteorological offices with forecasts of en-route meteorological conditions concerning upper winds, upper-air temperatures, direction, speed and height of maximum wind, tropopause height and significant weather in pictorial and/or alphanumeric form suitable, as far as practicable, for direct use by operators, flight crew members, air traffic services units and other aeronautical users;

b) to supply meteorological authorities and other users with upper wind, upper-air temperature, direction, speed and height of maximum wind and tropopause height forecasts and forecasts of significant weather phenomena for grid points in digital form.

These objectives shall be achieved through a comprehensive, integrated, world-wide and, as far as practicable, uniform system, and in a cost-effective manner.

3.2 World area forecast centres

3.2.1 A Contracting State, having accepted the responsibility for providing a world area forecast centre (WAFC) within the framework of the world area forecast system, shall arrange for that centre:

a) to prepare global forecasts for grid points in digital form for all required levels and in a standard format; the forecasts shall comprise upper winds, upper-air temperatures, tropopause heights and maximum wind speed, direction and height;

b) to prepare global forecasts of significant weather phenomena;

c) to issue the forecasts referred to in a) and b) above in digital and/or pictorial form; and

d) to prepare and issue amendments to the forecasts.

Note 1.— Criteria for the issuance of amendments to the forecasts are given in 3.2.11 and 3.2.12.

Note 2.— Specifications for the preparation of significant weather and upper-air prognostic charts are contained in the Appendix.

3.2.2 **Recommendation.—** *In case of interruption of the operation of a WAFC, its functions should be carried out by the other WAFC.*

3.2.3 **Recommendation.—** *The forecasts of upper winds and upper-air temperatures, direction, speed and height of maximum winds and tropopause heights prepared twice daily by a WAFC should be valid for 12, 18, 24 and 30 hours after the time (0000 and 1200 UTC) of the synoptic data on which the forecasts were based and should be available for start of transmission in the above order as soon as technically feasible but not later than 6 hours after standard time of observation.*

3.2.4 **Recommendation.—** *Forecasts of significant weather phenomena prepared by WAFCs should be issued four times a day for fixed valid times of 0000, 0600, 1200 and 1800 UTC. The transmission of each forecast should be completed as soon as technically feasible but at least twelve hours before its validity time.*

3.2.5 **Recommendation.—** *Forecasts of significant weather phenomena should include all the items listed in 9.6.1. When the forecasts are issued in chart form, they should be in agreement with the specifications in 3.3.7.*

3.2.6 **Recommendation.—** *The grid point forecasts prepared by a WAFC should comprise:*

a) wind and temperature data for flight levels 50 (850 hPa), 100 (700 hPa), 180 (500 hPa), 240 (400 hPa), 300 (300 hPa), 340 (250 hPa), 390 (200 hPa) and 450 (150 hPa);

b) tropopause height, and direction, speed and height of maximum wind; and

c) wind and temperature data for flight levels 530 (100 hPa) and 600 (70 hPa) when and where required.

3.2.7 **Recommendation.—** *The grid point forecasts of upper winds and upper-air temperatures, direction, speed and height of maximum winds and tropopause heights should be prepared by a WAFC in a fixed grid with a horizontal resolution of 140 km.*

Note.— 140 km represents a distance of about 1.25° of latitude.

3.2.8 WAFCs shall adopt uniform formats and codes for the supply of forecasts and amendments.

3.2.9 **Recommendation.—** *The grid point forecasts of upper winds, upper-air temperatures, direction, speed and height of maximum winds and tropopause heights should be issued by a WAFC in the GRIB code form.*

Note.— The GRIB code form is contained in WMO Publication No. 306, Manual on Codes, *Volume I, Part B — Binary Codes.*

3.2.10 **Recommendation.—** *The upper wind and upper-air temperature forecasts in pictorial form should be issued for flight levels as determined by regional air navigation agreement.*

3.2.11 **Recommendation.—** *Amendments to upper wind and upper-air temperature forecasts should be issued in accordance with the following criteria:*

Upper wind	*Change in direction of 30° or more, provided the wind speed is 60 km/h (30 kt) or more before or after the change; change in speed of 40 km/h (20 kt) or more.*
Upper-air temperatures	*Change of more than 5°C.*

3.2.12 **Recommendation.—** *WAFCs should apply the following criteria for the amendment of significant en-route weather forecasts:*

Aircraft icing and turbulence	*Newly expected occurrence; error in expected position of phenomena; intensity increasing; intensity decreasing from severe to light or nil, or from moderate to nil.*
Jet streams	*Newly expected occurrence or disappearance; error in expected position > 400 km; error in speed > 20 per cent; error in core height > 900 m (3 000 ft).*
Other significant en-route weather phenomena	*Newly expected occurrence; no longer expected.*

3.2.13 **Recommendation.—** *Amendments to the upper wind and upper-air temperature forecasts should be prepared in accordance with the criteria in 3.2.11 in the form of amended meteorological bulletins and abbreviated plain-language messages and should be issued with the minimum possible delay.*

Note.— Guidance on the use of abbreviated plain language is given in Attachment A.

3.2.14 **Recommendation.—** *Amendments to forecasts of significant weather phenomena should be issued with the minimum possible delay in accordance with the criteria in 3.2.12 and supplied in the form of abbreviated plain-language messages.*

Note.— Guidance on the preparation of abbreviated plain-language significant weather forecast messages is given in Attachment A.

3.3 Regional area forecast centres

3.3.1 A Contracting State, having accepted, by regional air navigation agreement, the responsibility for providing a regional area forecast centre (RAFC) within the framework of the area forecast system, shall arrange for that centre:

a) to receive global digital grid point data from a WAFC, so as to meet the needs of meteorological authorities and other users within its service area, including those needs related to centralized flight planning;

b) to store the digital grid point data received from a WAFC, and to process and supply selectively these data to meteorological authorities and other users in its service area, in an agreed format;

c) to prepare upper wind and temperature charts on the basis of the data received, and to supply the relevant charts and abbreviated plain-language amendments thereto to users as agreed between the RAFC and the users within its service area;

Note.— The upper wind and temperature charts will be produced from grid point data received from a WAFC, except on those occasions when the RAFC considers it essential to adjust the chart(s) on the basis of recent basic data received.

d) to notify the relevant WAFC immediately of the content of and reasons for any amendments it has issued to the forecast received from the WAFC;

e) to prepare significant weather charts and, as required, significant weather forecast messages in abbreviated plain language, for its area of responsibility;

Note.— In order to prepare these charts and amendments thereto the RAFC will also need to receive basic synoptic and asynoptic data, including satellite data (polar-orbiting and geostationary) and aircraft meteorological reports.

f) to supply the significant weather charts, significant weather forecast messages in abbreviated plain language, and plain-language amendments thereto in the same manner as in c) above;

g) to exchange the significant weather charts and abbreviated plain-language amendments thereto with other RAFCs as necessary, so as to enable each centre to provide significant weather charts for its area of coverage;

h) to prepare WINTEM messages and issue them to users as required.

Note 1.— Specifications for the preparation of significant weather and upper-air prognostic charts are contained in the Appendix.

Note 2.— Guidance on the preparation of abbreviated plain-language significant weather forecast messages is contained in Attachment A.

Note 3.— The WINTEM code is contained in WMO Publication No. 306, Manual on Codes, *Volume I.*

3.3.2 **Recommendation.—** *The lists of States/territories served by the RAFCs in each service area, as shown in the air navigation plans, should be adjusted as necessary in accordance with regional air navigation agreement.*

3.3.3 **Recommendation.—** *The areas of responsibility for the preparation of significant weather forecasts should be as agreed by the RAFCs responsible for providing significant weather charts and plain-language amendments thereto for flight operations conducted over the area of coverage, and subject to subsequent regional air navigation agreement.*

Note.— The areas of responsibility are contained in the relevant regional air navigation plan.

3.3.4 **Recommendation.—** *The areas of coverage of the forecasts in chart and/or alphanumeric form supplied to the users should be determined by agreement between the relevant RAFC and the users.*

Note.— Maximum areas of coverage suitable for use in flight documentation are contained in the relevant regional air navigation plan.

3.3.5 **Recommendation.—** *RAFC products should be issued four times a day for fixed valid times of 0000, 0600, 1200 and 1800 UTC. The transmission of each forecast should be completed at least 9 hours before its validity time, unless otherwise determined by regional air navigation agreement.*

Note.— Such regional agreement should take into account, as necessary, the flight documentation requirements for inter-regional flights and the exchange of SIGWX charts between RAFCs concerned.

3.3.6 **Recommendation.—** *The digital data should be transmitted to meteorological authorities and other users with minimum delay after receipt from the WAFC.*

3.3.7 **Recommendation.—** *The significant weather charts should include the phenomena listed in 9.6.1 between:*

a) flight levels 250 and 450;

b) flight levels 100 and 250 for limited geographical areas, as determined by regional air navigation agreement; and

c) flight levels 450 and 600 if so determined by regional air navigation agreement. When so determined, forecasts covering the layer between flight levels 450 and 600 should be combined with those at a) above.

3.3.8 **Recommendation.—** *The upper wind and upper-air temperature charts should be provided for flight levels as determined by regional air navigation agreement.*

3.3.9 **Recommendation.—** *Amendments to significant weather forecasts should be supplied in the form of abbreviated plain-language messages.*

Note.— Guidance on the preparation of abbreviated plain-language significant weather forecast messages is contained in Attachment A.

3.3.10 **Recommendation.—** *RAFCs should apply the following criteria for the amendment of significant en-route weather forecasts:*

Aircraft icing and turbulence	*Newly expected occurrence; error in expected position of phenomena; intensity increasing; intensity decreasing from severe to light or nil, or from moderate to nil.*
Jet streams	*Newly expected occurrence or disappearance; error in expected position > 400 km; error in speed > 20 per cent; error in core height > 900 m (3 000 ft).*
Other significant en-route weather phenomena	*Newly expected occurrence; no longer expected.*

3.3.11 **Recommendation.—** *RAFCs should supply to meteorological authorities and other users within their service areas amendments to upper wind and upper-air temperature forecasts with minimum delay after receipt from a WAFC.*

3.4 Meteorological offices

3.4.1 Each Contracting State shall establish one or more aerodrome and/or other meteorological offices which shall be adequate for the provision of the meteorological service required to satisfy operational needs.

3.4.2 An aerodrome meteorological office shall carry out all or some of the following functions as necessary to meet the needs of flight operations at the aerodrome:

a) prepare and/or obtain forecasts and other relevant information for flights with which it is concerned; the extent of its responsibilities to prepare forecasts shall be related to the local availability and use of en-route and aerodrome forecast material received from other offices;

b) prepare and/or obtain forecasts of local meteorological conditions;

c) maintain a continuous survey of meteorological conditions over the aerodromes for which it is designated to prepare forecasts;

d) provide briefing, consultation and flight documentation to flight crew members and/or other flight operations personnel;

e) supply other meteorological information to aeronautical users;

f) display the available meteorological information;

g) exchange meteorological information with other meteorological offices;

h) supply information received on pre-eruption volcanic activity, a volcanic eruption or volcanic ash cloud, to its associated air traffic services unit, aeronautical information service unit and meteorological watch office as agreed between the meteorological, aeronautical information service and ATS authorities concerned.

3.4.3 **Recommendation.—** *The aerodrome meteorological offices at which briefing, consultation and/or flight documentation are required, as well as the areas and/or air routes to be covered, should be determined by regional air navigation agreement and, as necessary, by supplementary agreement between the meteorological authority and the operator concerned.*

3.4.4 **Recommendation.—** *The aerodromes for which landing forecasts are required should be determined by regional air navigation agreement.*

3.4.5 The extent to which an aerodrome meteorological office prepares forecasts and/or makes use of products from WAFCs and/or RAFCs and other sources shall be determined by the meteorological authority concerned.

3.4.6 **Recommendation.—** *Aerodrome meteorological offices should use as far as practicable output products of the world area forecast system in the preparation of flight documentation.*

3.4.7 For aerodromes without meteorological offices:

a) the meteorological authority concerned shall designate one or more meteorological offices to supply meteorological information as required;

b) the competent authorities shall establish means by which such information can be supplied to the aerodromes concerned.

3.5 Meteorological watch offices

3.5.1 A Contracting State, having accepted the responsibility for providing air traffic services within a flight information region or a control area, shall establish one or more meteorological watch offices, or arrange for another Contracting State to do so.

3.5.2 A meteorological watch office shall:

a) maintain watch over meteorological conditions affecting flight operations within its area of responsibility;

b) prepare SIGMET and other information relating to its area of responsibility;

c) supply SIGMET information and, as required, other meteorological information to associated air traffic services units;

d) disseminate SIGMET information;

e) when required by regional air navigation agreement, in accordance with 7.3.1:

1) prepare AIRMET information related to its area of responsibility;

2) supply AIRMET information to associated air traffic services units; and

3) disseminate AIRMET information;

f) supply information received on pre-eruption volcanic activity, a volcanic eruption and volcanic ash cloud for which a SIGMET has not already been issued to its associated flight information centre or area control centre as agreed between the meteorological and ATS authorities concerned.

3.5.3 The extent to which a meteorological watch office makes use of products from WAFCs and/or RAFCs and other sources shall be determined by the meteorological authority concerned.

3.5.4 **Recommendation.—** *The boundaries of the area over which meteorological watch is to be maintained by a meteorological watch office should, in so far as is practicable, be coincident with the boundaries of a flight information region or a control area or a combination of flight information regions and/or control areas.*

3.5.5 **Recommendation.—** *Meteorological watch should be maintained continuously; however, in areas with a low density of traffic the watch may be restricted to the period relevant to expected flight operations.*

CHAPTER 4. METEOROLOGICAL OBSERVATIONS AND REPORTS

4.1 Aeronautical meteorological stations and observations

4.1.1 Each Contracting State shall establish at aerodromes and other points of significance to international air navigation, in its territory, such aeronautical meteorological stations as it determines to be necessary. An aeronautical meteorological station may be a separate station or may be combined with a synoptic station.

4.1.2 **Recommendation.—** *Each Contracting State should establish, or arrange for the establishment of, aeronautical meteorological stations on off-shore structures or at other points of significance in support of helicopter operations to off-shore structures, if required by regional air navigation agreement.*

4.1.3 Aeronautical meteorological stations shall make routine observations at fixed intervals. At aerodromes, the routine observations shall be supplemented by special observations whenever specified changes occur in respect of surface wind, visibility, runway visual range, present weather and/or cloud. Other non-routine observations, such as observations for take-off and landing, shall be made as agreed between the meteorological authority and the appropriate ATS authority.

4.1.4 **Recommendation.—** *The meteorological instruments used at an aerodrome should be situated in such a way as to supply data which are representative of the area for which the measurements are required.*

Note.— Specifications concerning the siting and construction of equipment and installations on operational areas, aimed at reducing the hazard to aircraft to a minimum, are contained in Annex 14, Volume I, Chapter 8.

4.1.5 **Recommendation.—** *Meteorological instruments at aeronautical meteorological stations should be exposed, operated and maintained in accordance with the practices, procedures and specifications promulgated by the World Meteorological Organization.*

4.1.6 **Recommendation.—** *The observers at an aerodrome should be located, in so far as is practicable, so as to supply data which are representative of the area for which the observations are required.*

4.1.7 **Recommendation.—** *Each Contracting State should arrange for its aeronautical meteorological stations to be inspected at sufficiently frequent intervals to ensure that a high standard of observations is maintained, that instruments and all their indicators are functioning correctly, and to check whether the exposure of the instruments has changed significantly.*

4.1.8 **Recommendation.—** *At aerodromes, suitable observation systems should be installed to complement the aids for final approach and landing. Where precision approaches and, in particular, where Operational Performance Category II, III A and III B operations are planned, those observation systems should include automated equipment for measuring or evaluating, as appropriate, and for monitoring and remote indicating of surface wind, runway visual range, cloud height, and where the state of technology permits, of other meteorological parameters affecting landing and take-off operations. At certain aerodromes, where high levels of traffic make this necessary, these devices should be integrated automatic systems for acquisition, processing, dissemination/display in real time of the meteorological parameters affecting landing and take-off operations.*

Note.— Operational performance categories are described in Annex 10, Volume I, Attachment C to Part I.

4.1.9 **Recommendation.—** *Where an integrated automatic system is used for the dissemination/display of meteorological information, it should be capable of accepting the manual insertion of data covering those meteorological elements which cannot be observed by automatic means.*

4.1.10 **Recommendation.—** *Where automatic observing equipment forms part of an integrated semi-automatic system, displays of data which are made available to the local ATS units should be a subset of and displayed parallel to those available in the local meteorological service unit. In those displays, each meteorological element should be annotated to identify, as appropriate, the locations for which the element is representative.*

4.1.11 The observations shall form the basis for the preparation of reports to be disseminated at the aerodrome of origin and for reports to be disseminated beyond the aerodrome of origin.

4.1.12 Owing to the variability of meteorological elements in space and time, to limitations of observing techniques and to limitations caused by the definitions of some of the elements, the specific value of any of the elements given in a report shall be understood by the recipient to be the best approximation to the actual conditions at the time of observation.

Note.— Guidance on the operationally desirable and currently attainable accuracy of measurement or observation is given in Attachment B.

4.2 Routine observations and reports

4.2.1 At aerodromes, routine observations shall be made throughout the 24 hours each day, except as otherwise agreed between the meteorological authority, the appropriate ATS authority and the operator concerned. Such observations shall be made at intervals of one hour or, if so determined by regional air navigation agreement, at intervals of one half-hour. At other aeronautical meteorological stations, such observations shall be made as determined by the meteorological authority taking into account the requirements of air traffic services units and aircraft operations.

4.2.2 Reports of routine observations shall be issued as routine reports to local air traffic services units as required and shall be made available to the operators and to other users at the aerodrome.

4.2.3 **Recommendation.—** *Routine reports should be disseminated beyond the aerodrome of origin in accordance with regional air navigation agreement.*

4.3 Special observations, special reports and selected special reports

4.3.1 A list of criteria for special observations shall be established by the meteorological authority, in consultation with the appropriate ATS authority, operators and others concerned. The list shall include the following:

a) those values which most closely correspond with the operating minima of the operators using the aerodrome;

b) those values which satisfy other local requirements of the air traffic services units and of the operators;

c) an increase in air temperature of 2°C or more from that given in the latest report, or an alternative threshold value as agreed between the meteorological authority, the appropriate ATS authority and operators concerned;

d) the available supplementary information concerning the occurrence of significant meteorological conditions in the approach and climb-out areas as given in 4.12.1;

e) those values which constitute criteria for selected special reports.

Note.— A selected special report is a report prepared in accordance with criteria listed in 4.3.3 and intended primarily for dissemination beyond the aerodrome of origin.

4.3.2 Reports of special observations shall be prepared for use at the aerodrome of origin; they shall be issued as special reports to local air traffic services units as soon as the specified conditions occur. However, by agreement between the meteorological authority and the appropriate ATS authority, they need not be issued in respect of:

a) any element for which there is in the local air traffic services unit an indicator corresponding to the one in the meteorological station, and where arrangements are in force for the use of this indicator to make observations to meet the needs for reports for landing and take-off;

b) runway visual range, when all changes of one or more steps on the reporting scale in use are being reported to the local air traffic services unit by an observer on the aerodrome.

Special reports shall also be made available to the operators and to other users at the aerodrome.

4.3.3 **Recommendation.—** *Reports of special observations indicating changes in accordance with the following criteria should be prepared as selected special reports:*

a) when the mean surface wind direction has changed by 60° or more from that given in the latest report, the mean speed before and/or after the change being 20 km/h (10 kt) or more;

b) when the mean surface wind speed has changed by 20 km/h (10 kt) or more from that given in the latest report;

c) when the variation from the mean surface wind speed (gusts) has increased by 20 km/h (10 kt) or more from that given in the latest report, the mean speed before and/or after the change being 30 km/h (15 kt) or more;

d) when the wind changes through values of operational significance. The threshold values should be established by the meteorological authority in consultation with the appropriate ATS authority and operators concerned, taking into account changes in the wind which would:

1) require a change in runway(s) in use; and

2) indicate that the runway tailwind and crosswind components have changed through values representing the main operating limits for typical aircraft operating at the aerodrome;

e) when the visibility changes to or passes:

1) 800, 1 500 or 3 000 m;

2) 5 000 m, in cases where significant numbers of flights are operated in accordance with the visual flight rules;

f) when the runway visual range changes to or passes 150, 350, 600 or 800 m;

g) when the onset, cessation or change in intensity of any of the following weather phenomena or combinations thereof occurs:

— freezing precipitation
— freezing fog
— moderate or heavy precipitation (including showers thereof)
— low drifting dust, sand or snow
— blowing dust, sand or snow (including snowstorm)
— duststorm
— sandstorm
— thunderstorm (with or without precipitation)
— squall
— funnel cloud (tornado or waterspout);

h) when the height of base of the lowest cloud layer of BKN or OVC extent changes to or passes:

1) 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft);

2) 450 m (1 500 ft), in cases where significant numbers of flights are operated in accordance with the visual flight rules;

i) when the amount of a cloud layer below 450 m (1 500 ft) changes:

1) from SKC, FEW or SCT to BKN or OVC; or

2) from BKN or OVC to SKC, FEW or SCT;

j) when the sky is obscured and the vertical visibility changes to or passes through 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft).

4.3.4 When a deterioration of one weather element is accompanied by an improvement in another element, a single selected special report shall be issued; it shall then be treated as a deterioration report.

4.3.5 **Recommendation.—** *A selected special report representing a deterioration in conditions should be disseminated immediately after the observation. A selected special report representing an improvement in conditions should be disseminated only after the improvement has been maintained for 10 minutes; it should be amended before dissemination, if necessary, to indicate the conditions prevailing at the end of that 10-minute period. A selected special report representing a deterioration of one weather element and an improvement in another element should be disseminated immediately after the observation.*

4.3.6 **Recommendation.—** *Selected special reports should be disseminated beyond the aerodrome of origin in accordance with regional air navigation agreement.*

4.4 Observations and reports for take-off and landing

Recommendation.— *The agreement between the meteorological authority and the appropriate ATS authority referred to in 4.1.3 should cover, amongst other things:*

a) the provision in air traffic services units of indicators or instruments of the kind referred to in 4.5.4 (surface wind), 4.7.6 (runway visual range) and 4.11.2 (pressure) or in 4.1.8 (integrated automatic systems);

b) the calibration and maintenance of these indicators/instruments;

c) the use to be made of these indicators/instruments by air traffic services personnel;

d) as and where necessary, supplementary visual observations (for example, of meteorological phenomena of operational significance in the climb-out and approach areas) if and when made by air traffic services personnel to update or supplement the information supplied by the meteorological station;

e) meteorological information obtained from aircraft taking off or landing (for example, on wind shear);

f) if available, meteorological information obtained from ground weather radar.

4.5 Observing and reporting of surface wind

Introductory Note.— Selected criteria applicable to meteorological information referred to in 4.5 to 4.12 for inclusion in aerodrome reports are given in tabular form in Attachment C.

4.5.1 **Recommendation.—** *The mean direction and the mean speed of the surface wind should be measured, as well as significant variations of the wind direction and speed. Since, in practice, the surface wind cannot be measured directly on the runway, surface wind observations for take-off and landing should be the best practicable indication of the winds which an aircraft will encounter during take-off and landing.*

4.5.2 **Recommendation.—** *For reports for take-off, the surface wind observations should be representative of conditions along the runway, and for reports for landing the observations should be representative of the touchdown zone. Surface wind information for take-off and landing should be representative of conditions at a height of 6 to 10 m (20 to 30 ft) above the runway. Surface wind observations made for reports disseminated beyond the aerodrome should be representative of conditions at a height of 6 to 10 m (20 to*

30 ft) above the whole runway where there is only one runway and the whole runway complex where there is more than one runway.

4.5.3 **Recommendation.—** *Representative surface wind observations should be obtained by the use of sensors appropriately sited as determined by local conditions. Sensors for surface wind observations for reports for take-off and landing should be sited to give the best practicable indication of conditions along the runway, e.g. lift-off and touchdown zones. At aerodromes where topography or prevalent weather conditions cause significant differences in surface wind at various sections of the runway, additional sensors should be provided.*

4.5.4 Surface wind indicators relating to each sensor shall be located in the meteorological station with corresponding indicators in the appropriate air traffic services units. The indicators in the meteorological station and in the air traffic services units shall relate to the same sensors, and where separate sensors are required as specified in 4.5.3, the indicators shall be clearly marked to identify the runway and section of runway monitored by each sensor.

4.5.5 **Recommendation.—** *The averaging period for wind observations should be:*

a) 10 minutes for reports disseminated beyond the aerodrome except that when the 10-minute period includes a marked discontinuity in the wind direction and/or speed, only data occurring since the discontinuity should be used for obtaining mean values, hence the time interval in these circumstances should be correspondingly reduced;

b) 2 minutes for reports used at the aerodrome for take-off and landing and for wind indicators in air traffic services units.

Note.— A marked discontinuity occurs when there is an abrupt and sustained change in wind direction of 30° or more, with a wind speed of 20 km/h (10 kt) before or after the change, or a change in wind speed of 20 km/h (10 kt) or more, lasting at least 2 minutes.

4.5.6 **Recommendation.—** *In reports for take-off and landing, variations in the wind direction should be given when the total variation is 60° or more with mean speeds above 6 km/h (3 kt); such directional variations should be expressed as the two extreme directions between which the wind has varied during the past 10 minutes. Variations from the mean wind speed (gusts) during the past 10 minutes should be reported only when the variation from the mean speed is 20 km/h (10 kt) or more; such speed variations (gusts) should be expressed as the maximum and minimum speeds attained. When the 10-minute period includes a marked discontinuity in the wind direction and/or speed, only variations in direction and speed occurring since the discontinuity should be reported. The variations in direction and speed should be derived:*

a) for non-automated systems from the wind direction and speed indicators or from the anemograph recorder trace if available; and/or

b) for automated systems from the actual measured values of wind direction and speed, and not from the 2-minute and 10-minute running averages required under 4.5.5.

In reports for take-off, surface winds of 6 km/h (3 kt) or less should include a range of wind directions, whenever possible, if the total variation is 60° or more.

Note.— See note under 4.5.5.

4.5.7 **Recommendation.—** *Where multiple sensors are installed, the 2-minute time averages of and significant variations in the surface wind direction and speed for each sensor used in reports for take-off and landing should be monitored by automatic equipment.*

4.5.8 **Recommendation.—** *In reports in abbreviated plain language, the wind direction and speed and significant variations thereof should be given; the wind direction should be given in three figures rounded to the nearest 10 degrees true, for example, 277° should be given as "280"; this should be followed by "/" and by the wind speed. The units used for speed should be kilometres per hour or knots and should be indicated in the written form of the message. When directional variations are to be reported, the two extreme directions between which the wind has varied should be reported in degrees, for example, "VRB BTN 350/AND 050/". When variations from the mean speed are to be reported they should be reported as the maximum and minimum values of the speed attained in kilometres per hour or knots in the form "MAX70 MNM20" or "MAX35 MNM10", respectively. When the wind speed is less than 2 km/h (1 kt), this should be indicated by the term "CALM". In reports for take-off, light variable winds of 6 km/h (3 kt) or less and variations in wind direction should be indicated in the form "VRB BTN 350/AND 050/6KMH" (or "VRB BTN 350/AND 050/3KT"); in other reports, where it is not possible to report a mean wind direction with variations in wind direction of 180° or more, such as in light wind conditions (6 km/h (3 kt) or less), or at higher wind speeds, for example, when a thunderstorm passes over the aerodrome, a variable wind direction should be indicated by the term "VRB" in the form "VRB6KMH" (or "VRB3KT").*

4.5.9 **Recommendation.—** *In reports disseminated beyond the aerodrome:*

a) variations from the mean wind direction should be given if the total variation is 60° or more with mean speeds above 6 km/h (3 kt);

b) maximum wind speed should be included only if it exceeds the mean speed by 20 km/h (10 kt) or more;

c) minimum wind speed should not be given.

4.6 Observing and reporting of visibility

4.6.1 **Recommendation.—** *The horizontal visibility should be measured or be observed by reference to objects whose distance from the point of observation is known.*

4.6.2 **Recommendation.—** *Where observations are made using automatic observing equipment, provision should be made for manual insertion of the horizontal visibility value(s) in the corresponding displays.*

4.6.3 **Recommendation.—** *For reports for take-off the visibility observations should be representative of the take-off and climb-out area, and for reports for landing the observations should be representative of the approach and landing area. Visibility observations made for reports disseminated beyond the aerodrome should be representative of the aerodrome and its immediate vicinity; in such observations special attention should be given to significant directional variations.*

4.6.4 **Recommendation.—** *In reports in abbreviated plain language, the name of the element should be given and the units used for visibility should be specified clearly. When the visibility is less than 500 m it should be expressed in steps of 50 m in the form "VIS 350M", when it is 500 m or more but less than 5 km in steps of 100 m; 5 km or more but less than 10 km in kilometre steps, in the form "VIS 7KM"; and when it is 10 km or more, it should be given as 10 km, except when the conditions for the use of CAVOK apply.*

Note 1.— Specifications concerning the use of CAVOK are given in 4.13.2.

Note 2.— Guidance on currently attainable accuracy for observing visibility is given in Attachment B.

4.6.5 **Recommendation.—** *In reports disseminated beyond the aerodrome, when the visibility is not the same in different directions the lowest visibility should be reported. When the visibility is not the same in different directions and the visibility in one or more directions is more than 50 per cent above the lowest visibility, the lowest visibility observed should be reported and its general direction in relation to the site of the meteorological station indicated by reference to one of the eight points of the compass, for example, "VIS 1200M TO S". If the lowest visibility is observed in more than one direction, then the most operationally significant direction should be reported. Directional variations in visibility should be reported when the lowest visibility is less than 1 500 m and the visibility in another direction is more than 5 000 m, for example "VIS 1200M TO S 6KM TO W". Where such variations in visibility are observed in more than one direction, then the most operationally significant direction should be reported. When the visibility is fluctuating rapidly, and significant directional variations cannot be given, the lowest visibility should be reported, with no indication of direction.*

4.7 Observing and reporting of runway visual range

4.7.1 **Recommendation.—** *Since, in practice, the runway visual range cannot be measured directly on the runway and in view of other limitations imposed by observation methods, a runway visual range observation should be the best possible assessment of the range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line. For this assessment a height of approximately 5 m (15 ft) should be regarded as corresponding to the average eye level of a pilot in an aircraft.*

Note.— Guidance on the subject of runway visual range is contained in the ICAO Manual of Runway Visual Range Observing and Reporting Practices *(Doc 9328).*

4.7.2 **Recommendation.—** *Runway visual range observations should be representative of the touchdown zone and, as may be selected by the authority concerned, of the middle and far sections of the runway.*

4.7.3 **Recommendation.—** *Runway visual range observations should be made on all runways intended for use during periods of reduced visibility and in particular on:*

a) precision approach runways;

b) runways used for take-off and having high-intensity edge lights and/or centre line lights.

Note.— Precision approach runways are defined in Annex 14, Volume I, Chapter 1, under "Instrument runway".

4.7.4 **Recommendation.—** *Runway visual range observations should be carried out at a lateral distance from the runway centre line of not more than 120 m. The site for observations to be representative of the touchdown zone should be located about 300 m along the runway from the threshold. The sites for observations to be representative of the middle and far sections of the runway should be located at a distance of 1000 to 1500 m along the runway from the threshold and at a distance of about 300 m from the other end of the runway. The exact position of these sites and, if necessary, additional sites should be decided after considering aeronautical, meteorological and climatological factors such as long runways, swamps and other fog-prone areas.*

4.7.5 **Recommendation.—** *Runway visual range observations should be made, and the runway visual range reported, throughout periods when either the horizontal visibility or the runway visual range is observed to be less than 1 500 m.*

4.7.6 **Recommendation.—** *Where runway visual range is determined by instrumental means, one indicator — for example, recorder and dials — or more if required, should be located in the meteorological station with corresponding* *indicators, for example, dials or digital indicators, in the appropriate air traffic services units. The indicators in the meteorological station and in the air traffic services units should be connected to the same measuring device(s).*

4.7.7 **Recommendation.—** *Where a transmissometer is used for determination of runway visual range:*

a) the conversion of its readings should be based on the appropriate intensity of the runway lights;

b) the averaging period of its readings should be 1 minute; and

c) its readings should be updated as necessary to permit the provision of current, representative values.

Note.— Guidance on the conversion of transmissometer readings into runway visual range is given in Attachment D.

4.7.8 **Recommendation.—** *When instruments are used for determination of runway visual range, computations should be made separately for each available runway. The light intensity to be used for the computation should be:*

a) for a runway with the lights switched on, the light intensity actually in use on that runway;

b) for a runway with lights switched off (or at the lowest setting pending the resumption of operations), the optimum light intensity that would be appropriate for operational use in the prevailing conditions.

4.7.9 **Recommendation.—** *The units providing air traffic service and aeronautical information service for an aerodrome should be kept informed without delay of changes in the serviceability status of the runway visual range observing system.*

4.7.10 **Recommendation.—** *The reporting scale should consist of increments between 25 m and 60 m for runway visual range up to 800 m and increments of 100 m for runway visual range above 800 m. Where the observations are made by counting runway edge lights, the reporting increments should be determined largely by the spacing of those lights. Any observed value which does not fit the reporting scale in use should be rounded down to the nearest lower step in the scale.*

4.7.11 **Recommendation.—** *Fifty metres should be considered the lower limit and 1 500 metres the upper limit for assessments of runway visual range. Outside of these limits reports should merely indicate that the runway visual range is less than 50 m or more than 1 500 m, in the form "RVR BLW 50M" or "RVR ABV 1500M", respectively.*

4.7.12 **Recommendation.—** *Runway visual range should be reported to the appropriate local air traffic services units, whenever there is a change in the value to be reported in accordance with the reporting scale (except where the provisions of 4.3.2 a) or b) apply). The transmission of such reports should normally be completed within 15 seconds after the termination of the observation.*

4.7.13 **Recommendation.—** *In reports in abbreviated plain language the name of the element should be given in abbreviated form and the units used should be included, for example, "RVR 400M". When runway visual range is above the maximum value which can be determined by the system in use, it should be reported, for example, in the form "RVR ABV 1200M", where the figure 1 200 is the maximum value that can be determined by the system. When the runway visual range is below the minimum value which can be determined by the system in use, it should be reported, for example, in the form "RVR BLW 150M" where the figure 150 is the minimum value that can be determined by that system. If runway visual range is observed from one location along the runway, about 300 m from the threshold, it should be included without any indication of location. If the runway visual range is observed from more than one location along the runway, the value representative of the touchdown zone should be given first, followed by the values representative of the mid-point and stop-end. The locations for which these values are representative should be indicated as "TDZ", "MID" and "END" respectively, for example, "RVR RWY 16 TDZ 600M MID 500M END 400M". When there is more than one runway in use, the available runway visual range values for each runway should be given and the runways to which the values refer should be indicated, for example, "RWY 26 RVR 500M RWY 20 RVR 800M"; if more than one runway is in use, but runway visual range is available only for one runway, that information should be indicated in the form "RWY 20 RVR 500M".*

4.7.14 **Recommendation.—** *In reports disseminated beyond the aerodrome only the value representative of the touchdown zone should be given and no indication of location on the runway should be included. Where there is more than one runway available for landing, touchdown zone runway visual range values should be included for all such runways up to a maximum of four and the runways to which the values refer should be indicated in the form "RWY 26 RVR 500M RWY 20 RVR 800M". Runway visual range should be based on the same light intensity settings as those appropriate for use during take-off and landing at the time the report is made, but excluding any temporary changes in the light intensity settings. When the runway visual range information is determined using instruments, the runway visual range reported should be the mean value during the 10-minute period immediately preceding the observation. If the runway visual range values during the 10-minute period have shown a distinct tendency, such that the mean during the first 5 minutes varies by 100 m or more from the mean during the second 5 minutes of the period, this should be indicated. When the variation of the runway visual range values shows an upward or downward tendency this should be indicated by the abbreviation "U" or "D" respectively in the form "RWY 12 RVR 200M/U". In circumstances when actual fluctuations* *during the 10-minute period indicate no distinct tendency this should be reported using the abbreviation "N". When indications of tendency are not available, none of the foregoing abbreviations should be included. If the one-minute runway visual range values during the 10-minute period immediately preceding the observation vary from the mean value by more than 50 m or more than 20 per cent of the mean value, whichever is greater, the one-minute mean minimum and the one-minute mean maximum values should be reported instead of the 10-minute mean value, in the form "RWY 26 RVR MNM700M MAX1200M". If the 10-minute period immediately preceding the observation includes a marked discontinuity in runway visual range values, only those values occurring after the discontinuity should be used to obtain mean values, and variations.*

Note.— A marked discontinuity occurs when there is an abrupt and sustained change in runway visual range, lasting at least 2 minutes, which reaches or passes through criteria for the issuance of selected special reports given in 4.3.3 f).

4.8 Observing and reporting of present weather

4.8.1 **Recommendation.—** *The present weather occurring at and/or near the aerodrome should be observed. For reports for take-off and landing, the present weather information should be representative, as far as is practicable, of the take-off and climb-out area or of the approach and landing area respectively. Observations of present weather made for reports disseminated beyond the aerodrome should be representative of the aerodrome and its immediate vicinity.*

4.8.2 **Recommendation.—** *Where observations are made using automatic observing equipment, provision should be made for manual insertion in the corresponding displays of those weather elements which cannot be determined adequately by that equipment.*

4.8.3 **Recommendation.—** *Present weather phenomena should be reported in terms of type and characteristics and qualified with respect to intensity or proximity to the aerodrome, as appropriate.*

4.8.4 **Recommendation.—** *The types of present weather phenomena which should be reported, their respective abbreviations and relevant criteria for their reporting of significance to aviation are as follows:*

a) Precipitation

Drizzle	*DZ*
Rain	*RA*
Snow	*SN*
Snow grains	*SG*
Ice pellets	*PE*
Ice crystals (very small ice crystals in suspension also known as diamond dust) — *Reported only when associated visibility is 5 000 m or less.*	*IC*
Hail — *Reported when diameter of largest hailstones is 5 mm or more.*	*GR*
Small hail and/or snow pellets — *Reported when diameter of largest hailstones is less than 5 mm.*	*GS*

b) Obscurations (hydrometeors)

Fog — *Reported when visibility is less than 1 000 m, except when qualified by "MI", "BC", "PR" or "VC" (see 4.8.5 and 4.8.6).*	*FG*
Mist — *Reported when visibility is at least 1 000 m but not more than 5 000 m.*	*BR*

c) Obscurations (lithometeors)

The following should be used only when the obscuration consists predominantly of lithometeors and the visibility is 5 000 m or less except "SA" when qualified by "DR" (see 4.8.5) and volcanic ash.

Sand	*SA*
Dust (widespread)	*DU*
Haze	*HZ*
Smoke	*FU*
Volcanic ash	*VA*

d) Other phenomena

Dust/sand whirls (dust devils)	*PO*
Squall	*SQ*
Funnel cloud (tornado or waterspout)	*FC*
Duststorm	*DS*
Sandstorm	*SS*

4.8.5 **Recommendation.—** *The characteristics of the present weather phenomena which should be reported, as necessary, and their respective abbreviations are as follows:*

Thunderstorm — *Used to report a thunderstorm with rain "TSRA", snow "TSSN", ice pellets "TSPE", hail "TSGR" or small hail and/or snow pellets "TSGS" or combinations thereof, for example, "TSRASN". When thunder is heard during the 10-minute period preceding the time of observation but no precipitation is observed at the aerodrome, the abbreviation "TS" should be used without qualification.*	*TS*

Shower — SH
— *Used to report showers of rain "SHRA", snow "SHSN", ice pellets "SHPE", hail "SHGR", small hail and/or snow pellets "SHGS", or combinations thereof, for example "SHRASN". Showers observed in the vicinity of the aerodrome (see 4.8.6) should be reported as "VCSH" without qualification regarding type or intensity of precipitation.*

Freezing (supercooled water droplets or precipitation, used only with FG, DZ and RA) — FZ

Blowing — BL
— *Used to report DU, SA or SN (including snowstorm) raised by the wind to a height of 2 m (6 ft) or more above the ground; in the case of snow, also used to report snow falling from a cloud and mixed with snow raised by the wind from the ground.*

Low drifting (used with DU, SA or SN raised by the wind to less than 2 m (6 ft) above ground level) — DR

Shallow (less than 2 m (6 ft) above ground level) — MI

Patches (fog patches randomly covering the aerodrome) — BC

Partial (a substantial part of the aerodrome covered by fog while the remainder is clear) — PR

4.8.6 **Recommendation.—** *The relevant intensity or, as appropriate, the proximity to the aerodrome of the reported present weather phenomena should be indicated as follows:*

	(abbreviated plain language)	*(METAR)*
Light	*FBL*	–
Moderate	*MOD*	*(no indication)*
Heavy	*HVY*	+

— *Used only with: precipitation; SH and TS (in these cases intensity refers to precipitation in accordance with 4.8.7); BLDU; BLSA; BLSN; DS; SS; and PO, FC (in these cases HVY means well developed).*

Vicinity — VC
— *Not at the aerodrome but not further away than approximately 8 km from the aerodrome perimeter and used only with DS, SS, FG, FC, SH, PO, BLDU, BLSA, BLSN and TS when not reported under 4.8.5.*

4.8.7 **Recommendation.—** *In reports in abbreviated plain language, one or more up to a maximum of three of the present weather abbreviations given in 4.8.4 and 4.8.5 should be used, as necessary, together with an indication, where appropriate, of the characteristics and intensity or proximity to the aerodrome, so as to convey a complete description of the present weather at or near the aerodrome of significance to flight operations. In reporting this information, the indication of intensity or proximity as appropriate, should be reported first followed respectively by the characteristics and the type of weather phenomena in the form "HVY TSRA" or "VC FG". Where two different types of weather are observed, they should be reported in two separate groups, in the form "HVY DZ FG" or "FBL DZ VC FG" where the intensity or proximity indicator refers to the weather phenomenon which follows the indicator. However, different types of precipitation occurring at the time of observation should be reported as one single group with the dominant type of precipitation reported first and preceded by only one intensity qualifier which refers to the intensity of the total precipitation in the form "HVY TSRASN" or "FBL SNRA FG".*

4.9 Observing and reporting of cloud

4.9.1 **Recommendation.—** *Cloud amount, type and height of base should be observed as necessary to describe the general cloud distribution.*

4.9.2 **Recommendation.—** *Where ceilometers are used as a part of automated observing equipment to measure height of cloud base, provision should be made for manual insertion of cloud amounts and, where appropriate, cloud type(s), together with the heights of those layers or masses not directly measurable by the ceilometer(s).*

4.9.3 **Recommendation.—** *Cloud observations for reports for landing should be representative of the approach area or, in the case of aerodromes with precision approach runways, of the middle marker site of the instrument landing system. Cloud observations made for reports disseminated beyond the aerodrome should be representative of the aerodrome and its immediate vicinity.*

Note.— Specifications concerning the middle marker site of an instrument landing system are given in Annex 10, Volume I, Part I.

4.9.4 **Recommendation.—** *The height of the base of cloud should normally be reported above aerodrome elevation. When a precision approach runway is in use which has a threshold elevation 15 m (50 ft) or more below the aerodrome elevation, local arrangements should be made in order that the height of clouds reported to arriving aircraft should refer to the threshold elevation. In the case of reports from off-shore structures the height of the base of cloud should be given above mean sea level.*

4.9.5 **Recommendation.—** *In reports in abbreviated plain language, cloud amount should be given using the abbreviations "FEW" (1 to 2 oktas), "SCT" (3 to 4 oktas), "BKN" (5 to 7 oktas) or "OVC" (8 oktas). If there are no clouds and no restriction on vertical visibility and the abbreviation "CAVOK" is not appropriate, the abbreviation "SKC" should be used. When the sky is obscured and information on vertical visibility is available, it should be reported in the form "VER VIS", followed by the value of the vertical visibility and the units used. When several layers or masses of cloud are observed, their amount and height should be reported in the following order:*

a) the lowest layer or mass, regardless of amount to be reported as FEW, SCT, BKN or OVC as appropriate;

b) the next layer or mass, covering more than 2/8 to be reported as SCT, BKN or OVC as appropriate;

c) the next higher layer or mass, covering more than 4/8 to be reported as BKN or OVC as appropriate;

d) cumulonimbus and/or towering cumulus clouds, whenever observed and not reported in a) to c) above.

The type of cloud should be identified only for cumulonimbus and towering cumulus when observed at or near the aerodrome. These should be given as "CB" and "TCU" respectively. The height of the base of cloud should be reported in steps of 30 m (100 ft) up to 3 000 m (10 000 ft) together with the units used, in the form "300M" or "1000FT" and in steps of 300 m (1 000 ft) above 3 000 m (10 000 ft). When the cloud base is diffuse or ragged or fluctuating rapidly, the minimum height of the cloud, or cloud fragments, should be given, followed by the relevant abbreviation "DIF" or "RAG" or "FLUC". When an individual layer (mass) of cloud is composed of cumulonimbus and towering cumulus clouds with a common cloud base, the type of cloud should be reported as cumulonimbus only.

Note.— Towering cumulus (TCU) is used to indicate cumulus congestus clouds of great vertical extent.

4.10 Observing and reporting of air temperature and dew-point temperature

4.10.1 **Recommendation.—** *The air temperature and the dew-point temperature should be reported to the nearest whole degree Celsius, with observed values involving 0.5°C rounded up to the next higher whole degree Celsius, for example, +2.5°C should be rounded off to +3°C, –2.5°C should be rounded off to –2°C.*

4.10.2 **Recommendation.—** *Observations of air temperature and dew-point temperature should be representative of the runways.*

4.10.3 **Recommendation.—** *In reports in abbreviated plain language, the air temperature should be identified by "T" and the dew-point temperature by "DP" in the form "T21 DP8". For a temperature below 0°C the value should be preceded by "MS".*

4.11 Observing and reporting of pressure values

4.11.1 **Recommendation.—** *The atmospheric pressure should be measured and QNH and/or QFE values should be computed in tenths of a hectopascal.*

4.11.2 **Recommendation.—** *For local air traffic services units QNH and, if required, QFE should be kept current by routine issues, supplemented by the issue of new data whenever changes occur which exceed an agreed magnitude. Such supplementary data need not be issued when the air traffic services unit is equipped with a remote indicator from the barometer in the meteorological station or with a separate barometer, and where arrangements are in force for the use of the remote indicator, or separate barometer, to make observations to meet the need for reports for landing and take-off.*

4.11.3 **Recommendation.—** *The reference level for the computation of QFE should be the aerodrome elevation. For non-precision approach runways, the thresholds of which are 2 m (7 ft) or more below the aerodrome elevation, and for precision approach runways, the QFE, if required, should refer to the relevant threshold elevation.*

4.11.4 **Recommendation.—** *In routine reports disseminated at the aerodrome QNH should be included regularly and QFE should be included either on request or, if so agreed locally, on a regular basis. Those values should be rounded down to the nearest lower whole hectopascal. For example, QNH 995.6 hPa should be given as "QNH 995".*

4.11.5 **Recommendation.—** *In reports disseminated beyond the aerodrome of origin QNH values should be included and the values should be rounded down to the nearest lower whole hectopascal.*

4.12 Observing and reporting of supplementary information

4.12.1 **Recommendation.—** *Observations made at aerodromes should include the available supplementary information concerning significant meteorological conditions, particularly those in the approach and climb-out areas, and specifically the location of cumulonimbus or thunderstorm, moderate or severe turbulence, wind shear, hail, severe squall line, moderate or severe icing, freezing precipitation, severe mountain waves, sandstorm, duststorm, blowing snow or funnel cloud (tornado or waterspout). Where practicable, the* *information should identify the vertical extent and direction and rate of movement of the phenomenon. As icing, turbulence and to a large extent, wind shear, for the time being cannot be satisfactorily observed from the ground, evidence of their existence should be derived from aircraft observations during the climb-out or approach phases of flight to be made in accordance with Chapter 5, 5.5.*

Note.— The preparation and dissemination of warnings of wind shear in the climb-out and approach paths is dealt with in Chapter 7, 7.6.1 to 7.6.6.

4.12.2 **Recommendation.—** *Where observations are made using automatic observing equipment, provision should be made for manual insertion of information concerning significant meteorological conditions which cannot be determined adequately by that equipment.*

4.12.3 **Recommendation.—** *When any of the following weather phenomena or combinations thereof were observed at the aerodrome during the period since the last issued routine report or last hour, whichever is the shorter, but not at the time of observation, this should be reported, up to a maximum of three groups, in the supplementary information:*

- *— freezing precipitation*
- *— moderate or heavy precipitation (including showers thereof)*
- *— moderate or heavy blowing snow (including snowstorm)*
- *— duststorm or sandstorm*
- *— thunderstorm*
- *— funnel cloud (tornado or water spout)*
- *— volcanic ash.*

4.12.4 **Recommendation.—** *Information on the state of the runway should be included in accordance with regional air navigation agreement.*

4.12.5 **Recommendation.—** *The available supplementary information should be included in abbreviated plain language. Wind shear in the approach area should be reported, for example, as "SURFACE WIND 320/20KMH WIND AT 60M 360/50KMH IN APCH" (or "SURFACE WIND 320/10KT WIND AT 60 M 360/25KT IN APCH"). Moderate turbulence and icing in cloud in the climb-out area should be reported as "MOD TURB AND ICE INC IN CLIMB-OUT". Information on recent significant weather should be reported, for example, as "REDZ".*

4.12.6 **Recommendation.—** *Information on recent weather of operational significance as given in 4.12.3 observed at the aerodrome within the period since the last issued routine report or last hour, whichever is the shorter, but not at the time of observation and, where local circumstances so warrant, information on wind shear should be added in reports disseminated beyond the aerodrome, while other supplementary information should be added in such reports only in accordance with regional air navigation agreement. Information on recent significant weather should be added in the form, for example, "REFZRA". Information on wind shear should be added, if necessary, in the form "WS RWY 12" or "WS ALL RWY".*

Note.— The local circumstances referred to in 4.12.6 include, but are not necessarily limited to, wind shear of a non-transitory nature such as might be associated with low level temperature inversions or local topography.

4.12.7 **Recommendation.—** *Information on sea-surface temperature and the state of the sea should be included in reports from aeronautical meteorological stations established on off-shore structures in support of helicopter operations, as determined by regional air navigation agreement.*

Note.— The state of the sea is specified in WMO Publication No. 306, Manual on Codes, *Volume I, Code Table 3700.*

4.13 Contents of reports

4.13.1 **Recommendation.—** *Routine, special and selected special reports should contain the following information in the order indicated, except that special reports need not contain information as provided for under 4.3.2:*

a) identification of the type of report;

b) location indicator;

c) time of the observation;

d) surface wind direction and speed;

e) visibility;

f) runway visual range, when applicable;

g) present weather;

h) cloud amount, type (only for cumulonimbus and towering cumulus clouds at or near the aerodrome) and height of base;

i) air temperature and dew-point temperature (included in routine and selected special reports and, in accordance with regional air navigation agreement, in special reports);

j) QNH and, when applicable, QFE (QFE included only in reports disseminated locally at the aerodrome by agreement between the meteorological and air traffic services authorities and operators concerned);

k) supplementary information.

Note 1.— The location indicators referred to under b) and their significations are published in ICAO Doc 7910 — Location Indicators.

Note 2.— For explanation of towering cumulus see note following 4.9.5.

4.13.2 When the following conditions obtain simultaneously at the time of observation:

a) visibility, 10 km or more;

b) no cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater, and no cumulonimbus;

c) weather of significance to aviation as given in 4.8.4 and 4.8.5;

information on visibility, runway visual range, present weather and cloud amount, type and height shall be replaced in all meteorological reports by the term "CAVOK".

4.13.3 **Recommendation.—** *Where reports for take-off and landing are required by the local aerodrome control tower and/or approach control office, the contents of such reports should be determined by local agreement. All elements included in reports for take-off and landing should be based on observations which are representative of conditions existing immediately prior to the transmission of the report.*

4.14 Format of reports

4.14.1 Routine and special reports and, where required, reports for take-off and landing, which are not disseminated beyond the aerodrome of origin shall be in a form agreed with the air traffic services units, operators and other aeronautical users concerned.

4.14.2 Routine and selected special reports which are exchanged between meteorological offices shall be:

a) in the METAR or SPECI code forms prescribed by the World Meteorological Organization; or

b) when agreed between the meteorological authorities concerned, in abbreviated plain language or in teletypewriter characters and symbols, the significance of which has been agreed upon by the meteorological authorities concerned.

Note.— The METAR and SPECI code forms are contained in WMO Publication No. 306, Manual on Codes, *Volume I.*

4.14.3 **Recommendation.—** *Routine reports in the METAR code form and selected special reports in the SPECI code form should normally contain all information which the codes provide for, except the meteorological elements given in optional groups which should be included in accordance with regional air navigation agreement.*

4.14.4 **Recommendation.—** *Routine reports from aeronautical meteorological stations not at international aerodromes should, when disseminated in a code form prescribed by the World Meteorological Organization, be in the METAR code form except that, if so desired by the meteorological authority responsible for their preparation, they may be in the SYNOP code form.*

4.14.5 Reports in abbreviated plain language shall convey to aeronautical personnel a directly intelligible meaning through the use of:

a) abbreviations approved by ICAO for use in the international aeronautical telecommunication service; and

b) numerical values of self-explanatory nature;

supplemented, if suitable approved abbreviations are not available, by the vocabulary of a national language, taken with its usual meaning in aviation. With the exception of QNH and QFE, no signals of the Q Code shall be used in such reports.

Note.— The abbreviations referred to under a) are contained in the Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(Doc 8400).*

4.14.6 **Recommendation.—** *Routine reports in abbreviated plain language should be identified as "MET REPORT" and special and selected special reports as "SPECIAL". When a group of routine reports is dissemi-nated, the identifier need only be used with the first report; in the case of special and selected special reports the identifier should always be included with each report. The date of the observation should be indicated by two figures followed by the actual time the observation is made in hours and minutes UTC, in the form "042230Z". When a group of reports is included in a message, the actual time of the first report contained in the message should be given; the time of any other report included in the message should be given only if it differs from the time of the first report by more than 10 minutes.*

4.14.7 **Recommendation.—** *The terminology, units and scales employed in reports for take-off and landing should be the same as those used in routine, special and selected special reports for the same aerodrome.*

4.15 Observations and reports of volcanic activity

Recommendation.— *The occurrence of pre-eruption volcanic activity, volcanic eruptions and volcanic ash cloud* *should be reported without delay to the associated air traffic services unit, aeronautical information services unit and meteorological watch office. The report should be made in the form of a volcanic activity report comprising the following information in the order indicated:*

a) message type, VOLCANIC ACTIVITY REPORT;

b) station identifier, location indicator or name of station;

c) date/time of message;

d) location of volcano and name if known;

e) concise description of event including, as appropriate, level of intensity of volcanic activity, occurrence of an eruption and its date and time and the existence of a volcanic ash cloud in the area together with direction of ash cloud movement and height.

Note.— Pre-eruption volcanic activity in this context means unusual and/or increasing volcanic activity which could presage a volcanic eruption.

EXAMPLES OF REPORTS

Example 1.— Routine report

a) METAR for YUDO (Donlon/International):*

METAR YUDO 221630Z 24015KMH 0600 R12/1000U FG DZ SCT010 OVC020 17/16 Q1018 BECMG TL1700 0800 FG BECMG AT1800 9999 NSW

b) Abbreviated plain-language report (same location and weather conditions as METAR):

MET REPORT YUDO 221630Z 240/15KMH VIS 600M RWY12 RVR 1000M/U FG DZ SCT 300M OVC 600M T17 DP16 QNH 1018 BECMG TL1700 VIS 800M FG BECMG AT1800 VIS 10KM NSW

c) Meaning of both reports:

Routine report for Donlon/International* issued on the 22nd of the month at 1630 UTC; surface wind direction 240 degrees; wind speed 15 kilometres per hour; visibility 600 metres; runway visual range representative of the touchdown zone for runway 12 is 1 000 metres and the runway visual range values have shown an upward tendency during previous 10 minutes; fog and drizzle; scattered cloud at 300 metres; overcast at 600 metres; air temperature 17 degrees Celsius; dew-point temperature 16 degrees Celsius; QNH 1018 hectopascals; trend during next two hours visibility becoming 800 metres in fog by 1700 UTC; at 1800 UTC visibility becoming 10 kilometres or more and nil significant weather.

* Fictitious location

Note.— In this example, the primary units "kilometre per hour" and "metre" were used for wind speed and height of cloud base respectively. However, in accordance with Annex 5, the corresponding non-SI alternative units "knot" and "foot" may be used instead.

Example 2.— Selected special report

a) SPECI for YUDO (Donlon/International):*

SPECI YUDO 151115Z 05025G37KT 1200NE 6000S +TSRA BKN005CB 25/22 Q1008 TEMPO TL1200 0600 BECMG AT1200 9999 NSW NSC

b) Abbreviated plain-language report (same location and weather conditions as SPECI):

SPECIAL YUDO 151115Z 050/25KT MAX37 MNM10 VIS 1200M TO NE 6000M TO S HVY TSRA BKN CB 500FT T25 DP22 QNH 1008 TEMPO TL1200 VIS 600M BECMG AT1200 10KM NSW NSC

c) Meaning of both reports:

Selected special report for Donlon/International* issued on the 15th of the month at 1115 UTC; surface wind direction 050 degrees; wind speed 25 knots gusting between 10 and 37 knots (minimum wind speed not to be included in SPECI); visibility lowest to north east at 1 200 metres, visibility 6 000 metres to South; heavy thunderstorm with rain; broken cumulonimbus cloud at 500 feet; air temperature 25 degrees Celsius; dew-point temperature 22 degrees Celsius; QNH 1008 hectopascals; trend during next two hours, visibility temporarily 600 metres from 1115 to 1200, becoming at 1200 UTC visibility 10 km or more, thunderstorm ceases and nil significant weather and nil significant cloud.

* Fictitious location

Note.— In this example, the non-SI alternative units "knot" and "foot" were used for wind speed and height of cloud base respectively. However, in accordance with Annex 5, the corresponding primary units "kilometre per hour" and "metre" may be used instead.

Example 3.— Volcanic activity report

VOLCANIC ACTIVITY REPORT YUSB* 231500 MT TROJEEN* VOLCANO 5605N 12652W ERUPTED 231445 LARGE ASH CLOUD EXTENDING TO APPROX 30000 FEET MOVING SW

Meaning: Volcanic activity report issued by Siby/Bistock meteorological station at 1500 UTC on the 23rd of the month. Mt Trojeen volcano 56 degrees 5 minutes north 126 degrees 52 minutes west erupted at 1445 UTC on the 23rd; a large ash cloud was observed extending to approximately 30 000 feet and moving in a south-westerly direction.

* Fictitious locations

CHAPTER 5. AIRCRAFT OBSERVATIONS AND REPORTS

5.1 Obligations of States

Each Contracting State shall arrange, according to the provisions of this chapter, for observations to be made by aircraft of its registry operating on international air routes and for the recording and reporting of these observations.

5.2 Aircraft observations

The following aircraft observations shall be made:

a) routine aircraft observations during en-route and climb-out phases of the flight; and

b) special and other non-routine aircraft observations during any phase of the flight.

5.3 Reporting of aircraft observations during flight

5.3.1 Aircraft observations shall be reported by air-ground data link. Where air-ground data link is not available or appropriate, aircraft observations shall be reported by voice communications.

5.3.2 Aircraft observations shall be reported during flight at the time the observation is made or as soon thereafter as is practicable.

5.4 Routine aircraft observations

5.4.1 **Recommendation.—** *When air-ground data link is used and automatic dependent surveillance (ADS) is being applied, automated routine observations should be made every 15 minutes during the en-route phase and every 30 seconds during the climb-out phase for the first 10 minutes of the flight.*

5.4.2 When voice communications are used, routine observations shall be made during the en-route phase in relation to those air traffic services reporting points or intervals:

a) at which the applicable air traffic services procedures require routine position reports; and

b) which are those separated by distances corresponding most closely to intervals of one hour of flying time.

5.4.3 **Recommendation.—** *For helicopter operations to and from aerodromes on off-shore structures, routine observations should be made from helicopters at points and times as agreed between the meteorological authorities and the helicopter operators concerned.*

5.4.4 In the case of air routes with high-density air traffic (e.g. organized tracks), an aircraft from among the aircraft operating at each flight level shall be designated, at approximately hourly intervals, to make routine observations in accordance with 5.4.1 or 5.4.2, as appropriate. The designation procedures shall be subject to regional air navigation agreement.

5.4.5 In the case of the requirement to report during the climb-out phase, an aircraft shall be designated, at approximately hourly intervals, at each aerodrome to make routine observations in accordance with 5.4.1.

5.4.6 When voice communications are used, an aircraft shall be exempted from making the routine observations specified in 5.4.2 when:

a) the aircraft is not equipped with RNAV equipment; or

b) the flight duration is 2 hours or less; or

c) the aircraft is at a distance equivalent to less than one hour of flying time from the next intended point of landing; or

d) the altitude of the flight path is below 1 500 m (5 000 ft).

5.4.7 **Recommendation.—** *When voice communications are used, additional exemptions may be prescribed by regional air navigation agreement for flights over routes and areas with high density air traffic and/or with adequate synoptic networks. Such procedures should take the form of exemption or designation procedures and should:*

a) make it possible for the minimum requirements for aircraft observations of all meteorological offices concerned to be met; and

b) be as simple as possible to implement and preferably not involving consideration of individual cases.

5.5 Special and other non-routine aircraft observations

5.5.1 Special observations shall be made by all aircraft whenever the following conditions are encountered or observed:

a) severe turbulence; or

b) severe icing; or

c) severe mountain wave; or

d) thunderstorms, without hail, that are obscured, embedded, widespread or in squall lines; or

e) thunderstorms, with hail, that are obscured, embedded, widespread or in squall lines; or

f) heavy duststorm or heavy sandstorm; or

g) volcanic ash cloud; or

h) pre-eruption volcanic activity or a volcanic eruption.

Note.— Pre-eruption volcanic activity in this context means unusual and/or increasing volcanic activity which could presage a volcanic eruption.

In addition, in the case of transonic and supersonic flights:

i) moderate turbulence; or

j) hail; or

k) cumulonimbus clouds.

5.5.2 When other meteorological conditions not listed under 5.5.1, e.g. wind shear, are encountered and which, in the opinion of the pilot-in-command, may affect the safety or markedly affect the efficiency of other aircraft operations, the pilot-in-command shall advise the appropriate air traffic services unit as soon as practicable.

Note.— According to Chapter 4, 4.12.1 and Chapter 7, 7.6.2, icing, turbulence and, to a large extent, wind shear, are elements which, for the time being, cannot be satisfactorily observed from the ground and for which in most cases aircraft observations represent the only available evidence.

5.5.3 **Recommendation.—** *When reporting aircraft observations of wind shear encountered during the climb-out and approach phases of flight, the aircraft type should be included.*

5.5.4 **Recommendation.—** *Where wind shear conditions in the climb-out or approach phases of flight were reported or forecast but not encountered, the pilot-in-command should advise the appropriate air traffic services unit as soon as practicable unless the pilot-in-command is aware that the appropriate air traffic services unit has already been so advised by a preceding aircraft.*

5.6 Content of air-reports

5.6.1 When voice communications are used, the elements contained in routine and special air-reports shall be:

Routine air-reports

Message type designator
Section 1
(Position information)
Aircraft identification
Position or latitude and longitude
Time
Flight level or altitude
Next position and time over
Ensuing significant point
Section 2
(Operational information)
Estimated time of arrival
Endurance
Section 3
(Meteorological information)
Air temperature
Wind direction
Wind speed
Turbulence
Aircraft icing
Humidity (if available)

Special air-reports

Message type designator
Section 1
(Position information)
Aircraft identification
Position or latitude and longitude
Time
Flight level or altitude
Section 3
(Meteorological information)
Condition prompting the issuance of a special air-report, to be selected from the list presented under 5.5.1

Note 1.— Air-reports are considered routine by default. The message type designator for special air-reports is specified in the Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services *(PANS-RAC, Doc 4444), Appendix 1.*

Note 2.— In the case of the transmission of a special air-report of pre-eruption volcanic activity, volcanic eruption or volcanic ash cloud, additional requirements are indicated in 5.8.

5.6.2 When air-ground data link is used, the elements contained in routine and special air-reports shall be:

Message type designator
Aircraft identification
Data block 1
 Latitude
 Longitude
 Pressure-altitude
 Time
Data block 2
 Wind direction
 Wind speed
 Temperature
 Turbulence (if available)
 Humidity (if available)
Data block 3
 Condition prompting the issuance of a special air-report (in special air-reports only), to be selected from the list presented under 5.5.1.

Note 1.— In the case of the transmission of a special air-report of pre-eruption volcanic activity, volcanic eruption or volcanic ash cloud, additional requirements are indicated in 5.8.

Note 2.— Data block 1 is available from the basic ADS message, data block 2 from the meteorological block of the ADS message and data block 3 from the pilot/controller two-way data-link message set. The ADS message format is specified in the Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services *(PANS-RAC, Doc 4444).*

5.7 Exchange of air-reports

5.7.1 The meteorological authority concerned shall make arrangements with the appropriate ATS authority to ensure that the meteorological observations reported by aircraft in flight to air traffic services units are delivered without delay to:

a) the WAFCs and, as appropriate, RAFCs; and

b) the associated meteorological watch office in case of all special air-reports and those routine reports which are received by voice communications.

5.7.2 The meteorological watch offices shall assemble the routine air-reports received by voice communications and shall disseminate them to other meteorological offices in accordance with regional air navigation agreement. The exchange of collectives on an hourly basis may be found desirable when reports are numerous.

5.7.3 The meteorological watch office shall transmit without delay special air-reports of pre-eruption volcanic activity, a volcanic eruption or volcanic ash cloud received to the associated regional meteorological centre(s) providing advisory information concerning volcanic ash cloud, in accordance with 7.2.7.

5.7.4 When a special air-report is received at the meteorological watch office but the forecaster considers that the phenomenon causing the report is not expected to persist and, therefore, does not warrant issuance of a SIGMET, the special air-report shall be disseminated in the same way that SIGMET messages are disseminated in accordance with 7.2.9, i.e. to meteorological watch offices and other meteorological offices in accordance with regional air navigation agreement.

5.7.5 Air-reports at WAFCs and RAFCs shall be further disseminated as basic meteorological data.

5.7.6 **Recommendation.—** *Where supplementary dissemination of air-reports is required to satisfy special aeronautical or meteorological requirements, such dissemination should be arranged between the meteorological authorities concerned.*

5.7.7 Air-reports shall be exchanged in the format in which they are received, except that when voice communications are used, if the position is given by reference to an ATS reporting point, it shall be converted, by the meteorological watch office, into the corresponding latitude and longitude.

5.8 Recording and post-flight reporting of aircraft observations of volcanic activity

5.8.1 Special aircraft observations of pre-eruption volcanic activity, a volcanic eruption or volcanic ash cloud shall be recorded on the special air-report of volcanic activity form. A copy of the form shall be included with the flight documentation provided to flights operating on routes which, in the opinion of the meteorological authority concerned, could be affected by volcanic ash clouds.

Note.— The detailed instructions for recording and reporting volcanic activity observations are given in the Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services *(PANS-RAC, Doc 4444), Appendix 1.*

5.8.2 On arrival of a flight at an aerodrome, the completed report of volcanic activity shall be delivered by the operator or a flight crew member, without delay, to the aerodrome meteorological office, or if such office is not easily accessible to arriving flight crew members, the completed form shall be dealt with in accordance with local arrangements made by the meteorological authority and the operator.

5.8.3 The completed report of volcanic activity received by a meteorological office shall be transmitted without delay to the meteorological watch office responsible for the provision of meteorological watch for the flight information region in which the volcanic activity was observed.

CHAPTER 6. FORECASTS

6.1 Interpretation and use of forecasts

6.1.1 Owing to the variability of meteorological elements in space and time, to limitations of forecasting techniques and to limitations caused by the definitions of some of the elements, the specific value of any of the elements given in a forecast shall be understood by the recipient to be the most probable value which the element is likely to assume during the period of the forecast. Similarly, when the time of occurrence or change of an element is given in a forecast, this time shall be understood to be the most probable time.

Note.— Guidance on the operationally desirable accuracy of forecasts is given in Attachment E.

6.1.2 The issue of a new forecast by a meteorological office, such as a routine aerodrome forecast, shall be understood to cancel automatically any forecast of the same type previously issued for the same place and for the same period of validity or part thereof.

6.2 Aerodrome forecasts

6.2.1 An aerodrome forecast shall be prepared by the meteorological office designated by the meteorological authority concerned.

6.2.2 An aerodrome forecast shall consist of a concise statement of the expected meteorological conditions at an aerodrome during a specified period; it shall include surface wind, visibility, weather and cloud and expected significant changes to one or more of these elements during the period.

6.2.3 **Recommendation.—** *Additional elements should be included in aerodrome forecasts for local dissemination as agreed between the meteorological authority and the operators concerned.*

6.2.4 Meteorological offices preparing aerodrome forecasts shall keep the forecasts under continuous review and, when necessary, shall issue amendments promptly. The length of the forecast messages and the number of changes indicated in the forecast shall be kept to a minimum.

6.2.5 **Recommendation.—** *The criteria used for the inclusion of change groups in aerodrome forecasts or for the amendment of aerodrome forecasts should be based on the following:*

a) when the surface wind is forecast to change through values of operational significance the threshold values should be established by the meteorological authority in consultation with the appropriate ATS authority and operators concerned, taking into account changes in the wind which would:

1) require a change in runway(s) in use; and

2) indicate that the runway tailwind and crosswind components will change through values representing the main operating limits for typical aircraft operating at the aerodrome;

b) when the visibility is forecast to change to or pass through:

1) 150, 350, 600, 800, 1 500 or 3 000 m;

2) 5 000 m in cases where significant numbers of flights are operated in accordance with the visual flight rules;

c) when any of the following weather phenomena or combinations thereof are forecast to begin or end or change in intensity:

- *freezing precipitation*
- *freezing fog*
- *moderate or heavy precipitation (including showers thereof)*
- *low drifting dust, sand or snow*
- *blowing dust, sand or snow (including snowstorm)*
- *duststorm*
- *sandstorm*
- *thunderstorm (with or without precipitation)*
- *squall*
- *funnel cloud (tornado or waterspout)*
- *other weather phenomena given in 4.8.4 only if they are expected to cause a significant change in visibility;*

d) when the height of base of the lowest layer or mass of cloud of BKN or OVC extent is forecast to change to or pass through:

1) 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft); or

2) 450 m (1 500 ft), in cases where significant numbers of flights are operated in accordance with the visual flight rules;

EXAMPLES OF AERODROME FORECASTS

a) TAF for YUDO (Donlon/International):*

TAF YUDO 160000Z 160624 13018KMH 9000 BKN020 BECMG 0608 SCT015CB BKN020 TEMPO 0812 17025G40KMH 1000 TSRA SCT010CB BKN020 FM1230 15015KMH 9999 BKN020 BKN100

b) Abbreviated plain-language aerodrome forecast (for same location and weather conditions):

FCST YUDO 160000Z 16 06/24 130/18KMH VIS 9KM BKN 600M BECMG 06/08 SCT CB 450M BKN 600M TEMPO 08/12 170/25 KMH MAX40 VIS 1000M MOD TSRA SCT CB 300M BKN 600M FM1230 150/15KMH 10KM BKN 600M BKN 3000M

c) Meanings of both forecasts:

Aerodrome forecast for Donlon/International* issued on the 16th of the month at 0000UTC valid from 0600 UTC to 2400 UTC on the 16th of the month; surface wind direction 130 degrees; wind speed 18 kilometres per hour; visibility 9 kilometres, broken cloud at 600 metres; becoming between 0600 UTC and 0800 UTC, scattered cumulonimbus cloud at 450 metres and broken cloud at 600 metres; temporarily between 0800 UTC and 1200 UTC surface wind direction 170 degrees; wind speed 25 kilometres per hour gusting to 40 kilometres per hour; visibility 1 000 metres in a moderate thunderstorm with rain, scattered cumulonimbus cloud at 300 metres and broken cloud at 600 metres; from 1230 UTC surface wind direction 150 degrees; wind speed 15 kilometres per hour; visibility 10 km or more; broken cloud at 600 metres and broken cloud at 3 000 metres.

* Fictitious location

Note.— In this example, the primary units "kilometre per hour" and "metre" were used for wind speed and height of cloud base respectively. However, in accordance with Annex 5, the corresponding non-SI alternative units "knot" and "foot" may be used instead.

e) when the amount of a layer or mass of cloud below 450 m (1 500 ft) is forecast to change:

1) from SKC, FEW or SCT to BKN or OVC; or

2) from BKN or OVC to SKC, FEW or SCT;

f) when cumulonimbus clouds are forecast to develop or dissipate;

g) when the vertical visibility is forecast to change to or pass through 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft);

h) any other criteria based on local aerodrome operating minima, as agreed between the meteorological authority and the operators, including those concerned under 6.2.3.

6.2.6 **Recommendation.—** *The period of validity of routine aerodrome forecasts should be not less than 9 hours nor more than 24 hours; this period should be determined by regional air navigation agreement. The period of validity should be subdivided, as necessary, in accordance with 6.2.15. Routine aerodrome forecasts valid for less than 12 hours should be issued every 3 hours and those valid for 12 to 24 hours should be issued every 6 hours.*

6.2.7 **Recommendation.—** *Aerodrome forecasts and amendments to aerodrome forecasts which are disseminated locally should be in the form prescribed for the exchange of such information between meteorological offices, or in another form as agreed locally.*

6.2.8 Aerodrome forecasts and amendments thereto which are exchanged between meteorological offices shall be:

a) in the TAF code form prescribed by the World Meteorological Organization;

b) in abbreviated plain language; or

c) in teletypewriter characters and symbols, the significance of which has been agreed upon by the meteorological authorities concerned.

Note.— The TAF code form is contained in WMO Publication No. 306, Manual on Codes, *Volume I.*

6.2.9 **Recommendation.—** *Aerodrome forecasts should be exchanged in the TAF code form except as otherwise determined by regional air navigation agreement, or by agreement between the meteorological authorities concerned.*

6.2.10 **Recommendation.—** *Aerodrome forecasts in the TAF code form should contain all information for which the* *code provides except that the optional groups should be used in accordance with regional air navigation agreement or agreement between the meteorological authorities concerned.*

6.2.11 **Recommendation.—** *When a change in any of the elements given in 6.2.2 is required to be indicated in accordance with the criteria given in 6.2.5, the change indicators "BECMG" or "TEMPO" should be used followed by the time period during which the change is expected to occur. The time period should be indicated as the beginning and end of the period in whole hours UTC, for example, "BECMG 0608" (TAF code form) or "BECMG 06/08" (abbreviated plain language). Only those elements for which a significant change is expected should be included following a change indicator. However, in the case of significant changes in respect of cloud, all cloud groups, including layers or masses not expected to change, should be indicated.*

6.2.12 **Recommendation.—** *The change indicator "BECMG" and the associated time group should be used to describe changes where the meteorological conditions are expected to reach or pass through specified threshold values at a regular or irregular rate and at an unspecified time during the time period. The time period should normally not exceed 2 hours but in any case should not exceed 4 hours.*

6.2.13 **Recommendation.—** *The change indicator "TEMPO" and the associated time group should be used to describe expected frequent or infrequent temporary fluctuations in the meteorological conditions which reach or pass specified threshold values and last for a period of less than one hour in each instance and, in the aggregate, cover less than one-half of the forecast period during which the fluctuations are expected to occur, for example, "TEMPO 1214" (TAF code form) or "TEMPO 12/14" (abbreviated plain language). If the temporary fluctuation is expected to last one hour or longer, the change group "BECMG" should be used in accordance with 6.2.12 or the validity period should be subdivided in accordance with 6.2.15.*

6.2.14 **Recommendation.—** *The probability of occurrence of an alternative value of a forecast element or elements should be indicated, as necessary, by use of the abbreviation "PROB" followed by the probability in tens of per cent and the time period during which the alternative value(s) is (are) expected to apply. The probability information should be placed after the element or elements forecast and be followed by the alternative value of the element or elements in the form, "1500 PROB30 1214 0800 FG" (TAF code form) or "VIS 1500M PROB30 12/14 800M FG" (abbreviated plain language). The probability of a forecast of temporary fluctuations in meteorological conditions should be indicated, as necessary, by use of the abbreviation "PROB" followed by the probability in tens of per cent, placed before the change indicator "TEMPO" and associated time group, in the form "PROB40 TEMPO 1517" (TAF code form) or "PROB40 TEMPO 15/17" (abbreviated plain language). A probability of an alternative value or change of less than 30 per cent should not be considered sufficiently significant to be indicated. A probability of an alternative value or change of 50 per cent or more, for aviation purposes, should not be considered a probability but instead should be indicated, as necessary, by use of the change indicators "BECMG" or "TEMPO" or by sub-division of the validity period using the abbreviation "FM". The probability group should not be used to qualify the change indicator "BECMG" nor the time indicator "FM".*

6.2.15 **Recommendation.—** *Where one set of prevailing weather conditions is expected to change significantly and more or less completely to a different set of conditions, the period of validity should be subdivided into self-contained periods using the abbreviation "FM" followed immediately by a four-figure time group in whole hours and minutes UTC indicating the time the change is expected to occur, for example, "FM1800" (in both TAF code form and abbreviated plain language). The subdivided period following the abbreviation "FM" should be self-contained and all forecast conditions given before the abbreviation should be superseded by those following the abbreviation.*

6.2.16 **Recommendation.—** *In forecasting surface wind, the expected prevailing direction should be given. When it is not possible to forecast a prevailing surface wind direction due to its expected variability, for example, during light wind conditions (6 km/h (3 kt) or less) or thunderstorms, the forecast wind direction should be indicated by use of the abbreviation "VRB". When the wind is forecast to be calm this should be indicated by the term "CALM".*

6.2.17 **Recommendation.—** *When the visibility is forecast to be less than 500 m it should be expressed in steps of 50 m in the form "0350" (TAF code form) or "VIS 350M" (abbreviated plain language); when it is forecast to be 500 m or more but less than 5 km in steps of 100 m; 5 km or more but less than 10 km in kilometre steps in the form "7000" (TAF code form) or "VIS 7KM" (abbreviated plain language) and when it is forecast to be 10 km or more it should be expressed as 10 km except when conditions of CAVOK are forecast to apply. When visibility is forecast to vary in different directions the lowest forecast visibility should be given.*

Note.— Guidance on operationally desirable accuracy of forecasts of visibility is given in Attachment E.

6.2.18 **Recommendation.—** *The following weather phenomena or combinations thereof, their characteristics and, where appropriate, intensity should be forecast if they are expected to occur at the aerodrome:*

- *— freezing precipitation*
- *— freezing fog*
- *— moderate or heavy precipitation (including showers thereof)*
- *— low drifting dust, sand or snow*
- *— blowing dust, sand or snow (including snowstorm)*
- *— duststorm*

— sandstorm
— thunderstorm (with or without precipitation)
— squall
— funnel cloud (tornado or waterspout)
— other weather phenomena given in 4.8.4 only if they are expected to cause a significant change in visibility.

For example, moderate rain should be indicated in the form "BECMG 1214 RA" (in the TAF code form) or "BECMG 12/14 MOD RA" (in abbreviated plain language). The expected end of occurrence of those phenomena should be indicated by the abbreviation "NSW", in the form, for example, "BECMG 1618 NSW" (TAF code form) or "BECMG 16/18 NSW" (abbreviated plain language).

6.2.19 **Recommendation.—** *Cloud amount should be forecast using the abbreviations "FEW", "SCT", "BKN" or "OVC" as necessary. If no clouds are forecast, and the abbreviation "CAVOK" is not appropriate, the abbreviation "SKC" should be used. When it is expected that the sky will remain or become obscured and clouds cannot be forecast and information on vertical visibility is available at the aerodrome, the vertical visibility should be forecast in the form "VER VIS" followed by the forecast value of the vertical visibility and the units used. When several layers or masses of cloud are forecast, their amount and height of base should be included in the following order:*

a) the lowest layer or mass regardless of amount, to be forecast as FEW, SCT, BKN or OVC as appropriate;

b) the next layer or mass covering more than 2/8, to be forecast as SCT, BKN or OVC as appropriate;

c) the next higher layer or mass covering more than 4/8 to be forecast as BKN or OVC as appropriate; and

d) cumulonimbus clouds whenever forecast and not already included under a) to c) above.

When so determined by regional air navigation agreement, cloud information should be limited to cloud of operational significance, i.e. cloud below 1 500 m (5 000 ft) or the highest minimum sector altitude whichever is greater, and cumulonimbus whenever forecast. In applying this limitation, when no cumulonimbus and no cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude whichever is greater are forecast, and "CAVOK" or "SKC" are not appropriate, the abbreviation "NSC" should be used.

6.2.20 **Recommendation.—** *An aerodrome forecast in abbreviated plain language should be identified as "FCST" and an amendment thereto as "AMD FCST". The date the period of validity of the forecast begins should be indicated by two figures. The period of validity of the forecast should be given in a time group indicating the beginning and the end of that period by two figures each, separated by "/"; for example, a period of validity from 1200 UTC on the 3rd of the month to 2100 UTC should be given as "03 12/21".*

6.2.21 **Recommendation.—** *The order of the elements and the terminology, units and scales used in aerodrome forecasts in abbreviated plain language should be the same as those used in routine and special reports for the same aerodrome. Changes and probabilities should be indicated in such forecasts by means of the same abbreviations as are used in forecasts for the same aerodrome prepared in the TAF code form.*

6.3 Landing forecasts

6.3.1 A landing forecast shall be prepared by the meteorological office designated by the meteorological authority concerned; such forecasts are intended to meet requirements of local users and of aircraft within about one hour's flying time from the aerodrome.

6.3.2 **Recommendation.—** *Landing forecasts should be prepared either in the form of a self-contained forecast or in the form of a trend-type forecast, as determined by regional air navigation agreement.*

6.3.3 A self-contained landing forecast shall consist of a concise statement of the expected meteorological conditions at the aerodrome concerned and it shall contain any or all of the elements surface wind, visibility, significant weather and cloud. Other significant information shall be included as agreed between the meteorological authority and the operator concerned. The period of validity of a self-contained landing forecast shall not exceed 2 hours from the time of issue.

6.3.4 A trend-type landing forecast shall consist of a routine, special or selected special report for an aerodrome to which is appended a concise statement of the expected trend of the meteorological conditions at that aerodrome. The period of validity of a trend-type landing forecast shall be 2 hours from the time of the report which forms part of the landing forecast. The trend-type landing forecast shall indicate significant changes in respect of one or more of the elements surface wind, visibility, weather and cloud. Only those elements shall be included for which a significant change is expected. However, in the case of significant changes in respect of cloud, all cloud groups, including layers or masses not expected to change, shall be indicated. In the case of a significant change in visibility, the phenomenon causing the reduction of visibility shall also be indicated. When no change is expected to occur, this shall be indicated by the term "NOSIG", in both the METAR code form and the abbreviated plain-language version.

6.3.5 **Recommendation.—** *Elements other than surface wind, visibility, weather and cloud should, if so agreed between the meteorological authority and the operator concerned, be included in a trend-type landing forecast.*

6.3.6 When a change is expected to occur, the trend part of the trend-type forecast message shall begin with one of the change indicators "BECMG" or "TEMPO".

6.3.7 The change indicator "BECMG" shall be used to describe forecast changes where the meteorological conditions are expected to reach or pass through specified values at a regular or irregular rate. The period during which, or the time at which, the change is forecast to occur shall be indicated, using the abbreviations "FM", "TL", or "AT", as appropriate, each followed by a time group in hours and minutes. When the change is forecast to begin and end wholly within the trend forecast period, the beginning and end of the change shall be indicated by using the abbreviations "FM" and "TL" respectively with their associated time groups, for example, for a trend forecast period from 1000 to 1200 UTC in the form, "BECMG FM1030 TL1130" (in both METAR code form and abbreviated plain language). When the change is forecast to commence at the beginning of the trend forecast period but be completed before the end of that period, the abbreviation "FM" and its associated time group shall be omitted and only "TL" and its associated time group shall be used, for example "BECMG TL1100" (in both METAR code form and abbreviated plain language). When the change is forecast to begin during the trend forecast period and be completed at the end of that period, the abbreviation "TL" and its associated time group shall be omitted and only "FM" and its associated time group shall be used, for example "BECMG FM1100" (in both METAR code form and abbreviated plain language). When the change is forecast to occur at a specified time during the trend forecast period, the abbreviation "AT" followed by its associated time group shall be used, for example "BECMG AT1100" (in both METAR code form and abbreviated plain language). When the change is forecast to commence at the beginning of the trend forecast period and be completed by the end of that period or when the change is forecast to occur within the trend forecast period but the time is uncertain, the abbreviations "FM", "TL" or "AT" and their associated time groups shall be omitted and the change indicator "BECMG" shall be used alone.

6.3.8 The change indicator "TEMPO" shall be used to describe forecast temporary fluctuations in the meteorological conditions which reach or pass specified values and last for a period of less than one hour in each instance and, in the aggregate, cover less than one-half of the period during which the fluctuations are forecast to occur. The period during which the temporary fluctuations are forecast to occur shall be indicated, using the abbreviations "FM" and/or "TL", as appropriate, each followed by a time group in hours and minutes. When the period of temporary fluctuations in the meteorological conditions is forecast to begin and end wholly within the trend forecast period, the beginning and end of the period of temporary fluctuations shall be indicated by using the abbreviations "FM" and "TL" respectively with their associated time groups, for example, for a trend forecast period from 1000 to 1200 UTC in the form "TEMPO FM1030 TL1130" (in both METAR code form and abbreviated plain language). When the period of temporary fluctuations is forecast to commence at the beginning of the trend forecast period but cease before the end of that period, the abbreviation "FM" and its associated time group shall be omitted and only "TL" and its associated time group shall be used, for example, "TEMPO TL1130" (in both METAR code form and abbreviated plain language). When the period of temporary fluctuations is forecast to begin during the trend forecast period and cease by the end of that period, the abbreviation "TL" and its associated time group shall be omitted and only "FM" and its associated time group shall be used, for example "TEMPO FM1030" (in both METAR code form and abbreviated plain language). When the period of temporary fluctuations is forecast to commence at the beginning of the trend forecast period and cease by the end of that period, both abbreviations "FM" and "TL" and their associated time groups shall be omitted and the change indicator "TEMPO" shall be used alone.

6.3.9 The indicator "PROB" shall not be used in trend-type landing forecasts.

6.3.10 The trend part of the trend-type landing forecast shall indicate changes in the surface wind which involve:

a) a change in the mean wind direction of 60° or more, the mean speed before and/or after the change being 20 km/h (10 kt) or more;

b) a change in mean wind speed of 20 km/h (10 kt) or more;

c) changes in the wind through values of operational significance. The threshold values should be established by the meteorological authority in consultation with the appropriate ATS authority and operators concerned, taking into account changes in the wind which would:

1) require a change in runway(s) in use; and

2) indicate that the runway tailwind and crosswind components will change through values representing the main operating limits for typical aircraft operating at the aerodrome.

For example, an expected temporary surface wind from 250° at 70 km/h (35 kt) with maximum speeds (gusts) to 100 km/h (50 kt) throughout the period of the trend forecast shall be indicated in the form "TEMPO 25035G50KT" or "TEMPO 25070G100KMH" (METAR code form) and "TEMPO 250/35KT MAX50" or "TEMPO 250/70KMH MAX100" (abbreviated plain language).

6.3.11 When the visibility is expected to change to or pass any one of the values 150, 350, 600, 800, 1 500 or 3 000 m, the trend part of the trend-type landing forecast shall indicate the change. When significant numbers of flights are conducted in accordance with the visual flight rules, the forecast shall additionally indicate changes to or passing 5 000 m. For example, a temporary reduction throughout the period of the trend forecast of the visibility to 750 m in fog shall be rounded down to 700 m and indicated in the form "TEMPO 0700" (METAR code form) or "TEMPO VIS 700M" (abbreviated plain language).

6.3.12 The trend part of the trend-type landing forecast shall indicate the expected onset, cessation or change in intensity of the following weather phenomena or combinations thereof:

- — freezing precipitation
- — freezing fog
- — moderate or heavy precipitation (including showers thereof)
- — low drifting dust, sand or snow
- — blowing dust, sand or snow (including snowstorm)
- — duststorm
- — sandstorm
- — thunderstorm (with or without precipitation)
- — squall
- — funnel cloud (tornado or waterspout)
- — other weather phenomena given in 4.8.4 only if they are expected to cause a significant change in visibility.

For example, forecast temporary moderate freezing rain between 0300 and 0430 UTC shall be indicated in the form "TEMPO FM0300 TL0430 FZRA" (METAR code form) and "TEMPO FM0300 TL0430 MOD FZRA" (abbreviated plain language). The expected end of occurrence of those phenomena shall be indicated by the abbreviation "NSW". For example, an expected cessation at 1630 UTC , of significant weather, such as a thunderstorm, shall be indicated in the form "BECMG AT1630 NSW" (in both METAR code form and abbreviated plain language).

6.3.13 When the height of the base of a cloud layer of BKN or OVC extent is below, is expected to fall below or rise above 450 m (1 500 ft), the trend part of the trend-type landing forecast shall indicate changes to or passing any one of the following values: 30, 60, 150, 300 and 450 m (100, 200, 500, 1 000 and 1 500 ft). When the height of the base of a cloud layer is below, is expected to fall below or rise above 450 m (1 500 ft), the trend part of the trend-type landing forecast shall also indicate changes in cloud amount from SKC, FEW, or SCT increasing to BKN or OVC, or changes from BKN or OVC decreasing to SKC, FEW or SCT, for example a forecast rapid increase in stratus cloud at 1130 UTC from SCT to OVC shall be indicated in the form "BECMG AT1130 OVC010" (METAR code form) or "BECMG AT 1130 OVC 300M" (abbreviated plain language). When no cumulonimbus and no cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude whichever is greater are forecast, and "CAVOK" and "SKC" are not appropriate, the abbreviation "NSC" shall be used.

6.3.14 When the sky is expected to remain or become obscured and vertical visibility observations are available at the aerodrome, the trend part of the trend-type landing forecast shall indicate changes in vertical visibility to or passing any one of the following values: 30, 60, 150 or 300 m (100, 200, 500 or 1 000 ft).

6.3.15 Criteria for the indication of changes based on local aerodrome operating minima, additional to those specified in 6.3.10 to 6.3.14, shall be used as agreed between the meteorological authority and the operator(s) concerned.

6.3.16 The order of the elements and the terminology, units and scales used in the trend part of the trend-type landing forecast shall be the same as those used in the report to which it is appended.

6.4 Forecasts for take-off

6.4.1 A forecast for take-off shall be prepared by the meteorological office designated by the meteorological authority concerned.

6.4.2 **Recommendation.—** *A forecast for take-off should refer to a specified period of time and should contain information on expected conditions over the runway complex in regard to surface wind direction and speed and any variations thereof, temperature, pressure (QNH), and any other elements as agreed locally.*

6.4.3 **Recommendation.—** *A forecast for take-off should be supplied to operators and flight crew members on request within the 3 hours before the expected time of departure.*

6.4.4 **Recommendation.—** *The format of the forecast should be as agreed between the meteorological authority and the operator concerned. The order of the elements and the terminology, units and scales used in forecasts for take-off should be the same as those used in reports for the same aerodrome.*

6.4.5 **Recommendation.—** *Meteorological offices preparing forecasts for take-off should keep the forecasts under continuous review and, when necessary, should issue amendments promptly. The criteria for the issuance of amendments for forecasts for take-off for surface wind direction and speed, temperature and pressure and any other elements agreed locally should be agreed between the meteorological authority and the operators concerned. The criteria should be consistent with the corresponding criteria for special reports established for the aerodrome in accordance with 4.3.1.*

6.5 Area and route forecasts, other than forecasts issued by regional area forecast centres

Note.— Provisions concerning forecasts issued within the framework of the world area forecast system are contained in Chapter 3.

6.5.1 Area and route forecasts shall contain upper winds, upper-air temperatures, significant en-route weather phenomena and associated clouds. Other elements may be added as required. This information shall cover the flight operations for which they are intended in respect of time, altitude and geographical extent.

6.5.2 **Recommendation.—** *When the density of traffic operating below flight level 100 warrants the routine issue and dissemination of area forecasts for such operations, the frequency of issue and the fixed time or period of validity of those forecasts should be determined by the meteorological authority in consultation with the users.*

6.5.3 Meteorological offices preparing area and route forecasts shall keep the forecasts under continuous review and issue amendments as necessary.

6.5.4 A list of criteria to be used for amendments to area and route forecasts shall be established by the meteorological authority, in consultation with operators and other users concerned.

6.5.5 **Recommendation.—** *The list of criteria should call for the issue of amendments to area and route forecasts when the following changes are expected:*

Upper wind	*Change in direction of 30° or more, provided the wind speed is 60 km/h (30 kt) or more before or after the change; change in speed of 40 km/h (20 kt) or more.*
Upper-air temperatures	*Change of more than 5°C.*
Aircraft icing and turbulence	*New expectation; intensity increasing; intensity decreasing from severe to light or from moderate to nil.*
Other significant en-route weather phenomena	*New expectation; no longer expected.*

6.5.6 Area and route forecasts, and amendments thereto, disseminated locally, shall be in one of the forms prescribed for the exchange of such information between meteorological offices or in another form as agreed locally.

6.5.7 Area and route forecasts and amendments thereto which are exchanged between meteorological offices in a code form prescribed by the World Meteorological Organization shall be in the ARFOR, WINTEM or ROFOR code form.

Note.— The ARFOR, WINTEM and ROFOR code forms are contained in WMO Publication No. 306, Manual on Codes, *Volume I.*

6.5.8 **Recommendation.—** *The order of the elements in area and route forecasts (or amendments thereto) in abbreviated plain language should normally follow that of the corresponding coded form of message. The terminology and units employed should be consistent with those used in the related aerodrome reports and forecasts. The identifier employed should be "AREA FCST" or "ROUTE FCST" respectively, preceded in the case of amendments by "AMD". The CAVOK procedure applied in aerodrome forecasts should not be used in area and route forecasts.*

6.6 Area forecasts for low-level flights to support issuance of AIRMET information

6.6.1 When the density of traffic operating below flight level 100 warrants the issuance of AIRMET information in accordance with 7.3.1, area forecasts for such operations shall be exchanged between meteorological offices responsible for the issuance of flight documentation for low-level flights in the flight information regions concerned.

6.6.2 Area forecasts for low-level flights exchanged between meteorological offices in support of the issuance of AIRMET information shall be prepared in a format agreed upon between the meteorological authorities concerned. When abbreviated plain language is used, the forecast shall be prepared as a GAMET area forecast, employing approved ICAO abbreviations and numerical values. The area forecasts shall be issued to cover the layer between the ground and flight level 100 (or up to flight level 150 in mountainous areas) and shall contain information on en-route weather phenomena hazardous to low-level flights. The area forecasts shall contain the following information as necessary and, when prepared in GAMET format, in the order indicated:

a) location indicator of the air traffic services unit serving the flight information region(s) to which the area forecast for low-level flights refers; for example, "YUCC";

b) message identification using the abbreviation "GAMET";

c) date-time groups indicating the period of validity in UTC; for example, "VALID 220600/221200";

d) location indicator of the meteorological office originating the message, followed by a hyphen to separate the preamble from the text; for example, "YUDO-";

e) on the next line, name of the flight information region, or a sub-area thereof, for which the area forecast for low-level flights is issued; for example "AMSWELL FIR/2";

f) widespread mean surface wind speed exceeding 60 km/h (30 kt); for example, "SFC WSPD: 10/12 65 KMH";

g) widespread areas of surface visibility below 5 000 m; for example, "SFC VIS: 06/08 N OF 51 DEG N 3000 M";

h) significant weather, i.e. thunderstorms and heavy sand- and duststorm (except for phenomena for which a SIGMET message has already been issued); for example, "SIGWX: 11/12 ISOL TS";

i) mountain obscuration; for example, "MT OBSC: MT PASSES S OF 48 DEG N OBSC";

j) widespread areas of broken or overcast cloud with height of base less than 300 m (1 000 ft) above ground level and/or any occurrence of cumulonimbus (CB) clouds without thunderstorm; for example, "CLD: 06/09 OVC 800 FT N OF 51 DEG N";

k) icing (except for that occurring in convective clouds and for severe icing for which a SIGMET message has already been issued); for example, "ICE: MOD FL050/080";

l) turbulence (except for that occurring in convective clouds and for severe turbulence for which a SIGMET message has already been issued); for example, "TURB: MOD ABV FL090";

m) mountain wave (except for severe mountain wave for which a SIGMET message has already been issued); for example, "MTW: MOD ABV FL080 E OF 63 DEG N";

n) SIGMET messages applicable to the FIR concerned or the sub-area thereof, for which the area forecast is valid; for example, "SIGMET APPLICABLE: 3,5".

Each of the items f) to n) shall, when applicable, be included in the GAMET area forecast beginning on a new line. Items for which no hazardous phenomenon is expected to occur, or which are already covered by a SIGMET message, shall be omitted from the area forecast. When no weather phenomena hazardous to low-level flights occur and no SIGMET information is applicable, the term "HAZARDOUS WX NIL" shall replace all items listed under f) to n). When a weather phenomenon hazardous to low-level flights has been included in the GAMET area forecast and the phenomenon forecast does not occur, or is no longer forecast, a GAMET AMD shall be issued, amending only the weather element concerned.

Note.— Specifications regarding the issuance of AIRMET information amending the area forecast in respect of weather phenomena hazardous for low-level flights are given in 7.3.1.

6.6.3 Area forecasts for low-level flights exchanged between meteorological offices in support of the issuance of AIRMET information shall be issued every 6 hours for a period of validity of 6 hours and transmitted to meteorological offices concerned not later than one hour prior to the beginning of their validity period.

Note.— The requirements for flight documentation for low-level flights are stated in 9.6.3 and 9.8.3.

EXAMPLE OF GAMET AREA FORECAST

YUCC GAMET VALID 220600/221200 YUDO-
AMSWELL FIR/2
SFC WSPD: 10/12 65 KMH
SFC VIS: 06/08 N OF 51 DEG N 3000 M
SIGWX: 11/12 ISOL TS
CLD: 06/09 OVC 800 FT N OF 51 DEG N
ICE: MOD FL050/080
TURB: MOD ABV FL090
SIGMETS APPLICABLE: 3,5

Meaning: An area forecast for low-level flights (GAMET) issued for sub-area two of the Amswell* flight information region (identified by YUCC Amswell area control centre) by the Donlon/International* meteorological office (YUDO); the message is valid from 0600 UTC to 1200 UTC on the 22nd of the month; surface wind speeds: between 1000 UTC and 1200 UTC 65 kilometres per hour; surface visibility: between 0600 UTC and 0800 UTC 3 000 metres north of 51 degrees north; significant weather phenomena: between 1100 UTC and 1200 UTC isolated thunderstorms without hail; clouds: between 0600 UTC and 0900 UTC overcast at 800 feet above ground level north of 51 degrees north; icing: moderate between flight level 050 and 080; turbulence: moderate above flight level 090 (at least up to flight level 100); SIGMET messages 3 and 5 applicable to the validity period and sub-area concerned.

* Fictitious locations

CHAPTER 7. SIGMET AND AIRMET INFORMATION, AERODROME WARNINGS AND WIND SHEAR WARNINGS

7.1 SIGMET information — general provisions

7.1.1 SIGMET information shall be issued by a meteorological watch office and shall give a concise description in abbreviated plain language concerning the occurrence and/or expected occurrence of specified en-route weather phenomena, which may affect the safety of aircraft operations, and of the development of those phenomena in time and space. The information shall be indicated using one of the following as appropriate:

a) at subsonic cruising levels:

thunderstorm	
— obscured	OBSC TS
— embedded	EMBD TS
— frequent	FRQ TS
— squall line	SQL TS
— obscured with heavy hail	OBSC TS HVYGR
— embedded with heavy hail	EMBD TS HVYGR
— frequent, with heavy hail	FRQ TS HVYGR
— squall line with heavy hail	SQL TS HVYGR
tropical cyclone	
— tropical cyclone with 10-minute mean surface wind speed of 63 km/h (34 kt) or more	TC (+ cyclone name)
turbulence	
— severe turbulence	SEV TURB
icing	
— severe icing	SEV ICE
— severe icing due to freezing rain	SEV ICE (FZRA)
mountain wave	
— severe mountain wave	SEV MTW
duststorm	
— heavy duststorm	HVY DS
sandstorm	
— heavy sandstorm	HVY SS
volcanic ash	
— volcanic ash	VA (+ volcano name, if known)

b) at transonic levels and supersonic cruising levels:

turbulence	
— moderate turbulence	MOD TURB
— severe turbulence	SEV TURB
cumulonimbus	
— isolated cumulonimbus	ISOL CB
— occasional cumulonimbus	OCNL CB
— frequent cumulonimbus	FRQ CB
hail	
— hail	GR
volcanic ash	
— volcanic ash	VA (+ volcano name, if known)

Note.— Guidance on the preparation of SIGMET messages is given in Attachment F.

7.1.2 SIGMET information shall not contain unnecessary descriptive material. In describing the weather phenomena for which the SIGMET is issued, no descriptive material additional to that given in 7.1.1 shall be included. SIGMET information concerning thunderstorms or a tropical cyclone shall not include references to associated turbulence and icing. However, the occurrence of heavy hail with thunderstorm shall be indicated.

7.1.3 SIGMET information shall be cancelled when the phenomena are no longer occurring or are no longer expected to occur in the area.

7.2 Format and exchange of SIGMET messages

7.2.1 A SIGMET message shall contain the following information as necessary and in the order indicated:

a) location indicator of the air traffic services unit serving the flight information region or control area to which the SIGMET message refers; for example, "YUCC";

Note.— In cases where the airspace is divided into a flight information region (FIR) and an upper flight information region (UIR), the SIGMET is identified by the location indicator of the air traffic services unit serving the FIR; nevertheless, the SIGMET message applies to the whole airspace within the lateral limits of

EXAMPLE OF SIGMET MESSAGE

YUCC SIGMET 5 VALID 221215/221600 YUDO-
AMSWELL FIR SEV TURB OBS AT 1210 YUSB FL250 MOV E 40 KMH WKN

Meaning: The fifth SIGMET message issued for the AMSWELL* flight information region (identified in abbreviated plain language and by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1215 UTC to 1600 UTC on the 22nd of the month; severe turbulence was observed at 1210 UTC over Siby/Bistock* aerodrome (YUSB) at flight level 250; the turbulence is expected to move eastwards at 40 kilometres per hour and to weaken in intensity.

* Fictitious locations

the FIR, i.e. to the FIR and to the UIR. The particular areas and/or flight levels affected by the meteorological phenomena causing the issuance of the SIGMET are given in the text of the message.

b) message identification and sequence number; for example, "SIGMET 5";

Note.— The sequence of SIGMET messages may be indicated by figures or a combination of figures and letters.

c) date-time groups indicating the period of validity in UTC; for example, "VALID 221215/221600";

d) location indicator of the meteorological watch office originating the message followed by a hyphen to separate the preamble from the text; for example, "YUDO-";

e) on the next line, name of the flight information region or control area for which the SIGMET is issued; for example, "AMSWELL FIR";

f) phenomenon and description of the phenomenon causing the issuance of the SIGMET taken, as appropriate, from the list given in 7.1.1; for example, "FRQ TS";

g) indication whether the information is observed and expected to continue, using the abbreviation "OBS" and where relevant the time of observation in UTC, or forecast using the abbreviation "FCST";

h) location (referring, where possible, to latitude and longitude and/or locations or geographic features well known internationally) and level; for example, "FCST TOPS FL390 S OF 54 DEGN" or "SIBY/BISTOK AT FL250";

i) movement or expected movement with reference to one of the eight points of compass given in kilometres per hour or knots, or stationary; for example, "MOV E 40 KMH";

j) changes in intensity; using, as appropriate, the abbreviations "INTSF", "WKN" or "NC";

k) on the next line, an outlook providing information beyond the period of validity specified under c) above, of the trajectory of the volcanic ash cloud and positions of the tropical cyclone centre; for example,

YUCC SIGMET 3 VALID 251600/252200 YUDO-
AMSWELL FIR TC GLORIA OBS 27.1N 73.1W AT 1600 UTC FRQ TS TOPS FL500 WI 150 NM OF CENTRE MOV NW 10KT NC
OTLK TC CENTRE 260400 28.5N 74.5W 261000 31.0N 76.0W

7.2.2 SIGMET messages shall be prepared in abbreviated plain language, using approved ICAO abbreviations and numerical values of self-explanatory nature supplemented, if suitable approved abbreviations are not available, by the vocabulary of a national language, taken with its usual meaning in aviation.

7.2.3 Messages containing SIGMET information for subsonic aircraft shall be identified as "SIGMET", those containing SIGMET information for supersonic aircraft during transonic or supersonic flight shall be identified as "SIGMET SST".

7.2.4 The sequence number referred to in 7.2.1 b) shall correspond with the number of SIGMET messages issued for the flight information region since 0001 UTC on the day concerned. Separate series of sequence numbers shall be used for "SIGMET" and "SIGMET SST" messages.

7.2.5 **Recommendation.—** *The period of validity of a SIGMET message should be not more than 6 hours, and preferably not more than 4 hours. It should be indicated by the term "VALID" followed by date-time groups indicating the beginning and the end of that period in six figures each, separated by "/"; for example, a period of validity from 1215 UTC to 1600 UTC on the 22nd day of the month should be given as "VALID 221215/221600".*

7.2.6 **Recommendation.—** *In the special case of SIGMET messages for volcanic ash cloud and tropical cyclones, an outlook should be included giving information for* *up to 12 hours beyond the period of validity specified in 7.2.5, concerning the trajectory of the volcanic ash cloud and positions of the tropical cyclone centre.*

7.2.7 **Recommendation.—** *The outlook included in SIGMET messages in accordance with 7.2.6 concerning volcanic ash cloud and tropical cyclones should be based, where possible, on advisory information provided by meteorological centres designated by regional air navigation agreement.*

7.2.8 **Recommendation.—** *A SIGMET message relating to the expected occurrence of weather phenomena listed in 7.1.1, with the exception of volcanic ash cloud and tropical cyclones, should be issued not more than 6 hours, and preferably not more than 4 hours, before the expected time of occurrence of that phenomenon. SIGMET messages concerning volcanic ash cloud or tropical cyclones expected to affect a flight information region should be issued up to 12 hours before the commencement of the period of validity or as soon as practicable if such advance warning of the existence of these phenomena is not available. SIGMET messages for volcanic ash and tropical cyclones should be updated at least every 6 hours.*

7.2.9 **Recommendation.—** *SIGMET messages should be disseminated to meteorological watch offices, WAFCs and, as appropriate, RAFCs and to other meteorological offices, in accordance with regional air navigation agreement.*

7.3 AIRMET information

7.3.1 AIRMET information shall be issued by a meteorological watch office in accordance with regional air navigation agreement, taking into account the density of air traffic operating below flight level 100. AIRMET information shall give a concise description in abbreviated plain language concerning the occurrence and/or expected occurrence of specified en-route weather phenomena, which have not been included in the area forecast for low-level flights issued in accordance with Section 6.6 and which may affect the safety of low-level flights, and of the development of those phenomena in time and space. The information shall be indicated using one of the following as appropriate:

At cruising levels below flight level 100 (or below flight level 150 in mountainous areas):

surface wind speed	
— widespread mean surface wind speed above 60 km/h (30 kt)	SFC WSPD (+ wind speed and units)
surface visibility	
— widespread areas affected by reduction of visibility to less than 5 000 m	SFC VIS (+ visibility)
thunderstorms	
— isolated thunderstorms without hail	ISOL TS
— occasional thunderstorms without hail	OCNL TS
— isolated thunderstorms with hail	ISOL TSGR
— occasional thunderstorms with hail	OCNL TSGR
mountain obscuration	
— mountains obscured	MT OBSC
cloud	
— widespread areas of broken or overcast cloud with height of base less than 300 m (1 000 ft) above ground level:	
— broken	BKN CLD (+ height of the base and units)
— overcast	OVC CLD (+ height of the base and units)
— cumulonimbus clouds without thunderstorm which are:	
— isolated	ISOL CB
— occasional	OCNL CB
— frequent	FRQ CB
icing	
— moderate icing (except for icing in convective clouds)	MOD ICE
turbulence	
— moderate turbulence (except for turbulence in convective clouds)	MOD TURB
mountain wave	
— moderate mountain wave	MOD MTW

Note.— Guidance on the preparation of AIRMET messages is given in Attachment F.

7.3.2 AIRMET information shall not contain unnecessary descriptive material. In describing the weather phenomena for which the AIRMET is issued, no descriptive material additional to that given in 7.3.1 shall be included. AIRMET information concerning thunderstorms or cumulonimbus clouds shall not include references to associated turbulence and icing. However, the occurrence of hail with thunderstorms shall be indicated.

Note.— The specifications for SIGMET information which is also applicable to low-level flights are given in 7.1.1.

7.3.3 AIRMET information shall be cancelled when the phenomena are no longer occurring or are no longer expected to occur in the area.

7.4 Format and exchange of AIRMET messages

7.4.1 An AIRMET message shall contain the following information, as necessary, and in the order indicated:

a) location indicator of the air traffic services unit serving the flight information region or control area to which the AIRMET message refers; for example, "YUCC";

b) message identification and sequence number; for example, "AIRMET 2";

c) date-time groups indicating the period of validity in UTC; for example, "VALID 221215/221600";

d) location indicator of the meteorological watch office originating the message followed by a hyphen to separate the preamble from the text; for example, "YUDO-";

e) on the next line, name of the flight information region or a sub-area thereof for which the AIRMET is issued; for example, "AMSWELL FIR";

f) phenomenon and description of the phenomenon causing the issuance of the AIRMET taken, as appropriate, from the list given in 7.3.1; for example, "MOD MTW";

g) indication whether the information is observed and expected to continue, using the abbreviation "OBS" and where relevant the time of observation in UTC, or forecast using the abbreviation "FCST";

h) location (referring, where possible, to latitude and longitude and/or locations or geographic features well known internationally) and level; for example, "OBS 48 DEG N 10 DEG E AT FL080";

i) movement or expected movement with reference to one of the eight points of compass given in kilometres per hour or knots, or stationary; for example, "STNR";

j) changes in intensity; using, as appropriate, the abbreviations "INTSF", "WKN" or "NC".

7.4.2 AIRMET messages shall be prepared in abbreviated plain language, using approved ICAO abbreviations and numerical values.

7.4.3 The sequence number referred to in 7.4.1 b) shall correspond with the number of AIRMET messages issued for the flight information region since 0001 UTC on the day concerned.

7.4.4 **Recommendation.**— *The period of validity of an AIRMET message should be not more than 6 hours, and preferably not more than 4 hours. It should be indicated by the term "VALID" followed by date-time groups indicating the beginning and the end of that period in six figures each, separated by "/"; for example, a period of validity from 1215 UTC to 1600 UTC on the 22nd day of the month should be given as "VALID 221215/221600".*

7.4.5 **Recommendation.**— *AIRMET messages should be disseminated to meteorological watch offices in adjacent flight information regions and to other meteorological offices, as agreed by the meteorological authorities concerned.*

7.5 Aerodrome warnings

7.5.1 Aerodrome warnings shall give concise information, in plain language, of meteorological conditions which could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services. The warnings shall be issued in accordance with local arrangements to operators, aerodrome services and to others concerned, by the meteorological office designated to provide service for that aerodrome.

EXAMPLE OF AIRMET MESSAGE

YUCC AIRMET 2 VALID 221215/221600 YUDO-
AMSWELL FIR MOD MTW OBS AT 1205 48 DEG N 10 DEG E AT FL080 STNR NC

Meaning: The second AIRMET message issued for the AMSWELL* flight information region (identified in abbreviated plain language and by YUCC Amswell area control centre) by the Donlon/International* meteorological watch office (YUDO) since 0001 UTC; the message is valid from 1215 UTC to 1600 UTC on the 22nd of the month; moderate mountain wave was observed at 1205 UTC at 48 degrees north and 10 degrees east at flight level 080; the mountain wave is expected to remain stationary and not to undergo any changes in intensity.

* Fictitious locations

7.5.2 **Recommendation.**— *Aerodrome warnings should relate to the occurrence or expected occurrence of one or more of the following phenomena:*

- *tropical cyclone*
- *thunderstorm*
- *hail*
- *snow*
- *freezing precipitation*
- *hoar frost or rime*
- *sandstorm*
- *duststorm*

— *rising sand or dust*
— *strong surface wind and gusts*
— *squall*
— *frost.*

7.5.3 **Recommendation.—** *When quantitative criteria are necessary for the issue of aerodrome warnings covering, for example, the expected maximum wind speed or the expected total snowfall, the criteria should be established by agreement between the meteorological office and the users of the warnings.*

7.6 Wind shear warnings

7.6.1 Wind shear warnings shall give concise information of the observed or expected existence of wind shear which could adversely affect aircraft on the approach path or take-off path or during circling approach between runway level and 500 m (1 600 ft) above that level and aircraft on the runway during the landing roll or take-off run. The warnings shall be prepared and disseminated for aerodromes where wind shear is considered a factor in accordance with local arrangements with the appropriate ATS authority and operators concerned and by the meteorological office designated to provide service for the aerodrome or disseminated directly from automated ground-based wind shear remote sensing or detection equipment referred to in 7.6.2 a) and b). Where local topography has been shown to produce significant wind shears at heights in excess of 500 m (1 600 ft) above runway level, then 500 m (1 600 ft) shall not be considered restrictive..

Note 1.— Wind shear conditions are normally associated with the following phenomena:

— *thunderstorms, microbursts, funnel cloud (tornado or waterspout), and gust fronts*
— *frontal surfaces*
— *strong surface winds coupled with local topography*
— *sea breeze fronts*
— *mountain waves (including low-level rotors in the terminal area)*
— *low-level temperature inversions.*

Note 2.— Guidance on the subject of wind shear is contained in the ICAO Circular Wind Shear *(Circ 186).*

Note 3.— Information on wind shear is also to be included as supplementary information in routine, special and selected special reports in accordance with 4.12.5 and 4.12.7.

7.6.2 **Recommendation.—** *Evidence of the existence of wind shear should be derived from:*

a) ground-based wind shear remote-sensing equipment, for example, Doppler radar;

b) ground-based wind shear detection equipment, for example, a system of surface wind and/or pressure sensors located in an array monitoring a specific runway or runways and associated approach and departure paths;

c) aircraft observations during the climb-out or approach phases of flight to be made in accordance with Chapter 5, 5.5.2; or

d) other meteorological information, for example, from appropriate sensors located on existing masts or towers in the vicinity of the aerodrome or nearby areas of high ground.

7.6.3 **Recommendation.—** *Wind shear warnings should be prepared in abbreviated plain language. Wind shear in the approach area should be reported, for example, as "WS WRNG SURFACE WIND 320/20KMH WIND AT 60M 360/50KMH IN APCH" or "WS WRNG SURFACE WIND 320/10KT WIND AT 60M 360/25KT IN APCH". Where microbursts are observed, reported by pilots or detected by ground-based wind shear detection or remote-sensing equipment, the wind shear warning should include a specific reference to microburst, for example, "WS WRNG MBST APCH RWY 26".*

7.6.4 **Recommendation.—** *Where information from ground-based wind shear detection or remote-sensing equipment is used to prepare a wind shear warning, the warning should, if practicable, relate to specific sections of the runway and distances along the approach path or take-off path as agreed between the meteorological authority, the appropriate ATS authority and the operators concerned, for example, "WS WRNG 30KT AIRSPEED LOSS 2NM FINAL RWY 13" or "WS WRNG 60KMH AIRSPEED LOSS 4KM FINAL RWY 13".*

7.6.5 **Recommendation.—** *When an aircraft report is used to prepare a wind shear warning, or to confirm a warning previously issued, the corresponding aircraft report, including the aircraft type, should be given unchanged in the warning, for example, "WS WRNG B747 REPORTED MOD WS IN APCH RWY 34 AT 1510".*

Note 1.— Following reported encounters by both arriving and departing aircraft two different wind shear warnings may exist, one for arriving aircraft and one for departing aircraft.

Note 2.— Specifications for reporting the intensity of wind shear are still undergoing development. It is recognized, however, that pilots, when reporting wind shear, may use the qualifying terms "moderate", "strong" or "severe", based to a large extent on their subjective assessment of the intensity of the wind shear encountered. In accordance with 7.6.5, such reports are to be incorporated unchanged in wind shear warnings.

7.6.6 **Recommendation.—** *Wind shear warnings for arriving aircraft and/or departing aircraft should be cancelled when aircraft reports indicate that wind shear no longer exists, or alternatively, after an agreed elapsed time. The criteria for the cancellation of a wind shear warning should be defined locally for each aerodrome, as agreed between the meteorological authority, the appropriate ATS authority and the operators concerned.*

CHAPTER 8. AERONAUTICAL CLIMATOLOGICAL INFORMATION

8.1 General provisions

Note.— In cases where it is impracticable to meet the requirements for aeronautical climatological information on a national basis, the collection, processing and storage of observational data may be effected through computer facilities available for international use, and the responsibility for the preparation of the required aeronautical climatological information may be delegated by agreement between the meteorological authorities concerned.

8.1.1 Aeronautical climatological information required for the planning of flight operations shall be prepared in the form of aerodrome climatological tables and aerodrome climatological summaries. Such information shall be supplied to aeronautical users as agreed between the meteorological authority and those users.

Note.— Climatological data required for aerodrome planning purposes are set out in Annex 14, Volume I, 3.1.3 and Attachment A.

8.1.2 **Recommendation.—** *Aeronautical climatological information should normally be based on observations made over a period of at least five years and the period should be indicated in the information supplied.*

8.1.3 **Recommendation.—** *Aeronautical climatological information should be exchanged on request between meteorological authorities. Operators and other aeronautical users desiring such information should normally apply to the meteorological authority responsible for its preparation.*

8.1.4 **Recommendation.—** *Meteorological observations for regular and alternate aerodromes should be collected, processed and stored in a form suitable for the preparation of aerodrome climatological information.*

8.1.5 **Recommendation.—** *Climatological data related to sites for new aerodromes and to additional runways at existing aerodromes should be collected starting as early as possible before the commissioning of those aerodromes or runways.*

8.2 Aerodrome climatological tables

8.2.1 **Recommendation.—** *Each Contracting State should make arrangements for collecting and retaining the necessary observational data and have the capability:*

a) to prepare aerodrome climatological tables for each regular and alternate international aerodrome within its territory; and

b) to make available such climatological tables to an aeronautical user within a time period as agreed between the meteorological authority and that user.

8.2.2 **Recommendation.—** *An aerodrome climatological table should give as applicable:*

a) mean values and variations therefrom, including maximum and minimum values, of meteorological elements (for example, of air temperature); and/or

b) the frequency of occurrence of present weather phenomena affecting flight operations at the aerodrome (for example, of sandstorms); and/or

c) the frequency of occurrence of specified values of one, or of a combination of two or more, elements (for example, of a combination of low visibility and low cloud).

8.2.3 **Recommendation.—** *Aerodrome climatological tables should include information required for the preparation of aerodrome climatological summaries in accordance with 8.3.2.*

8.3 Aerodrome climatological summaries

8.3.1 **Recommendation.—** *Aerodrome climatological summaries should follow the procedures prescribed by the World Meteorological Organization. Where computer facilities are available to store, process and retrieve the information, the summaries should be published, or otherwise made available to aeronautical users on request. Where such computer facilities are not available, the summaries should be prepared using the models specified by the World Meteorological Organization, and should be published and kept up to date as necessary.*

8.3.2 **Recommendation.—** *Aerodrome climatological summaries should cover:*

a) frequencies of the occurrence of runway visual range/visibility and/or height of the base of the lowest cloud layer of BKN or OVC extent below specified values at specified times;

b) frequencies of visibility below specified values at specified times;

c) frequencies of the height of the base of the lowest cloud layer of BKN or OVC extent below specified values at specified times;

d) frequencies of occurrence of concurrent wind direction and speed within specified ranges;

e) frequencies of surface temperature in specified ranges of 5°C at specified times; and *f) mean values and variations therefrom, including maximum and minimum values of meteorological elements required for operational planning purposes, including take-off performance calculations.*

Note.— Models of climatological summaries related to a) to e) above are given in WMO Publication No. 49, Technical Regulations, *Vol. II, C.3.2.*

8.4 Copies of meteorological observational data

Each meteorological authority, on request and to the extent practicable, shall make available to any other meteorological authority, to operators and to others concerned with the application of meteorology to international air navigation, meteorological observational data required for research, investigation or operational analysis.

CHAPTER 9. SERVICE FOR OPERATORS AND FLIGHT CREW MEMBERS

9.1 General provisions

9.1.1 Meteorological information shall be supplied to operators and flight crew members for:

a) pre-flight planning by operators;

b) use by flight crew members before departure;

c) aircraft in flight.

9.1.2 Meteorological information supplied to operators and flight crew members shall cover the flight in respect of time, altitude and geographical extent. Accordingly, the information shall relate to appropriate fixed times, or periods of time, and shall extend to that aerodrome of intended landing at which new information is to be supplied. On request, or whenever conditions impose doubt as to the practicability of landing at that aerodrome, additional information shall be included, covering the meteorological conditions expected between the aerodrome of intended landing and one alternate aerodrome designated by the operator. In addition, if agreed between the meteorological authority and the operator, information up to a further aerodrome may be supplied.

9.1.3 Meteorological information supplied to operators and flight crew members shall include upper winds and upper-air temperatures, significant en-route weather phenomena, meteorological reports, aerodrome forecasts, forecasts for take-off, landing forecasts, SIGMET information and those special air-reports not covered by a SIGMET and AIRMET information, which are available at the meteorological office and which are relevant to the planned flight operations.

9.1.4 Meteorological information supplied to operators and flight crew members shall include forecasts for the aerodrome of departure and for the aerodrome of intended landing. On request, forecasts shall also be supplied for one or more suitable en-route and destination alternate aerodromes as required by the operator to complete the operational flight plan.

9.1.5 **Recommendation.—** *Aerodrome forecasts additional to those referred to in 9.1.4 which may be required by an operator should be supplied, if available, by agreement between the meteorological authority and the operator.*

9.1.6 **Recommendation.—** *Meteorological information supplied to operators and flight crew members should include reports for the aerodrome of departure, take-off and en-route alternate aerodromes, the aerodrome of intended landing and destination alternate aerodromes located within 2 hours' flying time of the aerodrome of departure, but with possible exceptions for certain routes and operations, such as extended range operations and flights conducted under centralized operational control, as determined by regional air navigation agreement. Additional relevant reports should be supplied if available. Where such information is provided in the form of bulletins of reports, the time of observation indicated in the bulletin heading should be retained. In cases where a new bulletin to meet particular operational needs is compiled from reports taken from other bulletins, the time of observation of each report should be clearly identified, either in the new bulletin heading or as part of the individual reports.*

9.1.7 **Recommendation.—** *On request by the operator, the meteorological information supplied for flight planning should include data for the determination of the lowest usable flight level.*

9.1.8 Where necessary, the meteorological authority of the State providing service for operators and flight crew members shall initiate co-ordinating action with the meteorological authorities of other States with a view to obtaining from them the reports and/or forecasts required.

9.1.9 Meteorological information shall be supplied to operators and flight crew members by one or more of the following, as agreed between the meteorological authority and operator concerned, and with the order shown below not implying priorities:

a) written or printed material, including specified charts and forms;

b) grid point data in digital form;

c) briefing;

d) consultation;

e) display.

9.1.10 The meteorological authority, in consultation with the operator, shall determine:

a) the type and format of meteorological information to be supplied;

b) methods and means of supplying that information.

9.1.11 Meteorological information shall be supplied to operators and flight crew members at the location to be determined by the meteorological authority, after consultation with the operators and at the time to be agreed upon between the meteorological office and the operator concerned. The service shall normally be confined to flights originating within the territory of the State concerned, unless otherwise agreed between the meteorological authority and the operator concerned. At an aerodrome without a meteorological office, arrangements for the supply of meteorological information shall be as agreed upon between the meteorological authority and the operator concerned.

9.2 Information for pre-flight planning by operators

9.2.1 Meteorological information for pre-flight planning by operators shall include any or all of the following information, as required:

a) current and forecast upper winds, upper-air temperatures, tropopause heights and maximum wind information;

b) existing and expected significant en-route weather phenomena and jetstream information;

c) a forecast for take-off;

d) aerodrome reports and aerodrome forecasts.

9.2.2 **Recommendation.—** *Meteorological information for pre-flight planning by operators for supersonic aircraft should include data covering the levels used for transonic and supersonic flight, together with the levels that may be used for subsonic flight. Particular mention should be made of occurrence and expected occurrence, location and vertical extent of cumulonimbus clouds, turbulence and precipitation.*

9.2.3 **Recommendation.—** *Meteorological information for pre-flight planning by operators of helicopters flying to off-shore structures should include data covering the layers from sea-level to flight level 100. Particular mention should be made of the expected surface visibility, the amount, type (where available), base and tops of cloud below flight level 100, sea state and sea surface temperature, mean sea-level pressure, and the occurrence and expected occurrence of turbulence and icing, as determined by regional air navigation agreement.*

9.2.4 When upper-air information is supplied in chart form, it shall consist of charts for standard isobaric surfaces and/or other types of upper-air charts as applicable.

9.2.5 **Recommendation.—** *The upper wind and upper-air temperature information and the significant en-route weather information requested for pre-flight planning by the operator should normally be supplied as soon as it becomes available, but not later than 3 hours before departure. Other meteorological information requested for pre-flight planning by the operator should normally be supplied as soon as is practicable.*

9.2.6 **Recommendation.—** *Whenever it becomes apparent that the meteorological information to be included in the flight documentation will differ materially from that made available for pre-flight planning, the operator should be advised immediately and, if practicable, be supplied with the revised information.*

9.3 Briefing, consultation and display

9.3.1 Briefing and/or consultation shall be provided, on request, to flight crew members and/or other flight operations personnel. Its purpose shall be to supply the latest available information on existing and expected meteorological conditions along the route to be flown, at the aerodrome of intended landing, alternate aerodromes and other aerodromes as relevant, either to explain and amplify the information contained in the flight documentation or, if so agreed between the meteorological authority and the operator, in lieu of flight documentation.

9.3.2 Meteorological information used for briefing and consultation shall include any or all of the following, as required:

a) current and forecast upper winds, upper-air temperatures, tropopause heights and maximum wind information;

b) existing and expected significant en-route weather phenomena and jetstream information;

c) a forecast for take-off;

d) aerodrome reports and aerodrome forecasts.

9.3.3 **Recommendation.—** *Briefing and/or consultation for flight crew members of supersonic aircraft should include meteorological information covering the flight levels of transonic and supersonic flight. Particular mention should be made of occurrence and expected occurrence, location and vertical extent of cumulonimbus clouds, turbulence and precipitation.*

9.3.4 **Recommendation.—** *Briefing and/or consultation for low-level flights, including those in accordance with the visual flight rules, should include meteorological information covering altitudes up to flight level 100. Particular mention should be made of the occurrence or expected occurrence of precipitation, fog and other phenomena causing widespread reduction of visibility to less than 5 000 m, as well as the occurrence or expected occurrence of clouds which may affect the flight.*

9.3.5 If the meteorological office expresses an opinion on the development of the meteorological conditions at an aerodrome which differs appreciably from the aerodrome forecast included in the flight documentation, the attention of flight crew members shall be drawn to the divergence. The portion of the briefing dealing with the divergence shall be recorded at the time of briefing and this record shall be made available to the operator.

9.3.6 The required briefing, consultation, display and/or flight documentation shall normally be provided by the meteorological office associated with the aerodrome of departure. At an aerodrome where these services are not available, arrangements to meet the requirements of flight crew members shall be as agreed upon between the meteorological authority and the operator concerned. In exceptional circumstances, such as an undue delay, the meteorological office associated with the aerodrome shall provide or, if that is not practicable, arrange for the provision of a new briefing, consultation and/or flight documentation as necessary.

9.3.7 **Recommendation.—** *The flight crew member or other flight operations personnel for whom briefing, consultation and/or flight documentation has been requested should visit the meteorological office at the time agreed upon between the meteorological office and the operator concerned. Where local circumstances at an aerodrome make personal briefing or consultation impracticable, the meteorological office should provide those services by telephone or other suitable telecommunications facilities.*

9.3.8 To assist the flight crew members and others concerned with the preparation of the flight and for use in briefing and consultation, the meteorological office shall display the latest available:

a) routine and selected special reports;

b) aerodrome and landing forecasts;

c) aerodrome warnings relating to the local aerodrome;

d) forecasts for take-off;

e) SIGMET and AIRMET information and special air-reports not covered by a SIGMET;

f) current and prognostic charts;

g) meteorological satellite photographs or mosaics and/or nephanalyses;

h) ground-based weather radar information.

9.3.9 **Recommendation.—** *The material displayed should be readily accessible to the flight crew members or other flight operations personnel concerned. By agreement between the meteorological authority and the user, the display may be used in lieu of briefing and/or consultation.*

9.4 Flight documentation — general

9.4.1 **Recommendation.—** *Flight documentation for flights of more than two hours' duration should comprise information on:*

a) upper winds and upper-air temperatures;

b) expected significant en-route weather phenomena and, if relevant, tropopause heights and jetstreams;

c) aerodrome forecasts;

d) aerodrome reports and selected special reports for destination aerodromes and en-route and destination alternate aerodromes for extended range operations and flights conducted under centralized operational control, as determined by regional air navigation agreement;

e) SIGMET information and appropriate special air-reports for a distance corresponding to the first two hours' flying time and SIGMET information for volcanic ash cloud and tropical cyclone related to the whole route;

Note.— Appropriate special air-reports will be those not already used in preparation of SIGMET messages.

f) AIRMET information for low-level flights.

9.4.2 **Recommendation.—** *Flight documentation for flights of two hours' duration or less should comprise information on:*

a) upper winds and upper-air temperatures;

b) expected significant en-route weather phenomena and, if relevant, tropopause heights and jetstreams;

c) aerodrome forecasts;

d) aerodrome reports, selected special reports, SIGMET information and appropriate special air-reports;

Note.— Appropriate special air-reports will be those not already used in the preparation of SIGMET messages.

e) AIRMET information for low-level flights.

However, in accordance with regional air navigation agreement, or in the absence thereof when agreed between the meteorological authority and operator concerned, flight documentation for flights after a short intermediate stop or turnaround may be limited to the information operationally needed but in all cases the flight documentation should at least comprise information on c), d) and, if appropriate, e).

9.4.3 **Recommendation.—** *Meteorological offices should, as far as practicable, provide information received within the framework of the world area forecast system for flight documentation. The flight documentation should be presented in the form of charts, tabular forms, or abbreviated plain-language texts. Aerodrome forecasts should be presented in the TAF code, or in abbreviated plain-language text using a tabular presentation.*

Note.— Models of charts and forms for use in the preparation of flight documentation are given in the Appendix. These models and methods for their completion are developed by the World Meteorological Organization on the basis of relevant operational requirements stated by the International Civil Aviation Organization.

9.4.4 **Recommendation.—** *Charts included in flight documentation should have a high standard of clarity and legibility and should have the following physical characteristics:*

a) for convenience, the largest size of charts should be about 42 x 30 cm (standard size A3) and the smallest size should be about 21 x 30 cm (standard size A4). The choice between these sizes should depend on the route lengths and the amount of detail that needs to be given in the charts as agreed between meteorological authorities and users;

b) major geographical features, such as coastlines, major rivers and lakes should be depicted in a way that makes them easily recognizable;

c) for charts prepared by computer, meteorological data should take preference over basic chart information, the former cancelling the latter wherever they overlap;

d) major aerodromes should be shown as a dot and identified by the first letter of the name of the city the aerodrome serves as given in Table AOP of the relevant regional air navigation plan;

e) a geographical grid should be shown with meridians and parallels represented by dotted lines at each 10° latitude and longitude; dots should be spaced one degree apart;

f) latitude and longitude values should be indicated at various points throughout the charts (i.e. not only at the edges);

g) labels on the charts should be clear and simple and should present the name of the regional area forecast centre, the type of chart, date and valid time and if necessary the types of units used in an unambiguous way.

9.4.5 **Recommendation.—** *Meteorological information included in flight documentation should be represented as follows:*

a) winds on charts should be depicted by arrows with feathers and shaded pennants on a sufficiently dense grid;

b) temperatures should be depicted by figures on a sufficiently dense grid;

c) wind and temperature data selected from the data sets received from a world area forecast centre should be depicted in a sufficiently dense latitude/longitude grid; and

d) wind arrows should take precedence over temperatures and either should take precedence over chart background.

9.4.6 **Recommendation.—** *For short-haul flights charts should be prepared covering limited areas at a scale of 1:15 x 10^6 as required and subject to regional air navigation agreement.*

9.4.7 **Recommendation.—** *The minimum number of charts for flights between flight level 250 and flight level 450 should include a high-level significant weather chart (flight level 250 to flight level 450) and a forecast 250 hPa wind and temperature chart. The actual charts provided for pre-flight and in-flight planning and for flight documentation should be as agreed between meteorological authorities and other users and the appropriate regional area forecast centre(s) concerned within a service area.*

9.4.8 **Recommendation.—** *The set of charts to be provided under the area forecast system for flights below flight level 250 and for flights above flight level 450 including supersonic flights should be as agreed between user States and other users and the regional area forecast centre concerned within a service area.*

9.4.9 **Recommendation.—** *Flight documentation should normally be supplied as shortly before departure as is practicable.*

9.4.10 **Recommendation.—** *Whenever necessary and possible, the flight documentation should be brought up to date, in writing or orally, before it is supplied to flight crew members. In cases where a need for amendment arises after the flight documentation has been supplied, and before take-off of the aircraft, the meteorological office should, as agreed locally, issue the necessary amendment or updated information to the operator or to the local air traffic services unit, for transmission to the aircraft.*

9.4.11 **Recommendation.—** *In flight documentation height indications should be given as follows:*

a) all references to en-route meteorological conditions, such as height indications of upper winds, turbulence or bases and tops of clouds, should preferably be expressed *in flight levels; they may also be expressed in pressure-altitude, pressure, altitude or, for low-level flights, height above ground level;*

b) all references to aerodrome meteorological conditions, such as height indications of the bases of clouds, should be expressed in height above the aerodrome elevation.

9.4.12 **Recommendation.—** *The forms and charts included in flight documentation should be printed in English, French, Russian or Spanish; they should, wherever practicable, be completed in the language requested by the operator, preferably using one of those languages. Where appropriate, approved abbreviations should be used. The units employed for each element should be indicated; they should normally be those employed by the meteorological authority concerned.*

9.4.13 The meteorological authority shall retain a copy of the written or printed flight documentation, including charts and specified forms, supplied to flight crew members, for a period of at least 30 days from the date of issue. This information shall be made available, on request, for inquiries or investigations and, for these purposes, shall be retained until the inquiry or investigation is completed.

9.5 Flight documentation — upper wind and upper-air temperature information

9.5.1 Where upper wind and upper-air temperature information is supplied in chart form to flight crew members before departure, the charts shall be fixed time prognostic charts for standard isobaric surfaces. In tropical areas, or for short flights, current charts may be provided in lieu of prognostic charts; in such cases, the levels depicted shall correspond to the standard isobaric levels.

9.5.2 **Recommendation.—** *Where upper wind and upper-air temperature information is supplied in tabular form, it should include data for the same flight levels as for upper-air charts. This information should be given for spot locations on a regular grid.*

Note.— Examples of the form of presentation of tabular forecasts of upper winds and upper-air temperatures are given in the Appendix.

9.6 Flight documentation — significant weather charts

9.6.1 Where information on significant en-route weather phenomena is supplied in chart form to flight crew members before departure, the charts shall be significant weather charts valid for a specified fixed time. Such charts shall show, as appropriate to the flight:

a) thunderstorms;

b) tropical cyclone;

c) severe squall lines;

d) moderate or severe turbulence (in cloud or clear air);

e) moderate or severe icing;

f) widespread sandstorm/duststorm;

g) for flight level 100 to flight level 250, clouds associated with a) to f) above;

h) above flight level 250, cumulonimbus cloud associated with a) to f) above;

i) surface position of well-defined convergence zones;

j) surface positions, speed and direction of movement of frontal systems;

k) tropopause heights;

l) jetstreams; and

m) information on the location of volcanic eruptions which are producing ash clouds of significance to aircraft operations, name of volcano and time of first eruption, if known, and a reminder to users that reference should be made to SIGMETs issued for the area concerned.

Note 1.— For aircraft operating above flight level 250, items a) to f) are only required if expected to be above that level.

Note 2.— Thunderstorms shown on significant weather charts should include those which warrant the issuance of a SIGMET as given in 7.1.1 a).

Note 3.— The abbreviation "CB" should only be included where it refers to the occurrence or expected occurrence of an area of widespread cumulonimbus clouds or cumulonimbus along a line with little or no space between individual clouds, or to cumulonimbus embedded in cloud layers or concealed by haze. It does not refer to isolated or scattered cumulonimbus not embedded in cloud layers or concealed by haze.

Note 4.— Frontal systems should be included only when associated with significant en-route weather phenomena.

9.6.2 **Recommendation.—** *On significant weather charts, the inclusion of "CB" or the thunderstorm symbol should be understood to include all weather phenomena normally associated with cumulonimbus or thunderstorm, namely, moderate or severe icing, moderate or severe turbulence and hail.*

9.6.3 **Recommendation.—** *Significant weather charts for low-level flights, including those in accordance with the visual flight rules, operating up to flight level 100 should show, as appropriate to the flight:*

a) fronts and convergence zones and their expected movement;

b) areas and levels affected by thunderstorm, tropical cyclone, squall line, hail, moderate or severe turbulence in cloud or in clear air, mountain waves and associated downdrafts, aircraft icing, freezing precipitation, widespread sandstorm or duststorm, fog, precipitation and other phenomena causing widespread reduction of visibility to less than 5 000 m;

c) cloud amount, type and height indications of bases and tops;

d) surface visibility, if less than 5 000 m;

e) pressure centres and their expected movement;

f) height indication of 0°C level(s) if lower than the top of the airspace for which the forecast is provided;

g) sea-surface temperature and state of the sea if so determined by regional air navigation agreement.

h) information on the location of volcanic eruptions which are producing ash clouds of significance to aircraft operations, name of volcano and time of first eruption, if known, and a reminder to users that reference should be made to SIGMETs issued for the area concerned.

Note.— Examples of the form of presentation of significant weather charts are given in the Appendix.

9.7 Flight documentation — aerodrome forecasts

9.7.1 The flight documentation shall in all cases include the aerodrome forecasts for the aerodrome of departure, and for the aerodrome of intended landing. In addition, the flight documentation shall include aerodrome forecasts for one or more suitable alternate aerodromes, as needed to complete the operational flight plan and as selected by agreement between the meteorological authority and the operators, and taken from the list of aerodromes contained in the relevant regional air navigation plan.

9.7.2 **Recommendation.—** *By agreement between the meteorological authority and the operator the flight documentation should include forecasts for a limited number of alternate aerodromes en route and of aerodromes where intermediate stops are planned. In such cases use should be made of available forecasts for regular aerodromes.*

9.7.3 Aerodrome forecasts received from other meteorological offices shall be included in flight documentation without change in substance.

9.7.4 **Recommendation.—** *When an aerodrome forecast is not received in time, the meteorological office associated with the aerodrome of departure should make all practicable efforts to obtain the forecast but, if unobtainable, the office should, if possible, prepare a provisional forecast. The meteorological office should inform the flight crew member that the forecast is provisional and record its origin in the flight documentation.*

9.7.5 **Recommendation.—** *Aerodrome forecasts should be presented in the TAF code form; they may also be presented in tabular form or in the form of an abbreviated plain-language text. Where presentation in the TAF code form is used, the location indicators and the abbreviations used should be explained in the flight documentation. If several aerodrome forecasts are included in the TAF code form, they should be presented in a manner which permits the ready identification of the beginning and end of each forecast.*

Note.— Examples of the form of presentation of aerodrome forecasts are given in the Appendix.

9.8 Flight documentation — supplementary charts and other forms of presentation

9.8.1 **Recommendation.—** *Where flight documentation covering the significant en-route weather conditions is not supplied in chart form, it should be presented in tabular form and/or as an abbreviated plain-language text.*

Note.— Examples of the form of presentation of tabular forecasts are given in the Appendix.

9.8.2 **Recommendation.—** *Where flight documentation is supplied in the form of an abbreviated plain-language text, it should cover the whole route to be flown. If such documentation covers more than one route, it should permit ready identification by the user of the information relevant to the route to be flown.*

9.8.3 **Recommendation.—** *Flight documentation for low-level flights, including those in accordance with the visual flight rules, should contain the following information as appropriate to the flight and, where the forecasts are issued in the form of an abbreviated plain-language text, in the order indicated:*

a) pressure centres, fronts and convergence zones and their expected movements and developments;

b) significant weather phenomena as specified in 9.6.3 b);

c) cloud amount, type and height indications of bases and tops;

d) surface visibility, if less than 5 000 m;

e) pressure values for altimeter setting, if required;

f) height indication of 0°C level(s), if lower than the top of the airspace for which the forecast is supplied;

g) upper winds and upper-air temperatures for points separated by no more than 500 km (300 NM) and for altitude intervals not exceeding 1 500 m (5 000 ft) up to flight level 100. If available, upper winds and upper-air temperatures should be supplied for altitude intervals not exceeding 900 m (3 000 ft);

h) sea-surface temperature and state of the sea if so determined by regional air navigation agreement;

i) location of volcanic eruptions which are producing ash clouds of significance to aircraft operations, name of volcano and time of first eruption, if known, and a reminder to users that reference should be made to SIGMETs issued for the area concerned;

j) if necessary, a brief general indication (outlook) concerning changes which are expected to occur after the end of the forecast period.

9.9 Information for aircraft in flight

9.9.1 Meteorological information for use by aircraft in flight shall be supplied by a meteorological office to its associated air traffic services unit and through VOLMET broadcasts. Meteorological information for planning by the operator for aircraft in flight shall be supplied on request, as agreed between the meteorological authority or authorities and the operator concerned.

9.9.2 Meteorological information for use by aircraft in flight shall be supplied to air traffic services units in accordance with the specifications of Chapter 10.

9.9.3 **Recommendation.—** *Meteorological information should be supplied through VOLMET broadcasts as determined by regional air navigation agreement, and in accordance with the specifications of Chapter 11.*

9.9.4 **Recommendation.—** *If, in exceptional circumstances, an aircraft in flight requests meteorological information, the meteorological office which receives the request should arrange to supply the information with the assistance, if necessary, of another meteorological office.*

9.9.5 **Recommendation.—** *For supersonic aircraft in flight the meteorological office serving the aerodrome of intended landing should, on request by the operator, supply a forecast covering the transonic deceleration and subsonic descent phases. This forecast should be transmitted to the area control centre or flight information centre concerned within the two hours before arrival. The operator should advise the meteorological office, in good time, of the location of the descent path and of the time at which the aircraft is expected to commence the descent.*

9.9.6 **Recommendation.—** *Meteorological information for planning by the operator for aircraft in flight should be supplied during the period of the flight and should normally consist of any or all of the following:*

a) routine and special reports, aerodrome forecasts and landing forecasts;

b) SIGMET and AIRMET information and special air-reports relevant to the flight, unless the latter have been the subject of a SIGMET message;

c) upper wind and upper-air temperature information.

CHAPTER 10. INFORMATION FOR AIR TRAFFIC SERVICES, SEARCH AND RESCUE SERVICES AND AERONAUTICAL INFORMATION SERVICES

10.1 Information for air traffic services units

10.1.1 The meteorological authority shall designate a meteorological office to be associated with each air traffic services unit. The associated meteorological office shall, after co-ordination with the air traffic services unit, supply, or arrange for the supply of up-to-date meteorological information to the unit as necessary for the conduct of its functions.

10.1.2 **Recommendation.—** *The associated meteorological office for an aerodrome control tower or approach control office should be an aerodrome meteorological office.*

10.1.3 The associated meteorological office for a flight information centre or an area control centre shall be a meteorological watch office.

10.1.4 **Recommendation.—** *Where, owing to local circumstances, it is convenient for the duties of an associated meteorological office to be shared between two or more meteorological offices, the division of responsibility should be determined by the meteorological authority in consultation with the appropriate ATS authority.*

10.1.5 The following meteorological information shall be supplied, as necessary, to an aerodrome control tower by its associated aerodrome meteorological office:

a) routine, special and selected special reports, including current pressure data, aerodrome and landing forecasts and amendments thereto, for the aerodrome concerned;

b) SIGMET and AIRMET information, wind shear warnings and aerodrome warnings;

c) any additional meteorological information agreed upon locally, such as reports for take-off or forecasts of surface wind for the determination of possible runway changes;

d) information received on volcanic ash cloud, for which a SIGMET has not already been issued, as agreed between the meteorological and ATS authorities concerned.

10.1.6 The following meteorological information shall be supplied, as necessary, to an approach control office by its associated aerodrome meteorological office:

a) routine, special and selected special reports, including current pressure data, aerodrome and landing forecasts and amendments thereto for the aerodrome(s) with which the approach control office is concerned;

b) SIGMET and AIRMET information; wind shear warnings and appropriate special air-reports for the airspace with which the approach control office is concerned and aerodrome warnings;

c) any additional meteorological information agreed upon locally, such as reports for landing;

d) information received on volcanic ash cloud, for which a SIGMET has not already been issued, as agreed between the meteorological and ATS authorities concerned.

10.1.7 The following meteorological information shall be supplied, as necessary, to a flight information centre or an area control centre by its associated meteorological watch office:

a) routine reports and selected special reports, including current pressure data for aerodromes and other locations, aerodrome forecasts and landing forecasts and amendments thereto, covering the flight information region or the control area and, if required by the flight information centre or area control centre, covering aerodromes in neighbouring flight information regions, as determined by regional air navigation agreement;

b) forecasts of upper winds, upper-air temperatures and significant en-route weather phenomena and amendments thereto, particularly those which are likely to make operation under visual flight rules impracticable, SIGMET and AIRMET information and appropriate special air-reports for the flight information region or control area and, if determined by regional air navigation agreement and required by the flight information centre or area control centre, for neighbouring flight information regions;

c) any other meteorological information required by the flight information centre or area control centre to meet requests from aircraft in flight; if the information requested is not available in the associated meteorological watch office, that office shall request the assistance of another meteorological office in supplying it;

d) information received on volcanic ash cloud, for which a SIGMET has not already been issued, as agreed between the meteorological and ATS authorities concerned.

10.1.8 Information received on pre-eruption volcanic activity and/or a volcanic eruption shall be supplied, as necessary, to an ATS unit by its corresponding associated meteorological office as agreed between the meteorological and ATS authorities concerned.

10.1.9 Any meteorological information requested by an air traffic services unit in connexion with an aircraft emergency shall be supplied as rapidly as possible.

10.1.10 **Recommendation.—** *The information supplied to flight information centres and area control centres for supersonic aircraft should cover the levels used for transonic and supersonic flight and should include forecasts for subsonic descent paths to aerodromes in the flight information region.*

10.1.11 Where necessary for flight information purposes, current meteorological reports and forecasts shall be supplied to designated aeronautical telecommunication stations. A copy of such information shall be forwarded, if required, to the flight information centre or the area control centre.

10.1.12 **Recommendation.—** *Routine, special and selected special reports, aerodrome and landing forecasts, SIGMET and AIRMET information, upper wind and upper-air temperature forecasts and amendments thereto should be supplied tc air traffic services units in the form in which they are prepared, disseminated to other meteorological offices or received from other meteorological offices, unless otherwise agreed locally.*

10.1.13 **Recommendation.—** *When computer-processed upper-air data for grid points are made available to air traffic services units in digital form for use by air traffic services computers, the contents, format and transmission arrangements should be as agreed between the meteorological authority and the appropriate ATS authority. The data should normally be supplied as soon as is practicable after the processing of the forecasts has been completed.*

10.2 Information for search and rescue services units

10.2.1 Meteorological offices designated by the meteorological authority in accordance with regional air navigation agreement shall supply search and rescue services units with the meteorological information they require in a form established by mutual agreement. For that purpose, the designated meteorological office shall maintain liaison with the search and rescue services unit throughout a search and rescue operation.

10.2.2 Information to be supplied to rescue co-ordination centres shall include the meteorological conditions that existed in the last known position of a missing aircraft and along the intended route of that aircraft with particular reference to:

a) significant en-route weather phenomena;

b) cloud amount and type, particularly cumulonimbus; height indications of bases and tops;

c) visibility and phenomena reducing visibility;

d) surface wind and upper wind;

e) state of ground, in particular, any snow cover or flooding;

f) sea-surface temperature, state of the sea, ice cover if any and ocean currents, if relevant to the search area;

g) sea level pressure data.

10.2.3 **Recommendation.—** *On request from the rescue co-ordination centre, the designated meteorological office should arrange to obtain details of the flight documentation which was supplied to the missing aircraft, together with any amendments to the forecast which were transmitted to the aircraft in flight.*

10.2.4 **Recommendation.—** *To facilitate search and rescue operations the designated meteorological office should, on request, supply:*

a) complete and detailed information on the current and forecast meteorological conditions in the search area;

b) current and forecast conditions en route, covering flights by search aircraft from and returning to the aerodrome from which the search is being conducted.

10.2.5 **Recommendation.—** *On request from the rescue co-ordination centre the designated meteorological office should supply, or arrange for the supply of meteorological information required by ships undertaking search and rescue operations.*

10.3 Information for aeronautical information services units

10.3.1 **Recommendation.—** *The meteorological authority, in co-ordination with the appropriate civil aviation authority, should arrange for the supply of up-to-date meteorological information to relevant aeronautical information services units, as necessary, for the conduct of their functions.*

10.3.2 The following information shall be supplied, as necessary, to an aeronautical information services unit:

a) information on meteorological service for international air navigation, intended for inclusion in the aeronautical information publication(s) concerned;

Note.— Details of this information are given in Annex 15, Aeronautical Information Services, *Appendix 1, Part 1, 3.5 and Part 3, 2.2, 2.11, 3.2 and 3.11.*

b) information necessary for the preparation of NOTAM including, in particular, information on:

1) the establishment, withdrawal and significant changes in operation of aeronautical meteorological services. This information is required to be provided to the aeronautical information services unit sufficiently in advance of the effective date to permit issuance of NOTAM in compliance with Annex 15, 5.1.1 and 5.1.1.1;

2) the occurrence of volcanic activity.

Note.— The specific information required is given in 3.4.2 and 4.15 of this Annex.

c) information necessary for the preparation of aeronautical information circulars including, in particular, information on:

1) expected important changes in aeronautical meteorological procedures, services and facilities provided; and

2) effect of certain weather phenomena on aircraft operations.

CHAPTER 11. REQUIREMENTS FOR AND USE OF COMMUNICATIONS

Note.— It is recognized that it is for each Contracting State to decide upon its own internal organization and responsibility for implementing the communications facilities referred to in this Chapter.

11.1 Requirements for communications

11.1.1 Suitable telecommunications facilities shall be made available to permit aerodrome meteorological offices and, as necessary, aeronautical meteorological stations to supply the required meteorological information to air traffic services units on the aerodromes for which those offices and stations are responsible, and in particular to aerodrome control towers, approach control offices and the aeronautical telecommunications stations serving these aerodromes.

11.1.2 Suitable telecommunications facilities shall be made available to permit meteorological watch offices to supply the required meteorological information to air traffic services and search and rescue services units in respect of the flight information regions, control areas and search and rescue regions for which those offices are responsible, and in particular to flight information centres, area control centres and rescue co-ordination centres and the associated aeronautical telecommunications stations.

11.1.3 Suitable telecommunications facilities shall be made available to permit world and regional area forecast centres to supply the required world area forecast system products to meteorological offices, meteorological authorities and other users.

11.1.4 **Recommendation.—** *The telecommunications facilities used for the supply of world area forecast system products should be:*

a) for world area forecast centres, the aeronautical fixed service; and

b) for regional area forecast centres, the aeronautical fixed service, except as otherwise determined by regional air navigation agreement.

11.1.5 Telecommunications facilities between meteorological offices and, as necessary, aeronautical meteorological stations and aerodrome control towers or approach control offices shall permit communications by direct speech, the speed with which the communications can be established being such that the required points may normally be contacted within approximately 15 seconds.

11.1.6 **Recommendation.—** *Telecommunications facilities between meteorological offices and flight information centres, area control centres, rescue co-ordination centres and aeronautical telecommunications stations should permit:*

a) communications by direct speech, the speed with which the communications can be established being such that the required points may normally be contacted within approximately 15 seconds; and

b) printed communications, when a record is required by the recipients; the message transit time should not exceed 5 minutes.

Note.— In 11.1.5 and 11.1.6 "approximately 15 seconds" refers to telephony communications involving switchboard operation and "5 minutes" refers to printed communications involving retransmission.

11.1.7 **Recommendation.—** *The telecommunications facilities required in accordance with 11.1.5 and 11.1.6 should be supplemented, as and where necessary, by other forms of visual or audio communications, for example, closed-circuit television or separate information processing systems.*

11.1.8 **Recommendation.—** *As agreed between the meteorological authority and operators, provision should be made to enable operators to establish suitable telecommunications facilities for obtaining meteorological information from aerodrome meteorological offices or other appropriate sources.*

11.1.9 Suitable telecommunications facilities shall be made available to permit meteorological offices to exchange operational meteorological information with other meteorological offices.

11.1.10 **Recommendation.—** *The telecommunication facilities used for the exchange of operational meteorological information should be the aeronautical fixed service.*

11.1.11 **Recommendation.—** *Unless otherwise determined by regional air navigation agreement, AFTN messages and bulletins containing operational meteorological information should achieve transit times of less than the following:*

SIGMET messages and special air-reports . . . . 5 minutes

Abbreviated plain-language amendments to significant weather and upper air forecasts . . . . . 5 minutes

Amended aerodrome forecasts and corrections to aerodrome forecasts		*5 minutes*
Aerodrome reports *Trend-type landing forecasts*	*0-900 km (500 NM)*	*5 minutes*
Aerodrome forecasts *Selected special reports*	*more than 900 km (500 NM)*	*10 minutes*
WINTEM messages		*15 minutes*
Abbreviated plain-language significant weather forecast messages		*15 minutes*

11.1.12 **Recommendation.—** *When upper-air data for grid points in digital form are made available for use by air traffic services computers, the transmission arrangements should be as agreed between the meteorological authority and the appropriate ATS authority.*

11.1.13 **Recommendation.—** *When upper-air data for grid points in digital form are made available to operators for flight planning by computer, the transmission arrangements should be as agreed among the world or regional area forecast centre concerned, the meteorological authority and the operators.*

11.2 Use of aeronautical fixed service communications — meteorological bulletins in alphanumeric format

11.2.1 Meteorological bulletins containing operational meteorological information to be transmitted via the aeronautical fixed service shall be originated by the appropriate meteorological office or aeronautical meteorological station.

Note.— Meteorological bulletins containing operational meteorological information authorized for transmission via the aeronautical fixed service are listed in Annex 10, Volume II, Chapter 4, together with the relevant priorities and priority indicators.

11.2.2 **Recommendation.—** *Whenever possible, exchanges of operational meteorological information should be made in consolidated bulletins of the same types of meteorological information.*

11.2.3 **Recommendation.—** *Meteorological bulletins required for scheduled transmissions should be filed regularly and at the prescribed scheduled times. Aerodrome reports should be filed for transmission not later than 5 minutes after the actual time of observation. Aerodrome forecasts should be filed for transmission at least one hour before the commencement of their period of validity, unless otherwise determined by regional air navigation agreement.*

11.2.4 Meteorological bulletins containing operational meteorological information to be transmitted via the aeronautical fixed service facilities shall contain a heading consisting of:

a) an identifier of four letters and two figures;

b) the ICAO four-letter location indicator corresponding to the geographical location of the meteorological office originating or compiling the meteorological bulletin;

c) a date-time group;

d) if required, a three-letter indicator.

Note 1.— Detailed specifications on format and contents of the heading are given in the WMO Manual on the Global Telecommunications System, *Volume I and are reproduced in the ICAO* Manual of Aeronautical Meteorological Practice *(Doc 8896).*

Note 2.— ICAO location indicators are listed in ICAO Doc 7910 — Location Indicators.

11.2.5 Meteorological bulletins containing operational meteorological information to be transmitted via the aeronautical fixed telecommunication network (AFTN) shall be encapsulated in the text part of the AFTN message format.

11.3 Use of aeronautical fixed service communications — world area forecast system products

11.3.1 **Recommendation.—** *World area forecast system products in grid point or chart forms should be transmitted using binary data communications or digital facsimile techniques. The method and channels used for the dissemination of the products should be as determined by regional air navigation agreement.*

11.3.2 **Recommendation.—** *Where world area forecast system products are disseminated in chart form, the quality of the charts received should be such as to permit reproduction in a sufficiently legible form for flight planning and documentation. Charts received should be legible over 95 per cent of their area.*

11.3.3 **Recommendation.—** *Transmissions should be such as to ensure that their interruption should not exceed 10 minutes during any period of 6 hours.*

11.3.4 Meteorological bulletins containing WAFS products in digital form to be transmitted via aeronautical fixed service facilities shall contain a heading as given in 11.2.4.

11.4 Use of aeronautical mobile service communications

11.4.1 The contents and format of reports, forecasts and SIGMET information transmitted to aircraft shall be consistent with the provisions of Chapters 4, 6 and 7 of this Annex.

11.4.2 **Recommendation.—** *The contents and format of air-reports transmitted by aircraft should be consistent with the provisions of Chapter 5 of this Annex and of the* Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services *(PANS-RAC, Doc 4444), Appendix 1.*

11.4.3 The substance of a meteorological bulletin transmitted via the aeronautical mobile service shall remain unchanged from that contained in the bulletin as originated.

11.5 Use of aeronautical broadcasting service — contents of VOLMET broadcasts

11.5.1 Continuous VOLMET broadcasts, normally on very high frequencies (VHF), shall contain current aerodrome weather reports, with trend parts where available.

11.5.2 Scheduled VOLMET broadcasts, normally on high frequencies (HF), shall contain current aerodrome reports, with trend parts where available and, where so determined by regional air navigation agreement, aerodrome forecasts.

11.5.3 **Recommendation.—** *The aerodromes for which reports and forecasts are to be included in VOLMET broadcasts, the sequence in which they are to be transmitted and the broadcast time should be determined by regional air navigation agreement.*

11.5.4 **Recommendation.—** *When a report has not arrived from an aerodrome in time for a broadcast, the latest available report should be included in the broadcast, together with the time of observation.*

11.5.5 **Recommendation.—** *Aerodrome forecasts included in scheduled VOLMET broadcasts should have a period of validity of 9 hours; they should be issued every 3 hours and should, between these routine issues, be amended as necessary to ensure that a forecast, when transmitted, reflects the latest opinion of the meteorological office concerned.*

11.5.6 **Recommendation.—** *SIGMET messages should be included in scheduled VOLMET broadcasts if determined by regional air navigation agreement. Where this is done, the SIGMET message or an indication of "NIL SIGMET" should be transmitted at the beginning of the broadcast or of a five-minute time block.*

11.5.7 **Recommendation.—** *The contents and format of reports, forecasts and SIGMET information included in VOLMET broadcasts should be consistent with the provisions of Chapters 4, 6 and 7 of this Annex, as applicable to bulletins disseminated beyond the aerodrome of origin.*

APPENDIX. FLIGHT DOCUMENTATION — MODEL CHARTS AND FORMS

(See 9.4 to 9.8 of this Annex)

MODEL A1 — Aerodrome forecasts (tabular form)

MODEL A2 — Aerodrome forecasts (TAF code form)

MODEL TA1 — Tabular forecast of en-route conditions

MODEL TA2 — Tabular forecast of en-route conditions

MODEL TB — Tabular forecast of upper winds and upper-air temperatures
Example 1 — Spot locations
Example 2 — Grid mesh (from WINTEM)

MODEL IS — Upper wind and temperature chart for standard isobaric surface
Example 1 — Arrows and feathers (Mercator projection)
Example 2 — Arrows and feathers (Polar stereographic projection)

MODEL SWH — Significant weather chart (high level)
Example 1 — Mercator projection
Example 2 — Polar stereographic projection

MODEL SWM — Significant weather chart (medium level)

MODEL SWL — Significant weather chart (low level)
Example 1
Example 2

MODEL SN — Sheet of notations used in flight documentation

Model A1. Aerodrome forecasts (tabular form)

ISSUED BY .... METEOROLOGICAL OFFICE DATE .... TIME ....(UTC)

HEIGHTS ABOVE AERODROME ELEVATION

Aerodrome	Period of validity (UTC)	Type and time of change	Surface wind mean direction (Degrees true) mean windspeed maximum windspeed	Surface visibility (minimum)	Significant weather	Cloud: Lowest layer amount, height of base (feet) and type (if CB)	Cloud: Higher layers amount, height of base (feet) and type (if CB)	Remarks
MOMBASA	06-06	TEMPO 09-12	150/15 KT VRB/20 KT MAX 30 KT	10 KM 200 M	HVY SHRA	FEW 1500 SCT 1000 CB	BKN 1500	
NAIROBI	03-15	PROB 40 TEMPO 03-05 BECMG 05-06	060/05 KT VRB/03 KT 060/10 KT	2000 M 500 M 10 KM	FG NSW	OVC 0200 SCT 1500		EXTRACTED FROM TAF 00-24
KHARTOUM	12-18	PROB 30 TEMPO 12-15	030/05 KT 030/20 KT	10 KM 100 M	MOD BLSA	SCT 2500		EXTRACTED FROM TAF 06-06
CAIRO	06-06		060/10 KT	C A V O K				
ROME	12-06	FM 1400 FM 1800	270/10 KT 270/10 KT 330/15 KT	2000 M 5000 M 10 KM	HVY DZRA MOD RA NSW	BKN 500 BKN 1200 BKN 2500	OVC 1500 OVC 2000	TAF 06-06 AMENDED

Model A2. Aerodrome forecasts (TAF code form)

ISSUED BY.......................... METEOROLOGICAL OFFICE (DATE, TIME UTC)............

INTENSITY

" – " (light); no indicator (moderate); " + " [heavy or well-developed in the case of dust/sand whirls (dust devils) and funnel clouds] are used to indicate the forecast intensity of certain phenomena

DESCRIPTORS

MI – shallow
BC – patches
PR – partial
DR – low drifting
BL – blowing
SH – shower(s)
TS – thunderstorm
FZ – freezing (supercooled)

FORECAST WEATHER ABBREVIATIONS

DZ – drizzle
RA – rain
SN – snow
SG – snow grains
IC – ice crystals (diamond dust)
PE – ice pellets
GR – hail
GS – small hail and/or snow pellets
BR – mist
FG – fog
FU – smoke
VA – volcanic ash
DU – widespread dust
SA – sand
HZ – haze
PO – dust/sand whirls (dust devils)
SQ – squall
FC – funnel cloud(s) (tornado or waterspout)
SS – sandstorm
DS – duststorm

EXAMPLES

+SHRA – heavy shower of rain
FZDZ – moderate freezing drizzle
+TSSNGR – heavy thunderstorm with snow and hail
TSSN – moderate thunderstorm with snow
SNRA – moderate snow and rain

SELECTED ICAO LOCATION INDICATORS

YSSY	Sydney	HKNA	Nairobi/Jomo Kenyatta	OBBI	Bahrain
CYMX	Montreal/Mirabel	KJFK	New York/Kennedy	RJTT	Tokyo
EDDF	Frankfurt	LFPG	Paris/Charles de Gaulle	SBGL	Rio de Janeiro
EGLL	London/Heathrow	NZAA	Auckland	ZBAA	Beijing/Capital

RJTT	122130Z	130024 VRB03KT 4000 SCT025 BECMG 0305 9999 =
EGLL	090845Z	091212 27010KT 9999 SCT020 BKN080 FM2100 30015KT 3000 FZDZ BKN006 0VC060 FM0000 30015KT 0800 +RASN BKN004 0VC060 BECMG 0305 33020KT 5000 NSW SCT020 BKN100 BECMG 0709 9999 =
LFPG	160910Z	161212 10008KT CAVOK FM2000 VRB03KT 8000 SCT012 FM0400 VRB03KT 0800 FG FM0900 10008KT CAVOK =
OBBI	030300Z	030624 03010KT 9999 SCT010 PROB30 TEMPO 0915 03030KT 0500 BLSA FM1800 VRB02KT 8000 SCT020 =
HKNA	280215Z	280624 06010KT 9999 SCT025 TEMPO 1216 3000 SHRA BKN015 PROB40 TEMPO 1416 VRB20G30KT +TSRA SCT010CB BKN015 =

1/1/96

Model TA1. Tabular forecast of en-route conditions

DATE..		HEIGHTS IN FEET ABOVE MSL
ROUTE FROM ......BIGGIN HILL........TO.....AMSTERDAM..........VIA..........AIRWAYS..........		
VALID FOR DEPARTURE BETWEEN ......1500......UTC AND......1700......UTC AND FOR ARRIVAL BETWEEN ....1700...........UTC AND......2100.....UTC		
SPECIAL FEATURES OF THE METEOROLOGICAL SITUATION: ACTIVE COLD FRONT FROM HUMBER TO CHANNEL ISLES AT 1000 UTC MOVING EAST AT 20 KNOTS TO LIE NORTH/SOUTH ACROSS TRACK ABOUT 40 NM WEST OF AMSTERDAM BY 1900 UTC.		
ZONE	LONDON 02 ° E	AMSTERDAM
UPPER WINDS (DEGREES TRUE AND KNOTS) TEMPERATURES (DEGREES CELSIUS) 10 000 ft 5000 ft 2000 ft	280/30 MS 12 290/25 MS 03 290/20 PS 03	250/45 MS 09 240/35 00 230/30 PS 06
CLOUD	SCT CU 18 000/1500 BKN SC 10 000/2500 BKN AC LYR 18 000/12 000	ISOL EMBD CB 30 000/1000 BKN ST 800/500 OVC SC AS LYR 24 000/2000
SURFACE VISIBILITY	1500 M IN SHOWERS	5000 M IN RAIN AND 1000 M IN THUNDERSTORMS
SIGNIFICANT WEATHER	OCNL RAIN SHOWERS MODERATE OCNL SEVERE ICING 10 000/3500 MODERATE TURBULENCE IN CU 18 000/1500	MODERATE/HEAVY RAIN ISOL THUNDERSTORMS MODERATE OCNL SEVERE ICING 13 000/5000 MODERATE OCNL SEVERE TUBULENCE IN CB AND FRONTAL ZONE 30 000/1000
HEIGHT OF O°C ISOTHERM	3500	5000
FORECAST LOWEST MSL PRESSURE (hPa)	1008	1004
SUPPLEMENTARY INFORMATION		

Issued by .... **at**.............**UTC on**...................**19**... **by**...............**Forecaster.**

Notes: 1. Positive and negative values are indicated by the prefix "PS" (plus) and "MS" (minus) respectively.
2. When a single numerical value of an element is given in a forecast it is to be interpreted as representing the most probable mean of a range of values which the element may assume during the period of the forecast.

Abbreviations: SKC—O oktas, FEW—1 to 2 oktas, SCT—3 to 4 oktas, BKN—5 to 7 oktas, OVC—8 oktas, LYR—Layered, LOC—Locally, ISOL—Isolated, OCNL—Occasional, FRQ—Frequent, EMBD—Embedded.

Model TA2. Tabular forecast of en-route conditions

DATE .... HEIGHTS IN PRESSURE ALTITUDE IN HUNDREDS OF FEET

ROUTE FROM ...... BIGGIN HILL ...... TO ...... AMSTERDAM ...... VIA ...... AIRWAYS ......

VALID FOR DEPARTURE BETWEEN ...... 1500 ...... UTC AND ...... 1700 ...... UTC AND
FOR ARRIVAL BETWEEN ...... 1700 ...... UTC AND ...... 2100 ...... UTC

SPECIAL FEATURES OF THE METEOROLOGICAL SITUATION (SURFACE CENTRES AND FRONTS):

ACTIVE COLD FRONT FROM HUMBER TO CHANNEL ISLES AT 1000 UTC MOVING EAST AT 20 KNOTS TO LIE NORTH/SOUTH ACROSS TRACK ABOUT 40 NM WEST OF AMSTERDAM BY 1900 UTC.

ZONE	LONDON 02 ° E	AMSTERDAM
UPPER WINDS FL 300 (DEGREES TRUE AND KNOTS) FL 240 TEMPERATURES FL 180 (DEGREES CELSIUS) FL 100	250/50 MS 52 260/40 MS 40 270/35 MS 26 280/30 MS 12	230/65 MS 50 240/60 MS 36 240/50 MS 24 250/45 MS 09
SIGNIFICANT WEATHER AND ASSOCIATED CLOUD	MODERATE TURBULENCE IN SCT CU 180/015	MODERATE TO SEVERE ICING AND TURBULENCE IN ISOL EMBD CB 300/010
HEIGHT OF O°C ISOTHERM	035	050
* TROPOPAUSE HEIGHT	———	———
* JET STREAM	———	———
SUPPLEMENTARY INFORMATION		

* Above planned cruise level if not specified

Issued by .... at .... 1400 .... UTC on .... 19 ... by .... Forecaster.

Notes : 1. Pressure altitude is the height in feet of a level in the standard atmosphere above the datum level corresponding to a pressure of 1013.2 hPa

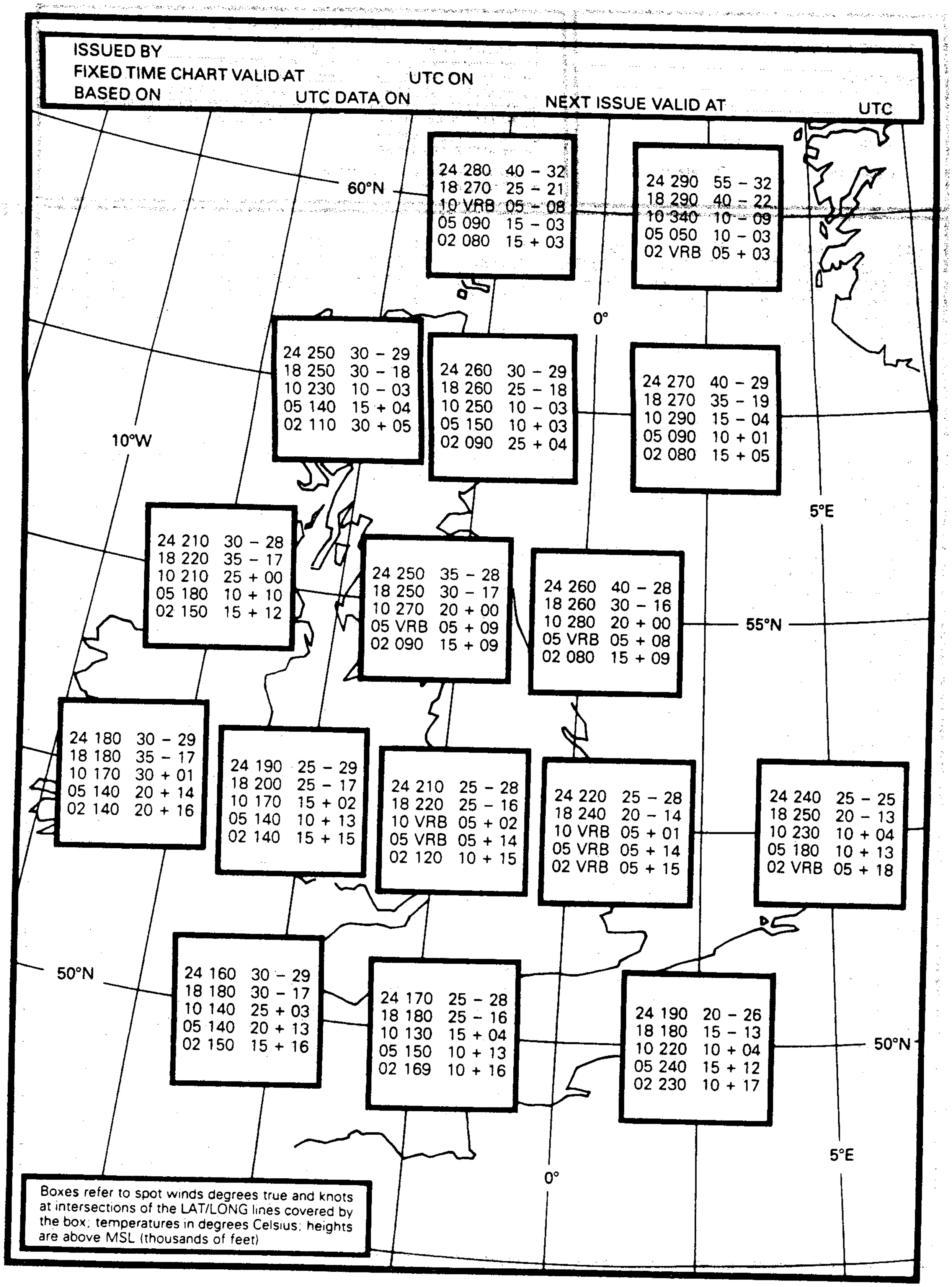
2. Positive and negative values are indicated by the prefix "PS" (plus) and "MS" (minus) respectively.

3. Only cloud associated with significant weather is shown. Low stratus and fog, when expected, will be shown for terminal areas in appropriate aerodrome forecasts.

4. When a single numerical value of an element is given in a forecast, it is to be interpreted as representing the most probable mean of a range of values which the element may assume during the period of the forecast.

Abbreviations : SKC—O oktas, FEW—1 to 2 oktas, SCT—3 to 4 oktas, BKN—5 to 7 oktas, OVC—8 oktas, LYR—Layered, LOC—Locally, ISOL—Isolated, OCNL—Occasional, FRQ—Frequent, EMBD—Embedded.

Model TB. Tabular forecast of upper winds and upper-air temperatures
Example 1 — Spot locations



Model TB. Tabular forecast of upper winds and upper-air temperatures
Example 2 — Grid mesh (from WINTEM)

GRID POINT FORECAST	
ISSUED BY	
At	UTC
Valid	UTC
Based on	UTC data on

DATA PRESENTATION

	Legend
FL of tropopause	FL = Flight level
FL, dd, fff of maximum wind	dd = wind direction (tens of degrees)
dd, fff, MTT FL450/150 hPa	fff = wind speed (knots)
dd, fff, MTT FL390/200 hPa	TT = temperature (°C) preceded by M or P as appropriate
dd, fff, MTT FL340/250 hPa	
dd, fff, MTT FL300/300 hPa	
dd, fff, MTT FL240/400 hPa	
dd, fff, MTT FL180/500 hPa	

Forecast values apply to centre points of 5°C squares of superimposed grid

10°S

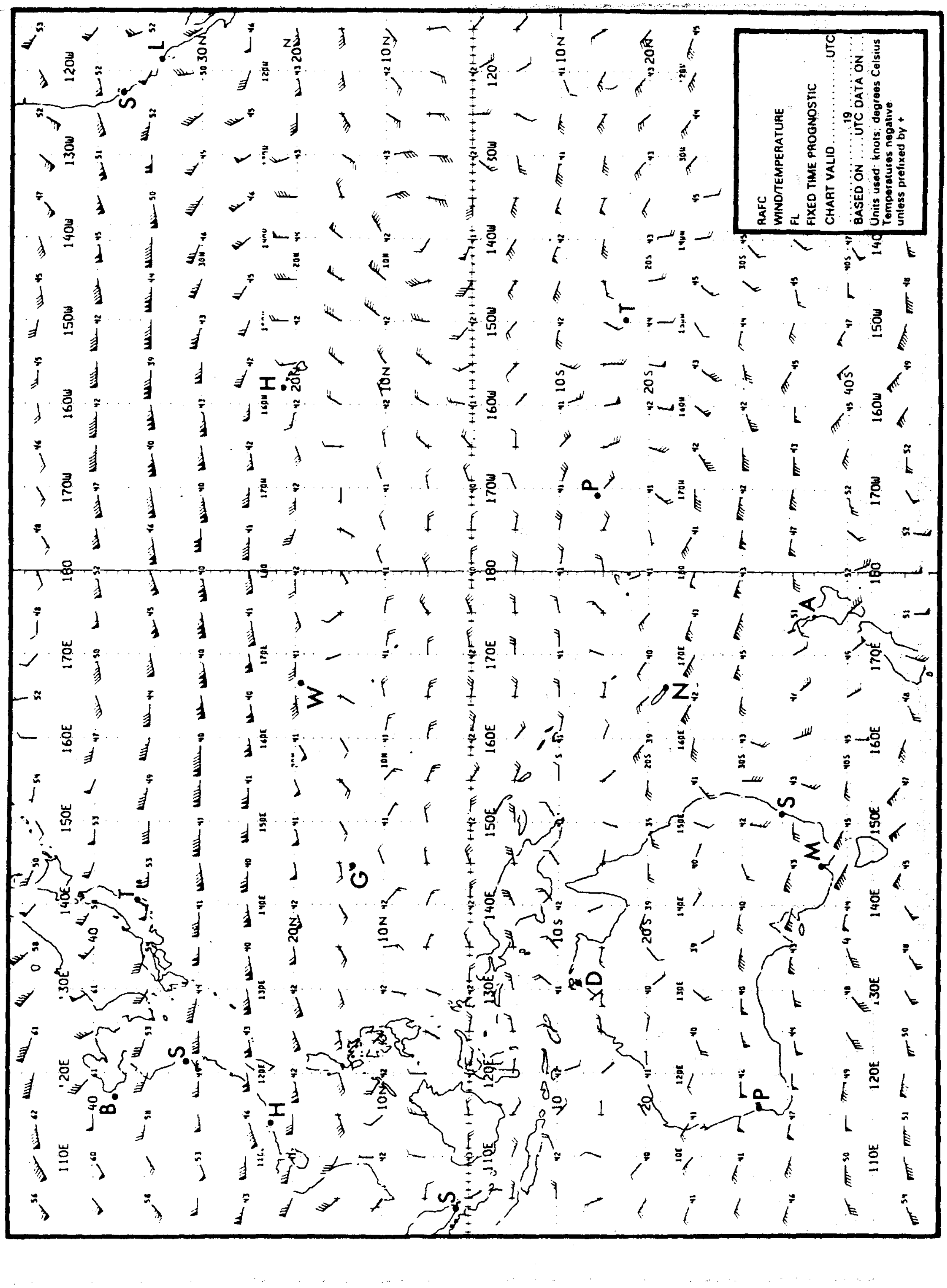
540	540	550	550	550	540	540	530	530
43006020	42002015	39031020	37030030	39030030	37030030	36032030	37033025	37035020
06015M66	08010M66	10010M66	35005M66	31010M66	18010M66	16015M66	15015M66	12015M67
35010M56	35010M55	31020M56	30025M57	30030M57	29020M58	32020M58	34020M59	36015M59
02010M44	01010M44	31015M44	31025M45	31025M45	31020M45	33020M45	33020M45	32010M45
33005M34	30005M34	36005M33	36010M34	29020M34	32025M34	34025M34	30020M33	28015M33
35005M18	35005M18	33010M18	34010M18	28020M19	28020M18	29015M19	31015M18	31010M18
20005M06	23005M06	21005M06	34005M07	04005M07	34005M07	32005M07	35010M06	04015M06
480	500	540	550	550	540	540	520	520
40032025	39032020	39024020	37038045	38027050	39027050	38027060	38030060	38029050
32020M64	29015M65	25005M66	21005M66	25010M66	26020M85	25025M65	26025M65	24015M65
33025M56	32020M56	29020M56	28040M57	27045M58	27050M58	28050M59	30055M58	30040M58
30020M44	29020M45	28020M45	28040M45	28040M45	27040M45	29050M46	30055M45	29045M42
29025M33	29015M33	28015M33	28050M34	28045M34	28040M34	29050M35	29055M34	28060M32
29020M18	28015M18	31010M18	29030M19	27025M19	27020M20	26035M19	28040M19	30040M17
29015M07	28010M06	35010M06	32015M07	23010M08	23005M09	23030M08	26035M07	33035M06
460	480	500	520	520	500	480	460	460
36029100	38032065	38030055	38028040	38026060	38026055	38025110	37027130	32027150
31060M61	31040M64	29040M65	26030M66	26045M66	26040M65	27050M64	27070M62	27075M61
31080M54	32060M57	30050M57	27035M57	26055M58	26050M58	28075M57	28095M53	27110M53
29095M41	30055M45	30045M46	28030M45	26050M44	27045M47	26090M43	28100M38	28100M40
30095M34	28060M34	29050M34	28035M34	26050M34	27050M35	26100M33	27100M31	30095M34
30065M20	30040M19	30035M19	29025M19	25035M20	25035M21	24080M21	27075M21	31080M20
31045M00	31030M08	31025M07	29020M08	25020M10	22030M10	23070M11	26055M13	30080M13
390	410	430	450	410	400	390	320	300
37031170	39031125	39031090	38028070	39026080	38024115	38022140	31026100	29030150
29110M56	30095M60	30065M63	27060M64	26050M63	25065M63	25080M62	25065M55	28070M51
29050M52	31125M54	31090M56	28065M58	26080M57	24110M58	25115M56	26085M48	30140M47
30155M42	30120M45	31080M47	30055M48	25070M49	24110M50	24120M43	25080M41	30145M45
30145M37	30115M37	30080M37	30060M36	25065M38	24105M38	24110M33	26080M37	30135M42
30115M26	31090M24	30060M23	29045M22	25040M24	23075M24	22085M24	24050M29	29080M31
30090M17	32075M15	31045M12	28035M11	25020M12	22050M14	21070M18	20040M22	28040M24
320	350	400	430	400	390	360	280	260
31030160	30031150	37031170	39029110	37024120	37022145	31022115	31023070	26031075
29105M50	30110M57	30105M61	28090M62	27080M62	26085M63	23070M60	24035M54	29035M50
30150M49	31140M55	30130M54	29110M57	24115M60	22140M61	23105M57	23060M48	32070M48
30135M44	31150M47	30135M48	29100M52	24115M54	22140M53	23110M47	23065M45	31060M49
30120M41	31135M41	30095M40	30070M41	23080M43	20130M41	22100M39	22065M46	31050M48
29085M32	32100M29	31080M27	31045M26	23040M28	20080M28	20085M29	20050M33	27015M34
29060M25	33080M20	31065M18	32025M15	25010M17	20045M19	18060M22	18030M24	19025M23
290	340	360	380	370	350	300	280	280
28029105	31032140	35031155	27029130	36027120	35022120	28018120	26019060	27020040
27045M50	30075M56	30095M59	30090M61	28085M62	26070M61	23040M59	23035M54	27025M51
29105M50	31135M57	31135M56	29120M60	26105M64	22105M62	22095M58	21045M52	27020M49
29100M51	31135M54	31120M56	31105M59	26095M60	21110M58	22105M54	21045M53	27025M49
29080M48	32135M47	32105M48	31080M47	25075M47	20105M47	21090M45	19045M49	22025M50
31035M36	33095M33	33085M33	32065M31	26040M32	20065M32	19080M32	18080M35	20030M36
02015M26	34065M23	34070M21	33055M20	30020M21	21035M21	19065M23	18040M25	19035M25
				370	350	320	300	300
				36027100	33024070	31020050	29016050	29014040
				28080M60	26065M60	25045M59	26025M56	24020M53
				28090M66	24065M64	22045M61	19020M56	19015M53
				27070M65	23055M63	20040M59	17035M56	16020M54
				28060M52	23045M52	20040M50	16040M52	14030M53
				29050M35	25035M35	20035M35	16045M37	14035M38
				31045M22	25030M23	20035M24	16045M26	15035M27

20°S — 30°S — 40°S

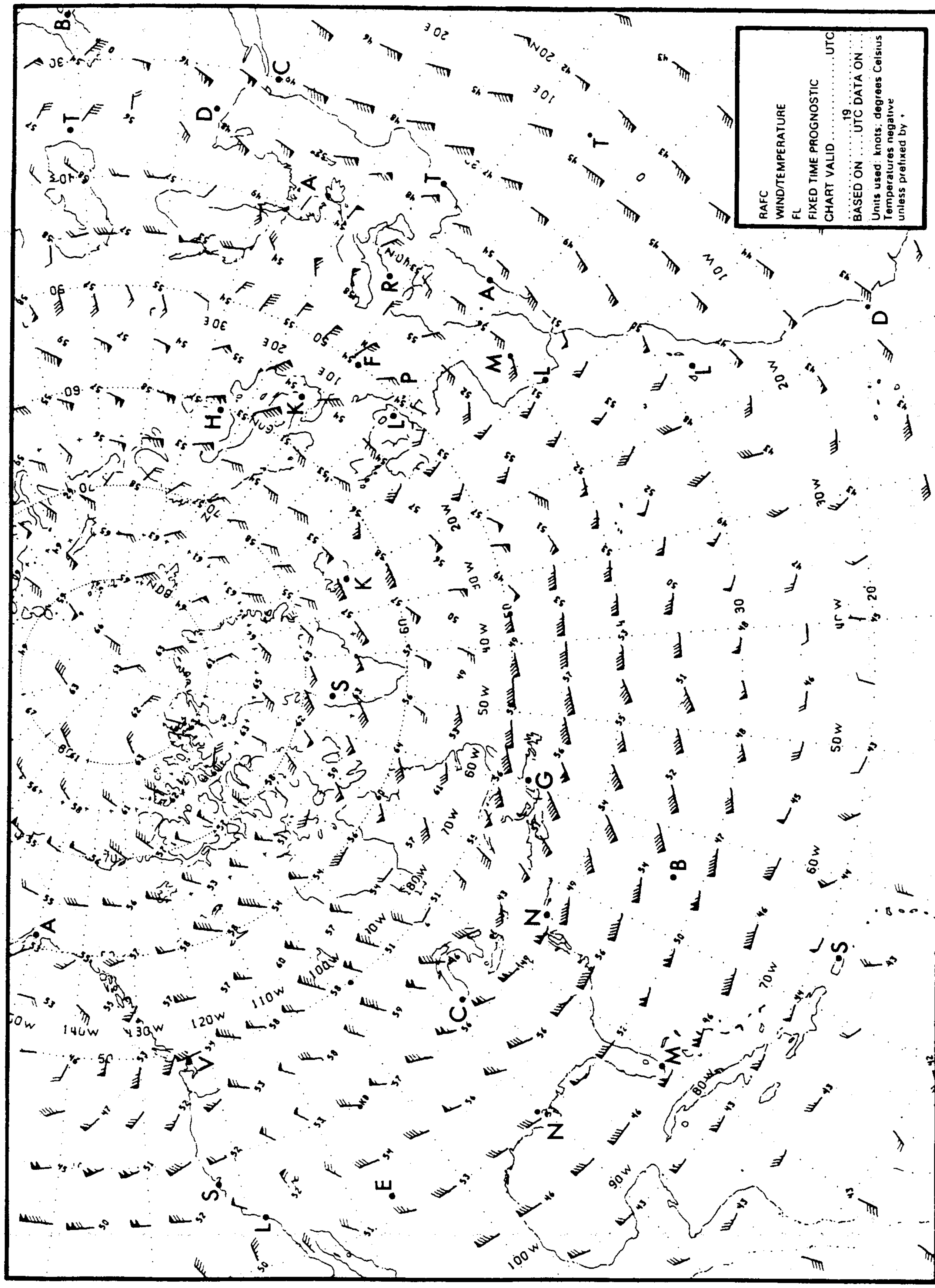
110°E 120°E 130°E 140°E 150°E

1/1/96

Model IS. Upper wind and temperature chart for standard isobaric surface
Example 1 — Arrows and feathers (Mercator projection)

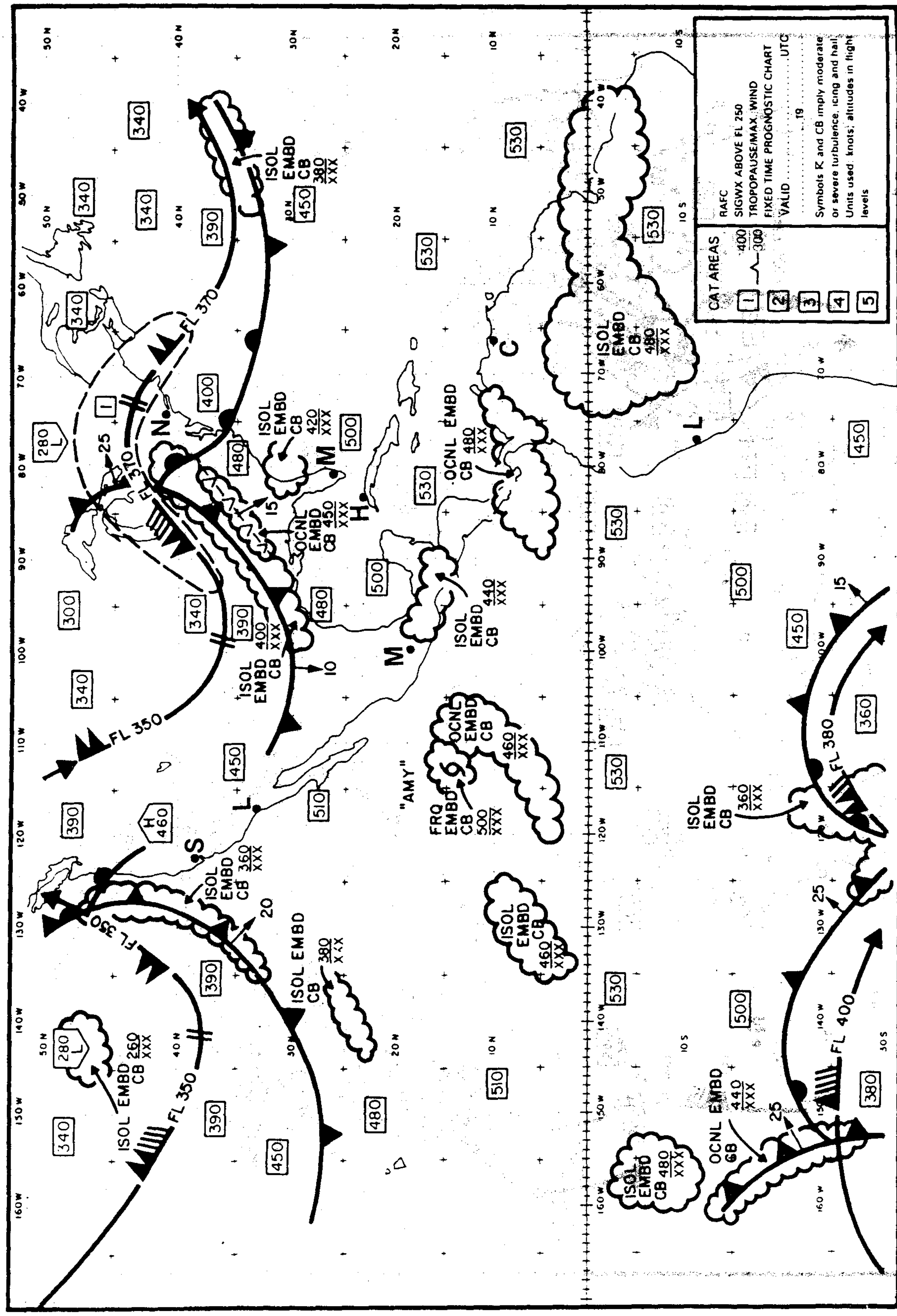


Model IS. Upper wind and temperature chart for standard isobaric surface
Example 2 — Arrows and feathers (Polar stereographic projection)

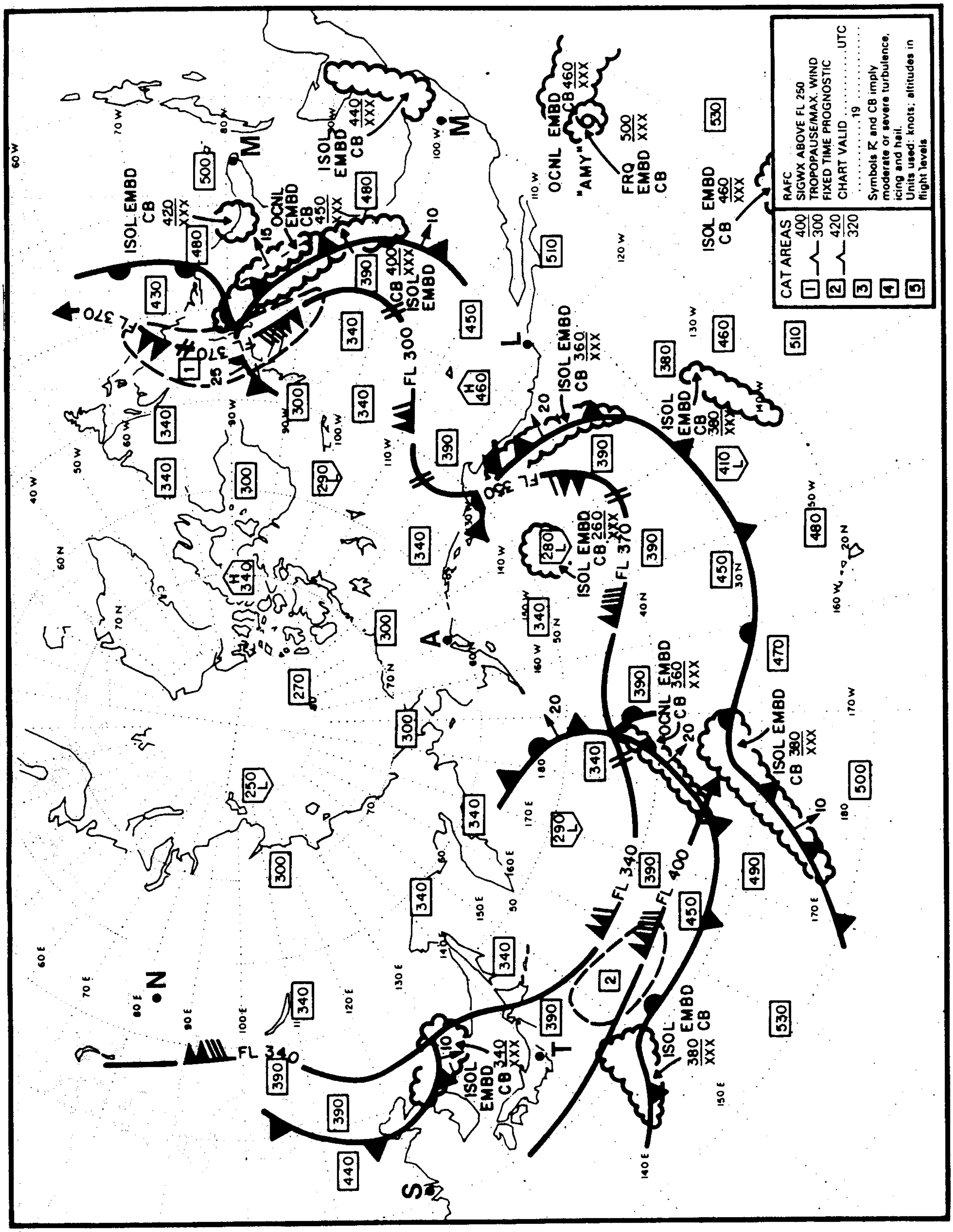


1/1/96

Model SWH. Significant weather chart (high level)
Example 1 — Mercator projection

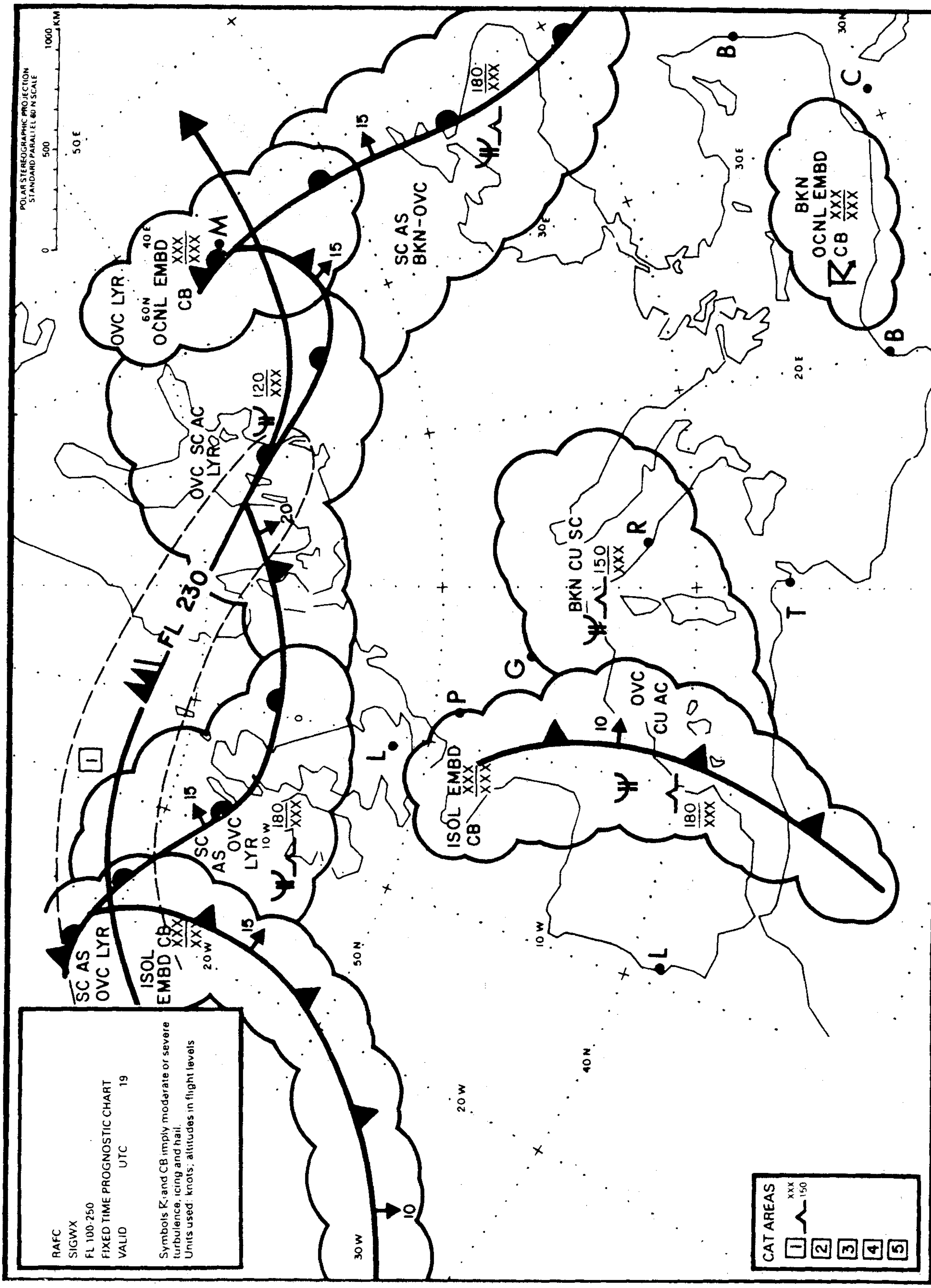


Model SWH. Significant weather chart (high level)
Example 2 — Polar stereographic projection

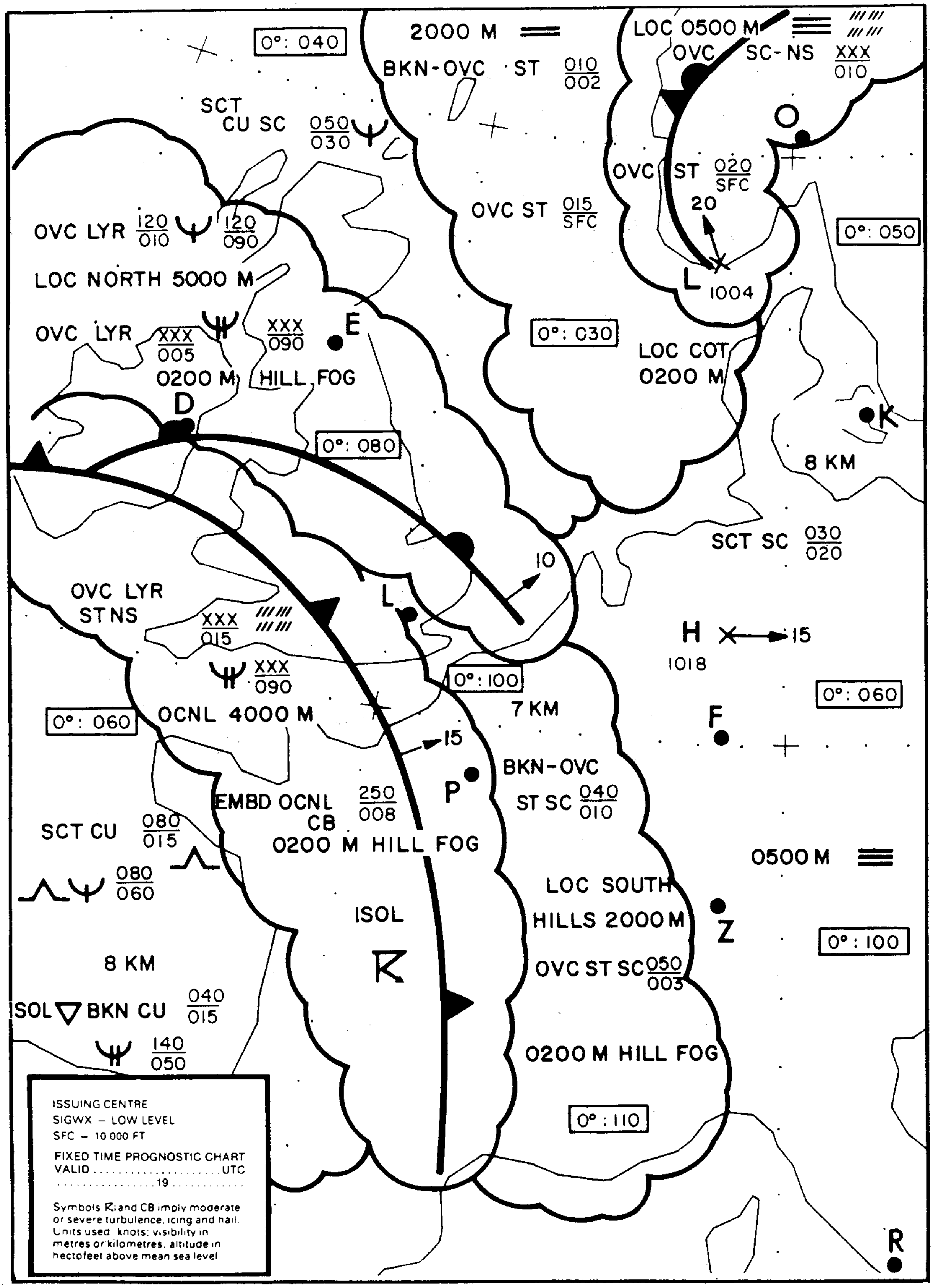


1/1/96

Model SWM. Significant weather chart (medium level)

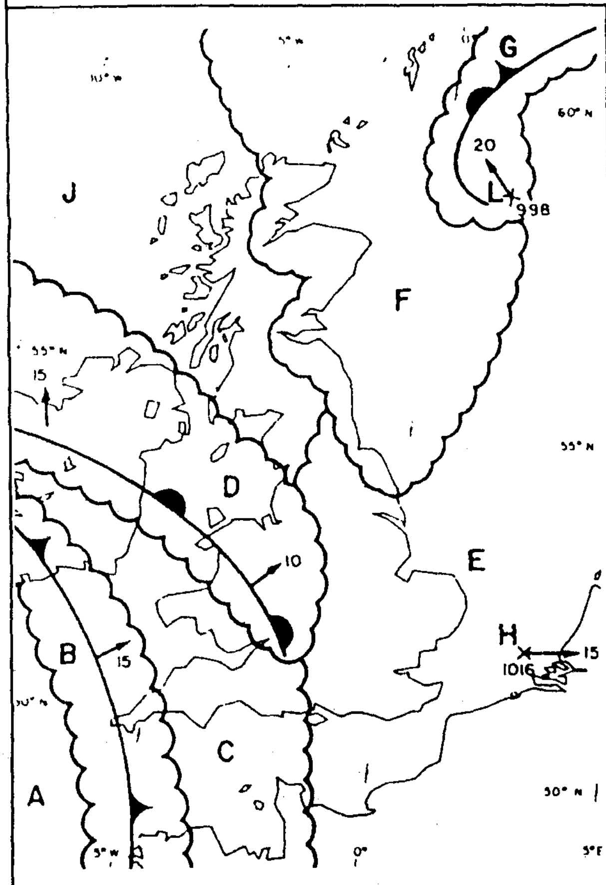


Model SWL. Significant weather chart (low level)
Example 1



Model SWL. Significant weather chart (low level)
Example 2

FIXED TIME CHART VALID. . . . . .UTC. . . . . .19. . . BASED ON. . . . . .UTC DATA ON . . . .



VARIANT	VIS	WEATHER	CLOUD, TURBULENCE, ICING	0°C
AREA A	10		SCT CU 025/080 050/080	50
ISOL	8	SHOWERS	BKN CU 015/XXX 050/XXX	
AREA B	10	RAIN	OVC LYR ST NS 015/XXX 050/XXX	50
OCNL	4000	HEAVY RAIN	EMBD CB 008/XXX HILL FOG	
ISOL	1000	THUNDERSTORM		
AREA C	7		BKN to OVC ST SC 010/040	100
LOC SOUTH COT HILLS	2000	DRIZZLE	OVC ST SC 003/050 HILL FOG	
AREA D	10	RAIN	OVC LYR SC NS 010/XXX 090/XXX	90
LOC NORTH	5000	RAIN	OVC LYR ST NS 005/XXX 090/XXX HILL FOG	
AREA E	8		SCT SC 020/030	40
LOC LAND	0500	FOG		
AREA F	2000	MIST	BKN to OVC ST 020/010	30
LOC COT HILLS	0200	FOG	OVC ST SFC/015	
AREA G	5000	RAIN	OVC CU SC NS 010/XXX 030/150	30
LOC NORTH	0500	FOG	OVC ST SFC/010	
AREA J	10		SCT CU SC 030/050 040/050	40
LOC HILLS NORTH			MOD CAT BLW 070	

SIGWX BELOW 10 000 FT
ISSUED BY. . . . . .AT . . . . .UTC

Note: 1. Pressure in hPa and speeds in knots.
2. Vis in m or km. Hill fog implies vis 200M or less.
3. Altitude in hectofeet above MSL XXX = above 10 000 ft.
4. ꝶ and CB imply MOD/SEV icing and turbulence.

WARNING AND/OR REMARKS:
EAST TO NE GALES SHETLAND TO HEBRIDES - SEVERE MOUNTAIN WAVES NW SCOTLAND - FOG PATCHES EAST ANGLIA - WDSPR FOG OVER NORTH FRANCE, BELGIUM AND HOLLAND

Model SN. Sheet of notations used in flight documentation

1. Symbols for significant weather

Thunderstorms	Drizzle
Tropical cyclone	Rain
Severe squall line*	Snow
Moderate turbulence	Shower
Severe turbulence	Widespread blowing snow
Mountain waves	Severe sand or dust haze
Slight aircraft icing	Widespread sandstorm or duststorm
Moderate aircraft icing	Widespread haze
Severe aircraft icing	Widespread mist
Widespread fog	Widespread smoke
Hail	Freezing precipitation **
Volcanic eruption***	

* In flight documentation for flights operating up to FL 100, this symbol refers to "squall line".

** This symbol does not refer to icing due to precipitation coming into contact with an aircraft which is at a very low temperature.

*** The following information referring to the symbol should be included in the side of the chart.
Volcanic eruption
Name of volcano (if known)
Latitude/longitude
Date and time of the first eruption (if known)
Check SIGMETs for volcanic ash

Note — Height indications between which phenomena are expected, top above base as per chart legend.

2. Fronts and convergence zones and other symbols used

Cold front at the surface	Position, speed and level of max. wind (FL 270)
Warm front at the surface	Convergence line
Occluded front at the surface	0°:100 Freezing level
Quasi-stationary front at the surface	Intertropical convergence zone
H 460 Tropopause High	10 State of the sea
270 L Tropopause Low	18 Sea surface temperature
380 Tropopause Level	

FL 300 — FL 340

The double bar denotes changes of level by 3000 ft or less and/or wind speeds by 37 km/h-20 kt. in the example, at the double bar the wind speed is 225 km/h-120kt.

The heavy line delineating the jet axis begins/ends at the points where a wind speed of 150 km/h-80 kt is forecast.

3. Abbreviations used to describe clouds

3.1 Type

CI = Cirrus
CC = Cirrocumulus
CS = Cirrostratus
AC = Altocumulus
AS = Altostratus
NS = Nimbostratus
SC = Stratocumulus
ST = Stratus
CU = Cumulus
CB = Cumulonimbus

3.2 Amount

Clouds except CB
SKC = sky clear (0/8)
FEW = few (1/8 to 2/8)
SCT = scattered (3/8 to 4/8)
BKN = broken (5/8 to 7/8)
OVC = overcast (8/8)

CB only
ISOL = individual CBs (isolated)
OCNL = well-separated CBs (occasional)
FRQ = CBs with little or no separation (frequent)
EMBD = CBs embedded in layers of other clouds or concealed by haze (embedded)

3.3 Heights

Heights are indicated on SWH and SWM charts in flight levels (FL), top over base. When XXX is used, tops or bases are outside the layer of the atmosphere to which the chart applies.
In SWL charts:
i) heights are indicated as altitudes above mean sea level
ii) the abbreviation SFC is used to indicate ground level

4. Depicting of lines and systems on specific charts

4.1 Models SWH and SWM — Significant weather charts (high and medium)

Scalloped line = demarcation of areas of significant weather
Heavy broken line = delineation of area of CAT
Heavy solid line interrupted by wind arrow and flight level = position of jet stream axis with indication of wind direction, speed in kt or km/h and height in flight levels
Figures on arrows = speed in kt or km/h of movements of frontal system
Flight levels inside small rectangles = height in flight levels of tropopause at spot locations, e.g. 340. Low and High points of the tropopause topography are indicated by the letters L or H respectively inside a pentagon with the height in flight levels.

4.2 Model SWL — Significant weather chart (low level)

X = position of pressure centres given in hectopascals
L = centre of low pressure
H = centre of high pressure
Scalloped lines = demarcation of area of significant weather
Dashed lines = altitude of 0°C isotherm in feet (hectofeet) or metres. Note: 0°C level may also be indicated by 0° : 060, i.e. 0°C level is at an altitude of 6000 ft
Figures on arrows = speed in kt or km/h of movement of frontal systems, depressions or anticyclones

Figure inside the state of the sea symbol = total wave height in feet or metres

Figure inside the sea surface temperature symbol = sea surface temperature in °C.

4.3 Arrows and feathers

Arrows indicate direction. Number of pennants and/or feathers correspond to speed.
Example:

270°/115 kt (equivalent to 213 km/h)
Pennants correspond to 50 kt or 93 km/h
Feathers correspond to 10 kt or 18 km/h
Half-feathers correspond to 5 kt or 9 km/h

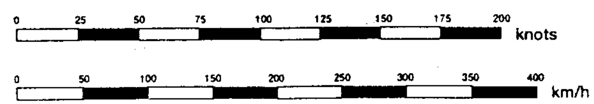
Conversion of knots into kilometres per hour

Kilometres per hour

knots	0	1	2	3	4	5	6	7	8	9
00	0	1.85	3.70	5.56	7.41	9.26	11.11	12.96	14.82	16.67
10	18.52	20.37	22.22	24.08	25.93	27.78	29.63	31.48	33.34	35.19
20	37.04	38.89	40.74	42.60	44.45	46.30	48.15	50.00	51.86	53.71
30	55.56	57.41	59.26	61.12	62.97	64.82	66.67	68.52	70.38	72.23
40	74.08	75.93	77.78	79.64	81.49	83.34	85.19	87.04	88.90	90.75
50	92.60	94.45	96.30	98.16	100.01	101.86	103.71	105.56	107.42	109.27
60	111.12	112.97	114.82	116.68	118.53	120.38	122.23	124.08	125.94	127.79
70	129.64	131.49	133.34	135.20	137.05	138.90	140.75	142.60	144.46	146.31
80	148.16	150.01	151.86	153.72	155.57	157.42	159.27	161.12	162.98	164.83
90	166.68	168.53	170.38	172.24	174.09	175.94	177.79	179.64	181.50	183.35
100	185.20	187.05	188.90	190.76	192.61	194.46	196.31	198.16	200.02	201.87
110	203.72	205.57	207.42	209.28	211.13	212.98	214.83	216.68	218.54	220.39
120	222.24	224.09	225.94	227.80	229.65	231.50	233.35	235.20	237.06	238.91
130	240.76	242.61	244.46	246.32	248.17	250.02	251.87	253.72	255.58	257.43
140	259.28	261.13	262.98	264.84	266.69	268.54	270.39	272.24	274.10	275.95
150	277.80	279.65	281.50	283.36	285.21	287.06	288.91	290.76	292.62	294.47
160	296.32	298.17	300.02	301.88	303.73	305.58	307.43	309.28	311.14	312.99
170	314.84	316.69	318.54	320.40	322.25	324.10	325.95	327.80	329.66	331.51
180	333.36	335.21	337.06	338.92	340.77	342.62	344.47	346.32	348.18	350.03
190	351.88	353.73	355.58	357.44	359.29	361.14	362.99	364.84	366.70	368.55

kt:	200	210	220	230	240	250	260	270	280	290
km/h:	370.40	388.92	407.44	425.96	444.48	463.00	481.52	500.04	518.56	537.08
kt:	300	310	320	330	340	350	360	370	380	390
km/h:	535.60	574.12	592.64	611.16	629.68	648.20	666.72	685.24	703.76	722.28
kt:	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
km/h:	0.19	0.37	0.56	0.74	0.93	1.11	1.30	1.48	1.67	

1 knot = 1.852 kilometres per hour



ATTACHMENT A. GUIDANCE ON AREA FORECASTS IN ABBREVIATED PLAIN LANGUAGE

(See 3.2.13, 3.2.14, 3.3.1 and 3.3.9 of this Annex)

PART 1 — FORMAT FOR ABBREVIATED PLAIN-LANGUAGE SIGNIFICANT WEATHER FORECAST MESSAGES AND AMENDMENTS THERETO TO SERVE INTERNATIONAL CIVIL AVIATION IN OPERATIONS ABOVE FLIGHT LEVEL 250

1. Specifications

1.1 For the purpose of these instructions, "abbreviated plain language" refers to a language conveying to aeronautical personnel a directly intelligible meaning through the use of abbreviations (except signals of the Q code) approved by ICAO and numerical values of self-explanatory nature supplemented, if suitable ICAO-approved abbreviations are not available, by other words taken with their usual meaning in aviation.

Note.— ICAO-approved abbreviations are published in ICAO Doc 8400, Procedures for Air Navigation Services — ICAO Abbreviations and Codes. *Signals of the Q code should not be used in abbreviated plain-language significant weather area forecast messages.*

1.2 In abbreviated plain-language significant weather forecast messages, the term "CB" should be understood to include pertinent weather phenomena normally associated with cumulonimbus, namely thunderstorms, moderate or severe turbulence, moderate or severe icing, and hail.

1.3 An abbreviated plain-language significant weather forecast message should be consistent with the significant weather forecast chart from which it was derived.

1.4 The format should be as follows:

a) World Meteorological Organization abbreviated heading.

b) Type of message; applicable vertical range; valid time; area to which the forecast message relates. Describe the forecast area by reference to latitude, to longitude, to latitude/longitude coordinates, to major geographical features, or to any combination thereof. Describe, in the same manner, any part of the area for which a significant weather forecast cannot be given because of lack of data.

c) Synopsis. Include descriptions of significant weather features, such as tropical cyclones, surface positions of frontal systems and well-defined convergence zones; their forecast positions; their speed and direction of movement; and intensification or weakening, if considered significant. Give forecast positions as in b). Describe direction of movement in terms of eight points of the compass related to true north; give speed of movement in kilometres per hour or knots.

d) Significant weather phenomena. Describe areas as in b). Describe the amount of cumulonimbus as ISOL EMBD CB (individual embedded cumulonimbus) or ISOL CB IN HAZE (individual cumulonimbus concealed in haze); OCNL EMBD CB (well separated embedded cumulonimbus) or OCNL CB IN HAZE (well separated cumulonimbus concealed in haze); or FRQ CB (cumulonimbus clouds with little or no separation). Describe cumulonimbus clouds contained in layers of other clouds as EMBD. Give bases and tops of significant weather phenomena as flight level (FL). If no significant weather is forecast, enter the term "SIGWX NIL".

Note.— Give bases of significant weather phenomena only if expected to be at or above the lowest level of the atmosphere for which the forecast is prepared. Similarly, give the tops of significant weather phenomena only if expected to be at or below the highest level of the atmosphere for which the forecast is prepared.

e) Turbulence. This should include turbulence, other than that associated with cumulonimbus, if expected to be moderate or severe, and the intensity thereof. Describe areas as in b). Give bases and tops of phenomenon as FL. If no turbulence in this category is forecast, no entry for turbulence should be given.

Note.— See Note under 1.4 d) for similar application.

f) Volcanic eruptions. Include information on the location of volcanic eruptions which are producing ash clouds of significance to aircraft operations, name of volcano and time of first eruption, if known, together with a reminder to users that reference should be made to SIGMETs issued for the area concerned.

2. Examples

Examples of abbreviated plain-language significant weather messages are given below.

Example 1

FAPN13 KWBC 101200
AREA FCST FL250 TO FL450 VALID 110000 FOR AREA 37N135E 48N108W 28N130W 28N158E 37N135E.

SYNOPSIS. COLD FRONT 45N179W 33N179W MOV E 20 KT. COLD FRONT 43N152W 44N140W 35N131W 29N134W MOV NE 15 KT INTSF.

SIGWX NIL

TURB. MOD CAT FL260 TO FL340 36N140E 36N150E 34N141E 36N140E. MOD CAT FL280 TO FL380 41N133W 45N125W 42N117W 40N120W 41N133W.

Example 2

FAEWI EJJJ 101300
AREA FCST FL250 TO FL450 VALID 110000 FOR AREA 50N20W 50N20E 30N20E 30N20W 50N20W.

SYNOPSIS. NO MAJOR WX SYSTEM.

SIGWX NIL.

Example 3

FANT10 KWBC 101200
AREA FCST FL250 TO FL600 VALID 110000 FOR AREA 55N88W 50N42E 33N13E 27N59W 55N88W.

SYNOPSIS. WARM FRONT 42N84W 43N79W 39N62W MOV NE 30 KT. OCCLUDED FRONT 63N40W 60N25W 50N29W MOV E 35 KT. COLD FRONT 50N29W 40N43W 31N60W MOV SE 10 KT INTSF.

SIGWX AND ASSOCIATED CLD. ISOL EMBD CB TOPS FL340 55N20E 55N30E 46N34E 44N24E 55N20E.

TURB. MOD CAT FL250 TO FL340 46N41W 53N40W 56N28W 50N32W 46N41W. MOD CAT FL250 TO FL350 62N30W 67N13W 63N08W 61N20W 62N30W.

Example 4

FANT10 KWBC 101400 AMD
AMD AREA FCST FL250 TO FL600 VALID 110000 FOR AREA 55N88W 50N42E 33N13E 27N59W 55N88W.

SYNOPSIS. NO MAJOR WX SYSTEM.

SIGWX AND ASSOCIATED CLD. FRQ CB TOPS FL480 48N80W 46N65W 41N65W 45N79W 48N80W.

OTHER AMD NIL.

Example 5

FAXT1 KWBC 101200
AREA FCST FL250 TO FL600 VALID 110000 FOR AREA 50N160W 50N43W 20S43W 20S160W 50N160W. FCST NIL FOR AREA SOUTH OF EQUATOR DUE LACK OF DATA.

SYNOPSIS. WARM FRONT 41N85W 43N80W 39N70W 39N61W MOV NE 30 KT. COLD FRONT 41N85W 29N94W MOV SE 25 KT. STNR FRONT 40N43W 30N63W. COLD FRONT 49N132W 45N130W 40N133W 30N144W MOV NE 15 KT INTSF.

SIGWX NIL.

TURB. MOD CAT FL280 TO FL380 41N116W 44N120W 45N125W 43N130W 42N133W 41N130W 39N116W 41N116W. MOD CAT FL280 TO FL380 44N105W 41N109W 39N105W 44N105W. MOD CAT FL240 TO FL350 50N70W 50N81W 44N87W 42N85W 45N75W 48N70W 50N70W.

PART 2 — FORMAT FOR ABBREVIATED PLAIN-LANGUAGE SIGNIFICANT WEATHER FORECAST MESSAGES AND AMENDMENTS THERETO TO SERVE INTERNATIONAL CIVIL AVIATION IN OPERATIONS BETWEEN FLIGHT LEVELS 100 AND 250

1. Specifications

1.1 For the purpose of these instructions, "abbreviated plain language" refers to a language conveying to aeronautical personnel a directly intelligible meaning through the use of abbreviations (except signals of the Q code) approved by ICAO and numerical values of self-explanatory nature supplemented, if suitable ICAO-approved abbreviations are not available, by other words taken with their usual meaning in aviation.

Note.— ICAO-approved abbreviations are published in ICAO Doc 8400, Procedures for Air Navigation Services — ICAO Abbreviations and Codes. *Signals of the Q code should not be used in abbreviated plain-language significant weather area forecast messages.*

1.2 In abbreviated plain-language significant weather forecast messages, the term "CB" should be understood to include pertinent weather phenomena normally associated with cumulonimbus, namely thunderstorms, moderate or severe turbulence, moderate or severe icing, and hail.

1.3 An abbreviated plain-language significant weather forecast message should be consistent with the significant weather forecast chart from which it was derived.

1.4 The format should be as follows:

a) World Meteorological Organization abbreviated heading.

b) Type of message; applicable vertical range; valid time; area to which the forecast message relates. Describe the forecast area by reference to latitude, to longitude, to latitude/longitude coordinates, to major geographical features, or to any combination thereof. Describe, in the same manner, any part of the area for which a significant weather forecast cannot be given because of lack of data.

c) Synopsis. Include descriptions of significant weather features, such as tropical cyclones, surface positions of frontal systems and well-defined convergence zones; their forecast positions; their speed and direction of movement; and intensification or weakening, if considered significant. Give forecast positions as in b). Describe direction of movement in terms of eight points of the compass related to true north; give speed of movement in kilometres per hour or knots.

d) Significant weather phenomena and associated clouds. Describe areas as in b). Give cloud amounts, except for cumulonimbus clouds, in terms of FEW (1 to 2 oktas), SCT (3 to 4 oktas), BKN (5 to 7 oktas), or OVC (8 oktas). Describe the amount of cumulonimbus as ISOL EMBD CB (individual embedded cumulonimbus) or ISOL CB IN HAZE (individual cumulonimbus concealed in haze); OCNL EMBD CB (well separated embedded cumulonimbus) or OCNL CB IN HAZE (well separated cumulonimbus concealed in haze); or FRQ CB (cumulonimbus clouds with little or no separation). Describe cumulonimbus clouds contained in layers of other clouds as EMBD. Give bases and tops of significant weather phenomena and associated clouds as flight level (FL). If no significant weather is forecast, enter the term "SIGWX NIL".

e) Turbulence. This should include turbulence, other than that associated with cumulonimbus, if expected to be moderate or severe, and the intensity thereof. Describe areas as in b). Give bases and tops of phenomenon as FL. If no turbulence in this category is forecast, no entry for turbulence should be given.

f) Icing. This should include icing, other than that associated with cumulonimbus, if expected to be moderate or severe, and the intensity thereof. Should also include icing in area(s) of forecast, freezing precipitation. Describe areas as in b). Give bases and tops of phenomenon as FL. If aircraft icing, other than that associated with cumulonimbus, is not forecast, no entry for icing should be given.

g) Volcanic eruptions. Include information on the location of volcanic eruptions which are producing ash clouds of significance to aircraft operations, name of volcano and time of first eruption, if known, together with a reminder to users that reference should be made to SIGMETs issued for the area concerned.

Note.— Give bases of significant weather phenomena (and associated clouds, if any) only if expected to be at or above the lowest level of the atmosphere for which the forecast is prepared. Similarly, give the tops of significant weather phenomena (and associated clouds, if any) only if expected to be at or below the highest level of the atmosphere for which the forecast is prepared.

2. Examples

Examples of abbreviated plain-language significant weather messages are given on the following page.

Example 1

FAPN16 KWBC 101200
AREA FCST FL100 TO FL250 VALID 110000 FOR AREA 37N135E 48N108W 28N130W 28N158E 37N135E.

SYNOPSIS. COLD FRONT 45N179W 33N179W MOV E 20 KT. COLD FRONT 43N152W 44N140W 35N131W 29N134W MOV NE 15 KT INTSF.

SIGWX NIL

ICE. MOD ICE INC FL100 TO FL180 42N140W 46N145W 47N138W 42N140W.

Example 2

FANT14 KWBC 101200
AREA FCST FL100 TO FL250 VALID 110000 FOR AREA 55N88W 50N42E 33N13E 27N59W 55N88W.

SYNOPSIS. WARM FRONT 42N84W 43N79W 39N62W MOV NE 30 KT. OCCLUDED FRONT 63N40W 60N25W 50N29W MOV E 35 KT. COLD FRONT 40N29W 40N43W 31N60W MOV SE 10 KT INTSF.

SIGWX AND ASSOCIATED CLD. ISOL EMBD CB 44N20E 55N30E 46N34E 44N24E 44N20E.

TURB. MOD CAT BASE FL240 47N41W 53N40W 56N28W 50N32W 47N41W. MOD CAT BASE FL250 62N30W 67N13W 63N08W 61N20W 62N30W.

ICE. MOD ICE INC FL100 TO FL130 55N03W 49N08W 43N00W 44N10E 50N14E 55N03E.

Example 3

FANT14 KWBC 101400 AMD
AMD AREA FCST FL100 TO FL250 VALID 110000 FOR AREA 55N88W 40N42E 33N13E 27N59W 55N88W.

SYNOPSIS. WARM FRONT 42N84W 43N79W 39N62W MOV NE 10 KT INTSF.

SIGWX AND ASSOCIATED CLD. FRQ CB 48N80W 46N65W 41N65W 45N79W 48N80W INTSF.

OTHER AMD NIL.

PART 3 — FORMAT FOR MESSAGES CONTAINING ABBREVIATED PLAIN-LANGUAGE AMENDMENTS TO UPPER-AIR FORECASTS

1. Specifications

1.1 For the purpose of these instructions, "abbreviated plain language" refers to a language conveying to aeronautical personnel a directly intelligible meaning through the use of abbreviations (except signals of the Q code) approved by the International Civil Aviation Organization (ICAO) and numerical values of self-explanatory nature supplemented, if suitable ICAO-approved abbreviations are not available, by other words taken with their usual meaning in aviation.

Note.— ICAO-approved abbreviations are published in ICAO Doc 8400, Procedures for Air Navigation Services — ICAO Abbreviations and Codes. *Signals of the Q code should not be used in abbreviated plain-language messages issued as amendments to relevant upper-air wind and temperature forecasts.*

1.2 Abbreviated plain-language amendments to upper-air forecasts should be understood to apply to all relevant forecasts prepared by world and regional area forecast centres for any specified area, level and valid time(s). Such forecasts could include meteorological charts, grid point data in numerical form and grid point data in digital form.

1.3 The area and levels for which amendments to upper-air forecasts are to be issued should be described with regard to horizontal dimensions by applicable latitude/longitude coordinates and with regard to vertical dimensions by applicable ICAO flight levels related to standard constant pressure surfaces.

1.4 To minimize the possibility of misinterpretation of the amendments, the procedures given below should be followed:

a) amendments should be issued in abbreviated plain language as an amended area forecast under a World Meteorological Organization abbreviated heading, using as date time group the standard time of observation in UTC on which the original forecast was based;

b) the amendment criteria given by Annex 3, 3.2.11 should be followed;

c) the valid time(s) to which an amendment is intended to apply should be given in terms of 12, 18, 24 and/or 30 hours following the standard time in UTC on which the original forecast was based;

d) the area to which an amendment to be issued is intended to apply should be described as a four-sided polygon in terms of latitude/longitude intersections giving corner coordinates of the polygon. To minimize the risk of misinterpretation, the corner coordinates should be given in a clockwise or counter-clockwise sequence. Latitude should be given in whole degrees (two digits) followed by N (north) or S (south). Longitude should be given in whole degrees (three digits) followed by E (east) or W (west);

e) the ICAO flight levels to which an amendment is intended to apply should be given in the text of the amendment messages;

f) amendments to forecasts of wind speed should be given in terms of percentage increase, using three digits (010, 020, 030, 120 and so forth) preceded by PS (plus) or of percentage decrease (010, 020, 030 and so forth up to a maximum decrease of 099) preceded by MS (minus);

g) amendments to forecasts of wind direction should be given in terms of clockwise or counter-clockwise rotation from the forecast being amended, using three digits (010, 020 and so forth up to 180) preceded by CW (for clockwise) or CC (for counter-clockwise); and

h) amendments to upper-air temperature forecasts should be given in three digits as absolute increases or decreases, in degrees Celsius, preceded by PS (plus) or MS (minus).

Note.— No entry should be made for any feature for which an amendment is not being issued.

2. Examples

Examples of messages containing amendments to upper-air forecasts are given on the following page.

Example 1

FXPA1 KWBC 241200 AMD
AMD AREA FCST

SPEED CHANGE PER CENT INCR (PS) OR DECR (MS).
DIRECTION CHANGE CLOCKWISE (CW) OR COUNTER-CLOCKWISE (CC).
TEMPERATURE CHANGE ABSOLUTE INCR (PS) OR DECR (MS).

AMEND WIND AND TEMPERATURE FORECAST IN AREA 38N160E 46N160E 47N178W 35N178W.
AMENDMENT VALID 18 HR 24 HR AND 30 HR AFTER 241200.

AMENDMENT FOR	FL250	FL300	FL340	FL390
WIND SPEED/PER CENT	PS035	PS035	PS035	PS035
WIND DIRECTION/DEG	CC020	CC020	CC020	CC020
TEMPERATURE/DEG C	PS005	PS005	PS005	PS005

AMEND WIND AND TEMPERATURE FORECAST IN AREA 47N177W 40N161W 30N161W 35N177W.
AMENDMENT VALID 18 HR 24 HR AND 30 HR AFTER 241200.

AMENDMENT FOR	FL250	FL300	FL340	FL390
WIND SPEED/PER CENT	MS025	MS040	MS050	MS040

Example 2

FXPA2 KWBC 241200 AMD
AMD AREA FCST

SPEED CHANGE PER CENT INCR (PS) OR DECR (MS).
DIRECTION CHANGE CLOCKWISE (CW) OR COUNTER-CLOCKWISE (CC).
TEMPERATURE CHANGE ABSOLUTE INCR (PS) OR DECR (MS).

AMEND WIND AND TEMPERATURE FORECAST IN AREA 33N143E 43N147E 45N159E 33N159E.
AMENDMENT VALID 18 HR AND 24 HR AFTER 241200.

AMENDMENT FOR	FL250	FL300	FL340	FL390
WIND SPEED/PER CENT	PS040	PS050	PS070	PS050
WIND DIRECTION/DEG	CW020	CW020	CW020	CW020
TEMPERATURE/DEG C	MS005	MS008	MS010	MS008

ATTACHMENT B. OPERATIONALLY DESIRABLE AND CURRENTLY ATTAINABLE ACCURACY OF MEASUREMENT OR OBSERVATION

Note.— The guidance contained in this table relates to Chapter 4 — Meteorological observations and reports, in particular to 4.1.12

Element to be observed	*Operationally desirable accuracy of measurement or observation*	*Attainable* accuracy of measurement or observation (1994)*
Mean surface wind	Direction: ± 10° Speed: ± 2 km/h (1 kt) up to 19 km/h (10 kt) ± 10% above 19 km/h (10 kt)	Direction: ± 5° Speed: ± 2 km/h (1 kt) up to 37 km/h (20 kt) ± 5% above 37 km/h (20 kt)
Variations from the mean surface wind	± 4 km/h (2 kt), in terms of longitudinal and lateral components	as above
Visibility	± 50 m up to 600 m ± 10% between 600 m and 1 500 m ± 20% above 1 500 m	± 50 m up to 500 m ± 10% between 500 m and 2 000 m ± 20% above 2 000 m up to 10 km
Runway visual range	± 10 m up to 400 m ± 25 m between 400 m and 800 m ± 10% above 800 m	± 25 m up to150 m ± 50 m between 150 m and 500 m ± 10% above 500 m up to 2 000 m
Cloud amount	± 1 okta	In daylight an observer can attain an accuracy of ± 1 okta at the point of observation. In darkness, and when atmospheric phenomena limit the viewing of low cloud, there will be difficulty in attaining that accuracy.
Cloud height	± 10 m (33 ft) up to 100 m (330 ft) ± 10% above 100 m (330 ft)	± 10 m (33 ft) up to 1 000 m (3 300 ft) ± 30 m (100 ft) above 1 000 m (3 300 ft) up to 3 000 m (10 000 ft)
Air temperature and dew point temperature	± 1°C	± 0.2 °C
Pressure value (QNH, QFE)	± 0.5 hPa	± 0.3 hPa

* The accuracy stated refers to assessment by instruments (except for cloud amount): it is not normally attainable in observations made without the aid of instruments.

ATTACHMENT C. SELECTED CRITERIA APPLICABLE TO AERODROME REPORTS

(The guidance in this table relates to Chapter 4 — Meteorological observations and reports, 4.5 to 4.12 inclusive)

	Surface wind			Visibility (VIS)			RVR[1] (A: −10, B: −5, C: OBS TIME) (Time, MIN)			Present weather	Cloud: Amount				Cloud: Type[2]	Temperature	Pressure (QNH, QFE)		Supplementary information
Specifications	Directional variations[3] ≥ 6 0° Mean speed		Speed variations[3]	Directional variations[4]	Special cases		Past tendency[5] $\mid \bar{R}_{5(AB)} - \bar{R}_{5(BC)} \mid$		Variations[5]		Layers reported if coverage								
	≤ 6 km/h (3 kt)	> 6 km/h (3 kt)	Exceeding the mean speed by ≥ 20 km/h (10 kt)	General rule	VIS ≥ 1.5× Minimum VIS in one or more directions	Minimum VIS < 1 500 m and VIS > 5 km in another direction	< 100 m	≥ 100 m	$\mid \bar{R}_1 - \bar{R}_{10} \mid > MAX[50\ m\ or\ 20\% \times \bar{R}_{10}]$	No general criteria applicable to all the WX phenomena (for specific criteria see 4.8.4-4.8.7)	Lowest layer	Next layer >	Next higher layer >	CB[6] or TCU	Identification		Parameters reported	Updated if changes > agreed magnitude	Parameter to be included
Take-off	2 min [7] 2 extreme directions	2 min 2 extreme directions	2 min Minimum and maximum speed	N/A	N/A	N/A	1 min N/A[8]	N/A	1 min N/A		Always	2/8	4/8	Always	CB TCU	No criteria	QNH QFE[9]	Yes	All[10]
Landing	2 min VRB[11] (no extremes)	2 min 2 extreme directions	2 min Minimum and maximum speed	N/A	N/A	N/A	1 min N/A	N/A	1 min N/A		Always	2/8	4/8	Always	CB TCU		QNH QFE[9]	Yes	All[10]
METAR	10 min VRB[11] (no extremes)	10 min 2 extreme directions	10 min Maximum speed[12]	Minimum VIS	Minimum VIS + direction	Minimum VIS + direction, and higher VIS + direction	10 min No tendency observed ("N")	Upward ("U") or downward ("D")	1 min Minimum and maximum (instead of 10-minute mean)		Always	2/8	4/8	Always	CB TCU		QNH	No	Recent WX of operational significance and wind shear[13]
Relevant reporting scales for all messages	Direction in three figures *rounded* off to the nearest 10 degrees (degrees 1-4 down, degrees 5-9 up)		Speed in 1 km/h or 1 kt Speed < 2 km/h (1 kt) indicated as CALM	*If* VIS < 500 m; 500 ≤ VIS < 5 000 m; 5 000 m ≤ VIS < 10 km; VIS ≥ 10 km	*Step applicable*: 50 m; 100 m; 1 km; None, given as 10 km or covered under CAVOK		*If* RVR ≤ 800 m; RVR > 800 m. The following subset of the above reporting scale is applied in EUR Region: RVR < 400 m; 400 ≤ RVR ≤ 800 m; RVR > 800 m	*Step applicable*: 25 – 60 m; 100 m[14]. 25 m; 50 m; 100 m		N/A	*If* Base ≤ 3 000 m (10 000 ft); Base > 3 000 m (10 000 ft) (Reference level: Aerodrome elevation[15] or mean sea level for off-shore structures)			*Step applicable*: 30 m (100 ft); 300 m (1 000 ft)		Rounded off to whole degrees: up (down) for decimals 5-9 (1-4)	In whole hPa[16] *rounding* down for decimals 1-9[17]		N/A

Notes.—

1. Considered for the past 10 minutes (exception: if the 10-minute period includes *a marked discontinuity* (i.e. RVR changes or passes 150; 350, 600 or 800 m, lasting ≥ 2 minutes), only data after the discontinuity to be used). A simple diagrammatic convention is used to illustrate those parts of the 10-minute period prior to the observation relevant to RVR criteria, i.e. AB, BC and AC.
2. Layer composed of CB and TCU *with a common base* should be reported as "CB".
3. Considered for the past 10 minutes (exception: if the 10-minute period includes *a marked discontinuity* (i.e. the direction changes ≥ 30° with a speed ≥ 20 km/h *or* the speed changes ≥ 20 km/h lasting ≥ 2 minutes), only data after the discontinuity to be used).
4. If several directions, the most operationally significant direction used.
5. Let $\bar{R}_1$ = any 1-minute mean RVR-value during period AC, $\bar{R}_{10}$ = 10-minute mean RVR-value during period AC, $\bar{R}_{5(AB)}$ = 5-minute mean RVR-value during period AB and $\bar{R}_{5(BC)}$ = 5-minute mean RVR-value during period BC.
6. CB (cumulonimbus) and TCU (towering cumulus = cumulus congestus of great vertical extent) if not already indicated as one of the other layers.
7. Time averaging, if applicable, indicated in the upper left-hand corner.
8. N/A = not applicable.
9. QFE is to be included if required.
10. As listed in 4.12.1 to 4.12.5.
11. Also used at higher wind speeds where it is not possible to report a mean wind direction (e.g. a thunderstorm passing over the aerodrome).
12. According to the WMO *Manual on Codes* (WMO — No. 306) paragraph 15.4.5 "It is recommended that the wind measuring systems should be such the peak gusts should represent a three-second average."
13. Also sea-surface temperature and state of the sea from off-shore structures. Other information may only be inserted in accordance with regional air navigation agreement.
14. Report if RVR and/or VIS < 1 500 m, limits for assessments 50 and 1 500 m.
15. For landing at aerodromes with precision approach runways and with the threshold elevation ≥ 15 m below the aerodrome elevation, the *threshold elevation* to be used as a reference.
16. Measured in 0.1 hPa.
17. Reference elevation for QFE should be aerodrome elevation except for precision approach runways, and non-precision approach runways with threshold ≥ 2 m (7 ft) below aerodrome elevation, where the reference level should be the relevant threshold elevation.

ATTACHMENT D. CONVERSION OF TRANSMISSOMETER READINGS INTO RUNWAY VISUAL RANGE

(See 4.7.7 of this Annex)

1. The conversion of transmissometer readings into runway visual range is based on Koschmieder's Law or Allard's Law, depending on whether the pilot can be expected to obtain his main visual guidance from the runway and its markings or from the runway lights. In the interest of standardization in runwây visual range assessments, this Attachment provides guidance on the use and application of the main conversion factors to be used in these computations.

2. In Koschmieder's Law one of the factors to be taken into account is the pilot contrast threshold. The agreed constant to be used for this is 0.05 (dimensionless)

3. In Allard's Law the corresponding factor is the illumination threshold. This is not a constant, but a continuous function dependent on the background luminance. The agreed relationship to be used in transmissometer systems with continuous adjustment of the illumination threshold by a background luminance sensor is shown by the curve in Figure D-1.

4. In transmissometer systems without continuous adjustment of the illumination threshold, the use of four equally spaced illumination threshold values with agreed corresponding background luminance ranges is convenient. The four values are shown in Figure D-1 in the form of a step function; they are tabulated in Table D-1 for greater clarity.

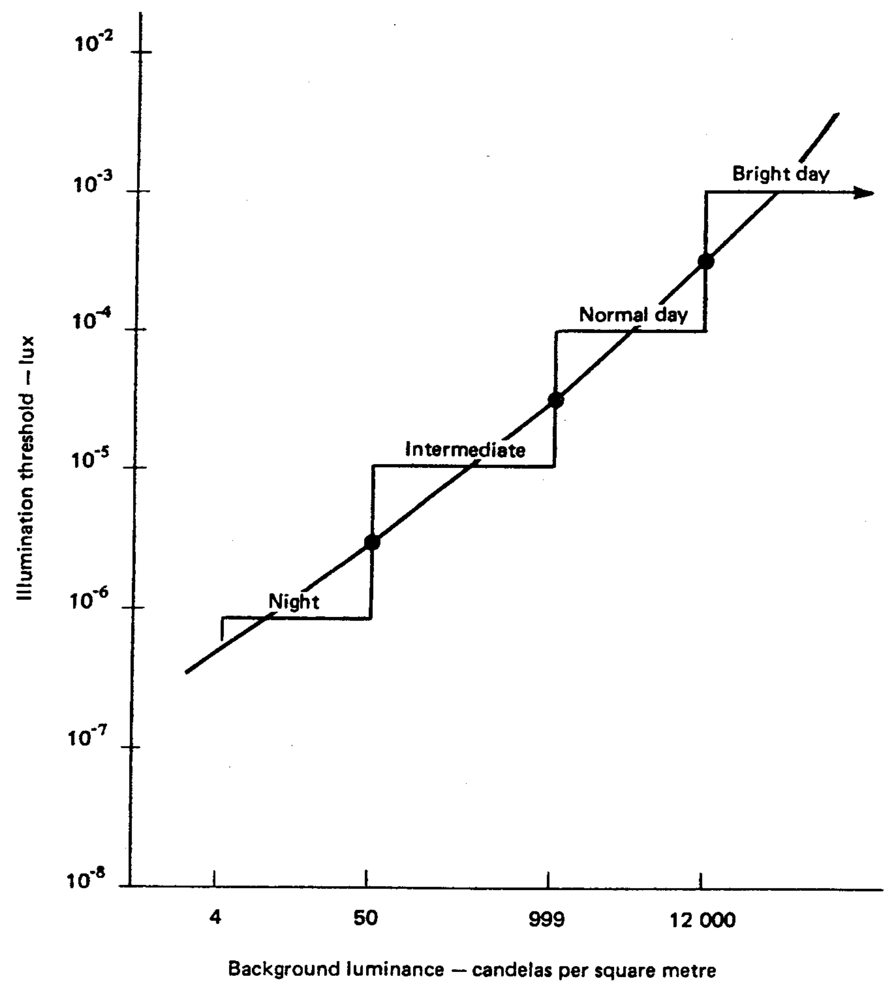


Figure D-1.

5. In transmissometer systems of the kind referred to in 4 above, values for illumination threshold other than those indicated by the step function and by Table D-1 may be used, provided they give corresponding or slightly lower values of runway visual range. The number of illumination threshold values to be used at any location will depend on the frequency of occurrence and on the duration of various levels of background luminance. For example, in some areas two values may be found adequate.

Note.— Information and guidance material on the runway lights to be used for assessment of runway visual range are contained in the ICAO Manual of Runway Visual Range Observing and Reporting Practices *(Doc 9328).*

Table D-1

	Illumination threshold	*Background luminance*
Night	8×10^{-7} lux	4 to 50 cd/m^2
Intermediate value	10^{-5} lux	51 to 999 cd/m^2
Normal day	10^{-4} lux	1 000 to 12 000 cd/m^2
Bright day (e.g. sunlit fog)	10^{-3} lux	more than 12 000 cd/m^2

ATTACHMENT E. OPERATIONALLY DESIRABLE ACCURACY OF FORECASTS

Note 1.— The guidance contained in this table relates to Chapter 6 — Forecasts, in particular to 6.1.1.

Note 2.— If the accuracy of the forecasts remains within the operationally desirable range shown in the second column, for the percentage of cases indicated in the third column, the effect of forecast errors is not considered serious in comparison with the effects of navigational errors and of other operational uncertainties.

Element to be forecast	*Operationally desirable accuracy of forecasts*	*Minimum percentage of cases within range*
	AERODROME FORECAST	
Wind direction	± 30°	80% of cases
Wind speed	± 9 km/h (5 kt) up to 46 km/h (25 kt) ± 20% above 46 km/h (25 kt)	80% of cases
Visibility	± 200 m up to 700 m 30% between 700 m and 10 km	80% of cases
Precipitation	Occurrence or non-occurrence	80% of cases
Cloud amount	± 2 oktas	70% of cases
Cloud height	± 30 m (100 ft) up to 120 m (400 ft) ± 30% between 120 m (400 ft) and 3 000 m (10 000 ft)	70% of cases
Air temperature	± 1°C	70% of cases
	LANDING FORECAST	
Wind direction	± 30°	90% of cases
Wind speed	± 9 km/h (5 kt) up to 46 km/h (25 kt) ± 20% above 46 km/h (25 kt)	90% of cases
Visibility	± 200 m up to 700 m ± 30% between 700 m and 10 km	90% of cases
Precipitation	Occurrence or non-occurrence	90% of cases

Element to be forecast	*Operationally desirable accuracy of forecasts*	*Minimum percentage of cases within range*
Cloud amount	± 2 oktas ± 30% between 700 m and 10 km	90% of cases
Cloud height	± 30 m (100 ft) up to 120 m (400 ft) ± 30% between 120 m (400 ft) and 3 000 m (10 000 ft)	90% of cases
	FORECAST FOR TAKE-OFF	
Wind direction	± 30°	90% of cases
Wind speed	± 9 km/h (5 kt) up to 46 km/h (25 kt) ± 20% above 46 km/h (25 kt)	90% of cases
Air temperature	± 1°C	90% of cases
Pressure value (QNH)	± 1 hPa	90% of cases
	AREA, FLIGHT AND ROUTE FORECASTS	
Upper-air temperature	± 3°C (Mean for 900 km/500 NM)	90% of cases
Upper wind	± 28 km/h (15 kt) up to flight level 250 ± 37 km/h (20 kt) above flight level 250 (Modulus of vector difference for 900 km/500 NM)	90% of cases
Significant en-route weather phenomena and cloud	Occurrence or non-occurrence	80% of cases
	Location: ± 100 km/60 NM	70% of cases
	Vertical extent: ± 600 m/2 000 ft	70% of cases

ATTACHMENT F. SIGMET AND AIRMET

(The guidance in this table relates to Chapter 7 — SIGMET and AIRMET information, aerodrome warnings and wind shear warnings and, in particular, to 7.1.1, 7.2.1, 7.3.1 and 7.4.1)

FIRST LINE				SUBSEQUENT LINES						
					Weather phenomenon plus description to be used in *(1) SIGMET MESSAGES[1]* *(f)*					
Location indicator of the ATS unit serving the FIR or CTA to which the SIGMET or AIRMET refers *(a)*	*Message number* *(b)*	*Validity period (UTC)* *(c)*	*Issuing MWO* *(d)*	*Name of FIR or CTA for which the SIGMET or AIRMET is issued* *(e)*	*a) At subsonic cruising levels*	*b) At transonic levels and supersonic cruising levels*	*Observed or forecast* *(g)*	*Location/ level* *(h)*	*Movement and direction* *(i)*	*Change in intensity* *(j)*
e.g. YUDD*	The number must correspond with the number of SIGMET or AIRMET messages issued for the FIR/UIR since 0000/UTC on the day concerned	Date time/ date time, e.g. "170600/ 171000"	e.g. "YUSO-*" First line always ends in hyphen	Always begins second line, e.g. "SHANLON* FIR/UIR"	OBSC[2] TS EMBD[3] TS FRQ[4] TS SQL[5] TS OBSC TS HVYGR[6] EMBD TS HVYGR FRQ TS HVYGR SQL TS HVYGR TC (+ name) SEV TURB[7] SEV ICE[8] FZRA[9] SEV MTW[10] HVY DS HVY SS VA (+ volcano name)	MOD TURB SEV TURB ISOL CB[11] OCNL CB FRQ CB GR VA (+ volcano name)	1. OBS to be used when the phenomenon is observed and forecast. Where relevant the time of observation should be added. 2. FCST to be used when the phenomenon is forecast but not yet observed.	Area (refer to latitude/longitude and/or well-known locations or geographical features) and flight levels affected, e.g. information on TS tops: "FCST TOPS FL390 S OF 54DEG N" or on severe turbulence: "SEV TURB BTN FL350/390"	Movement in KTS or KMH. Direction in relation to one of the eight points of the compass, for example "MOV E"	1. "WKN" 2. "NC" 3. "INTSF"
					(2) AIRMET MESSAGES					
					SFC WSPD (+ wind speed and units) SFC VIS (+ visibility) ISOL TS OCNL TS ISOL TSGR OCNL TSGR MT OBSC BKN CLD (+ height of the base and units) OVC CLD (+ height of the base and units) ISOL CB OCNL CB FRQ CB MOD ICE MOD TURB MOD MTW					

* Fictitious location

Notes.—

1. Only one of the weather phenomena listed in column (f) above should be selected and included in each SIGMET.

2. Obscured (OBSC) indicates that the thunderstorm (including, if necessary, cumulonimbus cloud which is not accompanied by a thunderstorm) is obscured by haze or smoke or cannot be readily seen due to darkness.

3. Embedded (EMBD) indicates that the thunderstorm (including cumulonimbus cloud which is not accompanied by a thunderstorm) is embedded within cloud layers and cannot be readily recognized.

4. Frequent (FRQ) indicates an area of thunderstorms within which there is little or no separation between adjacent thunderstorms.

5. Squall line (SQL) indicates thunderstorm along a line with little or no space between individual clouds.

6. Heavy hail (HVYGR) may be used as a further description of the thunderstorm as necessary.

7. Severe and moderate turbulence (TURB) refers only to low level turbulence associated with strong surface winds, rotor streaming, or turbulence whether in cloud or not (CAT) near to jet streams and is not required to be used for turbulence in convective clouds.

8. Severe and moderate icing (ICE) refers to severe icing in other than convective clouds.

9. Freezing rain (FZRA) refers to severe icing conditions caused by freezing rain.

10. A mountain wave (MTW) is considered:
    a) severe whenever an accompanying downdraft of 3.0 m/s (600 ft/min) or more and/or severe turbulence is observed or forecast;
    b) moderate whenever an accompanying downdraft of 1.75-3.0 m/s (350-600 ft/min) and/or moderate turbulence is observed or forecast.

11. The use of cumulonimbus, CB, is restricted to AIRMETs and SIGMETs related to SST flight during transonic and supersonic cruise.

General note.— Severe or moderate icing and severe or moderate turbulence (SEV ICE, MOD ICE, SEV TURB, MOD TURB) associated with thunderstorms, cumulonimbus clouds or tropical cyclones should not be included.

EXAMPLES

SIGMET

YUDD SIGMET 2 VALID 101200/101600 YUSO-
SHANLON FIR/UIR OBSC TS FCST TOPS FL390
S OF 54DEG N MOV E WKN

Cancellation of SIGMET

YUDD SIGMET 3 VALID 101345/101600 YUSO-
SHANLON FIR/UIR CNL SIGMET 2 101200/101600

AIRMET

YUDD AIRMET 1 VALID 151520/151800 YUSO-
SHANLON FIR ISOL TS OBS TOPS ABV FL100
N OF 50DEG S STNR WKN

Cancellation of AIRMET

YUDD AIRMET 2 VALID 151650/151800 YUSO-
SHANLON FIR CNL AIRMET 1 151520/151800

— END —

1/1/96

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL CHARTS

ANNEX 4

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

NINTH EDITION — JULY 1995

This edition incorporates all amendments adopted by the Council prior to 2 March 1995 and supersedes, on 9 November 1995, all previous editions of Annex 4.

For information regarding the applicability of the Standards and Recommended Practices, *see* Chapter 1 and Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-50	Incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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FOREWORD

Historical background

Standards and Recommended Practices for Aeronautical Charts were first adopted by the Council on 16 April 1948, pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago, 1944), and were designated as Annex 4 to the Convention. They became applicable on 1 March 1949.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each Amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. Information relating to the availability and amendment of aeronautical charts affecting aircraft operations, provided according to the Standards, Recommended Practices and Procedures specified in this Annex, should be notified and take effect in accordance with Annex 15.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interests of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note.*

It is to be noted that in the English text the following practice has been adhered to when writing the specifications: Standards employ the operative verb "shall" while Recommended Practices employ the operative verb "should".

Throughout this document measurements are given in the metric system followed in parentheses by corresponding measurements in the foot-pound system.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 4

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
1st Edition	Aeronautical Charts Division, First Session (November 1945), Second Session (April 1946), Third Session (January 1947)	World Aeronautical Chart (WAC) — ICAO 1:1 000 000; Instrument Approach and Landing Charts; Aeronautical Charts 1:500 000; Aeronautical Charts 1:250 000; Aeronautical Plotting Charts; Aeronautical Route Charts; Aeronautical Planning Charts.	16 April 1948 1 November 1948 1 March 1949
Amendment No. 1 included in 1st Edition	Aeronautical Charts Division, Fourth Session (March 1948)	Projection of WAC — ICAO 1:1 000 000.	6 December 1948 15 March 1949 15 March 1949
2nd Edition including Amendments 2-22	Aeronautical Charts Division, Fourth Session (March 1948)	Definitions; WAC — ICAO 1:1 000 000; Aeronautical Charts — ICAO 1:500 000; Aeronautical Charts — ICAO 1:250 000; Instrument Approach Charts — ICAO; Instrument Landing Charts — ICAO; Radio Facility Charts.	15 November 1949 1 June 1950 1 September 1950
23-28	Other activities of the Council	Abbreviations; Chart Symbols; Definitions.	25 June 1951 1 November 1951 1 January 1952
29	Aeronautical Charts Division, Fifth Session (October 1951)	Definitions; WAC — ICAO 1:1 000 000; Aeronautical Charts — ICAO 1:500 000; Aeronautical Charts — ICAO 1:250 000; Approach Charts — ICAO; Landing Charts — ICAO; Aeronautical Plotting Charts — ICAO; Radio Facility Charts; ICAO Chart Symbols; Aerodrome Obstruction Plans and Profiles — ICAO.	19 June 1952 1 December 1952 1 April 1953
30	Action by Air Navigation Commission in consultation with States	Removal of inconsistencies between Annexes 4 and 15.	22 February 1956 1 July 1956 1 December 1956
31, 32	Third Air Navigation Conference (October 1956); Recommendation of the Air Navigation Commission	Aerodrome Obstruction Charts; editorial amendments; ICAO Chart Symbols.	13 June 1957 1 October 1957 1 December 1957
33	Action by Air Navigation Commission in consultation with States	Application of Definitions of Danger Area, Prohibited Area and Restricted Area (Guidance material).	14 November 1958 — —
34	Aeronautical Information Services Division and Aeronautical Charts Division (AIS/MAP Division) Meeting (April-May 1959)	Definitions; General Specifications; Aerodrome Obstruction Chart — ICAO Types A and B; Plotting Chart — ICAO; Radio Navigation Chart — ICAO; Terminal Area Chart — ICAO; Instrument Approach Chart — ICAO; WAC — ICAO 1:1 000 000; Aeronautical Chart — ICAO 1:500 000; Visual Approach Chart; Landing Chart — ICAO; Aerodrome Chart — ICAO; Aeronautical Navigation Chart 1:2 000 000; Sheet Layout for the WAC — ICAO 1:1 000 000; ICAO Chart Symbols; Colour Guide; Hypsometric Tint Guide; Format for WAC — ICAO 1:1 000 000; Criteria for determination of Minimum Sector Altitudes; Attachments.	20 June 1960 1 October 1960 1 July 1961
35	AIS/MAP Division Meeting (April-May 1959)	Aerodrome Obstruction Chart — ICAO Type A.	8 December 1961 1 April 1962 1 July 1962

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
36	AIS/MAP Division Meeting (April-May 1959); Informal EUM/MAP Meeting (May 1961)	Minimum Sector Altitudes; Sheet lines WAC — ICAO 1:1 000 000.	14 December 1962 1 April 1963 1 November 1963
37	Canada; Switzerland; United Nations Technical Conference on the International Map of the World	Chart Symbols.	11 December 1963 1 June 1964 1 November 1964
38	AGA Division — 7th Session; PANS-ICAO Abbreviations and Codes (Doc 8400)	Definitions; General Specifications; Sample Aerodrome Obstruction Chart — ICAO Types A and B.	25 March 1964 1 August 1964 1 November 1964
39	RAC/OPS Meeting (1963)	Definitions; Explanatory notes on the Application of the Definitions of Danger Area, Prohibited Area and Restricted Area.	10 December 1965 10 April 1966 25 August 1966
40	AIS/MAP Divisional Meeting	Contours and portrayal of relief, hypsometric tints, chart symbols, WAC — ICAO 1:1 000 000, Aeronautical Chart — ICAO Small Scale; reference datum for heights of obstructions, definitions, Attachments.	13 June 1967 8 October 1967 8 February 1968
41	Fifth Air Navigation Conference; Obstacle Clearance Panel (First Meeting); All Weather Operations Panel (Third Meeting)	Definitions; Aerodrome Obstruction Chart — ICAO Type A; Landing Chart — ICAO; Aerodrome Chart — ICAO; ICAO Chart Symbols.	23 January 1969 23 May 1969 18 September 1969
42	Sixth Air Navigation Conference (1969)	Radio Navigation Chart — ICAO; Terminal Area Chart — ICAO.	15 May 1970 15 September 1970 4 February 1971
43	Fifth North Atlantic Regional Air Navigation Meeting (1970) Recommendation 17/5 a)	Aerodrome Chart — ICAO.	29 November 1971 29 March 1972 7 December 1972
44	Third Meeting of the All Weather Operations Panel, Recommendation 8/1	Precision Approach Terrain Chart — ICAO.	27 November 1972 27 March 1973 16 August 1973
45	Air Navigation Commission decisions on RAN Meeting recommendations of world-wide applicability; Sixth EUM RAN Meeting (Rec 16/24); Ninth Air Navigation Conference	Definitions; Aerodrome Obstruction Chart — ICAO Types A and B; Radio Navigation Chart — ICAO; Terminal Area Chart — ICAO; Instrument Approach Chart — ICAO; World Aeronautical Chart — ICAO 1:1 000 000; Aeronautical Chart — ICAO 1:500 000; Visual Approach Chart; Landing Chart — ICAO; Aerodrome Chart — ICAO; Aeronautical Navigation Chart — ICAO Small Scale; Precision Approach Terrain Chart — ICAO; ICAO Chart Symbols.	9 December 1977 9 April 1978 10 August 1978

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
46	Study on charts to be used in the cockpit; Recommendation 4/2 of the seventh meeting of the Obstacle Clearance Panel and Recommendation 10/1 of the AGA Divisional Meeting (1981)	Definitions; General specifications; Instrument Approach Chart — ICAO.	27 February 1984 30 July 1984 22 November 1984
47	Study on charts to be used in the cockpit; Recommendation 3/1 of the seventh meeting of the Obstacle Clearance Panel and Recommendation 8/2 of the AGA Divisional Meeting (1981)	Definitions; General specifications; Aerodrome Obstacle Chart — ICAO Types A and B; Plotting Chart — ICAO; Enroute Chart — ICAO; Area Chart — ICAO; Instrument Approach Chart — ICAO; World Aeronautical Chart — ICAO 1:1 000 000; Aeronautical Chart — ICAO 1:500 000; Visual Approach Chart — ICAO; Aerodrome Chart — ICAO; Aeronautical Navigation Chart — ICAO Small Scale; Precision Approach Terrain Chart — ICAO; ICAO Chart Symbols; Colour Guide. Introduces Aerodrome Ground Movement Chart — ICAO; Aircraft Parking/Docking Chart — ICAO; Standard Departure Chart — Instrument (SID) — ICAO; Standard Arrival Chart — Instrument (STAR) — ICAO; Aerodrome Obstacle Chart — ICAO Type C.	18 March 1985 29 July 1985 21 November 1985
48	Amendment 18 to Annex 6; Amendment 33 to Annex 14; Visual Aids Panel (Eleventh Meeting); Recommendation 2/2 and Secretariat	Aerodrome Obstacle Chart — ICAO Types A, B and C; Precision Approach Terrain Chart — ICAO; Standard Departure Chart — Instrument (SID) — ICAO; Standard Arrival Chart — Instrument (STAR) — ICAO; Instrument Approach Chart — ICAO; Visual Approach Chart — ICAO; Aerodrome Chart — ICAO; Aerodrome Ground Movement Chart — ICAO; Aircraft Parking/Docking Chart — ICAO; World Aeronautical Chart — ICAO 1:1 000 000; Aeronautical Chart — ICAO 1:500 000; Aeronautical Navigation Chart — ICAO Small Scale; Plotting Chart — ICAO; ICAO Chart Symbols.	24 February 1989 31 July 1989 16 November 1989
49	Amendment 33 to Annex 11; Amendment 39 to Annex 14; Adoption of Annex 14, Vol. II; Amendments 5 and 6 to Doc 8168, PANS-OPS, Vols. I and II, respectively	Definitions; General specifications; Enroute Chart — ICAO; Area Chart — ICAO; Instrument Approach Chart — ICAO; Visual Approach Chart — ICAO; Aerodrome Chart — ICAO; World Aeronautical Chart — ICAO 1:1 000 000; Aeronautical Chart — ICAO 1:500 000; ICAO Chart Symbols.	28 February 1992 27 July 1992 12 November 1992
50	Adoption by Council of WGS-84 as the standard geodetic reference system for international aviation; WAFS planning and implementation; PANS-OPS implementation problems; revision of the Manual of All-Weather Operations; integration of helicopter traffic with conventional aeroplane traffic; proposal by RGCSP/8; and the Secretariat	Definitions; introduction of new provisions concerning the promulgation, as of 1 January 1998, of WGS-84 related geographical coordinates; deletion of the requirement for presentation of level acceleration altitude/height; introduction of RNP type; inclusion of the note on close-in obstacles on SID charts; and introduction of new chart symbol for active volcano.	1 March 1995 24 July 1995 9 November 1995; 1 January 1998

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS, APPLICABILITY AND AVAILABILITY

1.1 Definitions

When the following terms are used in the Standards and Recommended Practices for Aeronautical Charts they have the following meanings:

Aerodrome. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome elevation. The elevation of the highest point of the landing area.

Aerodrome operating minima. The limits of usability of an aerodrome for:

a) take-off, expressed in terms of runway visual range and/or visibility and, if necessary, cloud conditions;

b) landing in precision approach and landing operations, expressed in terms of visibility and/or runway visual range and decision altitude/height (DA/H) as appropriate to the category of the operation; and

c) landing in non-precision approach and landing operations, expressed in terms of visibility and/or runway visual range, minimum descent altitude/height (MDA/H) and, if necessary, cloud conditions.

Aerodrome reference point. The designated geographical location of an aerodrome.

Aeronautical chart. A representation of a portion of the earth, its culture and relief, specifically designated to meet the requirements of air navigation.

Aircraft stand. A designated area on an apron intended to be used for parking an aircraft.

Air taxiway. A defined path on the surface established for the air taxiing of helicopters.

Air traffic service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Air transit route. A defined path on the surface established for the air transitting of helicopters.

Airway. A control area or portion thereof established in the form of a corridor equipped with radio navigation aids.

Altitude. The vertical distance of a level, a point or an object considered as a point, measured from mean sea level (MSL).

Apron. A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

Area minimum altitude. The lowest altitude to be used under instrument meteorological conditions (IMC) which will provide a minimum vertical clearance of 300 m (1 000 ft) or in designated mountainous terrain 600 m (2 000 ft) above all obstacles located in the area specified, rounded up to the nearest (next higher) 30 m (100 ft).

Arrival routes. Routes identified in an instrument approach procedure by which aircraft may proceed from the en-route phase of flight to an initial approach fix.

ATS route. A specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services.

Note.— The term ATS route is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route, etc.

Change-over point. The point at which an aircraft navigating on an ATS route segment defined by reference to very high frequency omnidirectional radio ranges is expected to transfer its primary navigational reference from the facility behind the aircraft to the next facility ahead of the aircraft.

Note.— Change-over points are established to provide the optimum balance in respect of signal strength and quality between facilities at all levels to be used and to ensure a common source of azimuth guidance for all aircraft operating along the same portion of a route segment.

Clearway. A defined rectangular area on the ground or water under the control of the appropriate authority, selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.

Culture. All features constructed on the surface of the earth by man, such as cities, railways, canals, etc.

Danger area. An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

Displaced threshold. A threshold not located at the extremity of a runway.

Elevation. The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.

Final approach. That part of an instrument approach procedure which commences at the specified final approach fix or point, or where such a fix or point is not specified,

a) at the end of the last procedure turn, base turn or inbound turn of a racetrack procedure, if specified; or

b) at the point of interception of the last track specified in the approach procedure; and

ends at a point in the vicinity of an aerodrome from which:

1) a landing can be made; or

2) a missed approach procedure is initiated.

Final approach and take-off area (FATO). A defined area over which the final phase of the approach manoeuvre to hover or landing is completed and from which the take-off manoeuvre is commenced. Where the FATO is to be used by performance class 1 helicopters, the defined area includes the rejected take-off area available.

Final approach fix or point. That fix or point of an instrument approach procedure where the final approach segment commences.

Final approach segment. That segment of an instrument approach procedure in which alignment and descent for landing are accomplished.

Flight information region. An airspace of defined dimensions within which flight information service and alerting service are provided.

Flight level. A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hectopascals (hPa) and is separated from other such surfaces by specific pressure intervals.

Note 1.— A pressure-type altimeter calibrated in accordance with the standard atmosphere:

a) when set to a QNH altimeter setting, will indicate altitude;

b) when set to a QFE altimeter setting, will indicate height above the QFE reference datum; and

c) when set to a pressure of 1 013.2 hPa may be used to indicate flight levels.

Note 2.— The terms height and altitude, used in Note 1 above, indicate altimetric rather than geometric heights and altitudes.

Glide path. A descent profile determined for vertical guidance during a final approach.

Height. The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

Helicopter stand. An aircraft stand which provides for parking a helicopter and, where air taxiing operations are contemplated, the helicopter touchdown and lift-off.

Heliport. An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Holding procedure. A predetermined manoeuvre which keeps an aircraft within a specified airspace while awaiting further clearance.

Hypsometric tints. A succession of shades or colour gradations used to depict ranges of elevation.

Initial approach segment. That segment of an instrument approach procedure between the initial approach fix and the intermediate approach fix or, where applicable, the final approach fix or point.

Instrument approach procedure. A series of predetermined manoeuvres by reference to flight instruments with specified protection from obstacles from the initial approach fix, or where applicable, from the beginning of a defined arrival route to a point from which a landing can be completed and thereafter, if a landing is not completed, to a position at which holding or en-route obstacle clearance criteria apply.

Intermediate approach segment. That segment of an instrument approach procedure between either the intermediate approach fix and the final approach fix or point, or between the end of a reversal, racetrack or dead reckoning track procedure and the final approach fix or point, as appropriate.

Isogonal. A line on a map or chart on which all points have the same magnetic variation for a specified epoch.

Isogriv. A line on a map or chart which joins points of equal angular difference between the North of the navigation grid and Magnetic North.

Landing area. That part of a movement area intended for the landing or take-off of aircraft.

Landing direction indicator. A device to indicate visually the direction currently designated for landing and for take-off.

Level. A generic term relating to the vertical position of an aircraft in flight and meaning variously, height, altitude or flight level.

Magnetic variation. The angular difference between True North and Magnetic North.

Note.— The value given indicates whether the angular difference is East or West of True North.

Manoeuvring area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Marking. A symbol or group of symbols displayed on the surface of the movement area in order to convey aeronautical information.

Minimum sector altitude. The lowest altitude which may be used under emergency conditions which will provide a minimum clearance of 300 m (1 000 ft) above all objects located in an area contained within a sector of a circle of 46 km (25 NM) radius centred on a radio aid to navigation.

Missed approach point (MAPt). That point in an instrument approach procedure at or before which the prescribed missed approach procedure must be initiated in order to ensure that the minimum obstacle clearance is not infringed.

Missed approach procedure. The procedure to be followed if the approach cannot be continued.

Movement area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

Obstacle clearance altitude (OCA) or obstacle clearance height (OCH). The lowest altitude or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria.

Note 1.— Obstacle clearance altitude is referenced to mean sea level and obstacle clearance height is referenced to the threshold elevation or in the case of non-precision approaches to the aerodrome elevation or the threshold elevation if that is more than 2 m (7 ft) below the aerodrome elevation. An obstacle clearance height for a circling approach is referenced to the aerodrome elevation.

Note 2.— For convenience when both expressions are used they may be written in the form "obstacle clearance altitude/height" and abbreviated "OCA/H".

Note 3.— See Procedures for Air Navigation Services — Aircraft Operations *(Doc 8168), Vol. I, Part III, 1.5 and Vol. II, Part III, 6.3 for specific applications of this definition.*

Obstacle free zone (OFZ). The airspace above the inner approach surface, inner transitional surfaces, and balked landing surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacles other than a low-mass and frangibly mounted one required for air navigation purposes.

Point light. A luminous signal appearing without perceptible length.

Precision approach procedure. An instrument approach procedure utilizing azimuth and glide path information provided by ILS or PAR.

Procedure turn. A manoeuvre in which a turn is made away from a designated track followed by a turn in the opposite direction to permit the aircraft to intercept and proceed along the reciprocal of the designated track.

Note 1.— Procedure turns are designated "left" or "right" according to the direction of the initial turn.

Note 2.— Procedure turns may be designated as being made either in level flight or while descending, according to the circumstances of each individual procedure.

Prohibited area. An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

Radar vectoring. Provision of navigational guidance to aircraft in the form of specific headings, based on the use of radar.

Relief. The inequalities in elevation of the surface of the earth represented on the aeronautical charts by contours, hypsometric tints, shading or spot elevations.

Reporting point. A specified geographical location in relation to which the position of an aircraft can be reported.

Required Navigation Performance (RNP). A statement of the navigation performance accuracy necessary for operation within a defined airspace.

Restricted area. An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

Reversal procedure. A procedure designed to enable aircraft to reverse direction during the initial approach segment of an instrument approach procedure. The sequence may include procedure turns or base turns.

RNP type. A containment value expressed as a distance in nautical miles from the intended position within which flights would be for at least 95 per cent of the total flying time.

Example.— RNP 4 represents a navigation accuracy of plus or minus 7.4 km (4 NM) on a 95 per cent containment basis.

Runway. A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Runway strip. A defined area including the runway and stopway, if provided, intended:

a) to reduce the risk of damage to aircraft running off a runway; and

b) to protect aircraft flying over it during take-off or landing operations.

Runway visual range (RVR). The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

Shoulder. An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.

Significant obstacle. Any natural terrain feature or man-made fixed object, permanent or temporary, which has vertical significance in relation to adjacent and surrounding features and which is considered a potential hazard to the safe passage of aircraft in the type of operation for which the individual chart series is designed.

Note.— The term "significant obstacle" is used in this Annex solely for the purpose of specifying the objects to be included on charts. Obstacles are specified in other terms in Annex 14, Volumes I and II, for the purpose of clearing and marking.

Significant point. A specified geographical location used in defining an ATS route or the flight path of an aircraft and for other navigation and ATS purposes.

Stopway. A defined rectangular area on the ground at the end of take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abandoned take-off.

Taxi-holding position. A designated position at which taxiing aircraft and other vehicles may be required to hold in order to provide adequate clearance from a runway.

Taxiing. Movement of an aircraft on the surface of an aerodrome under its own power, excluding take-off and landing.

Taxiway. A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another, including:

a) *Aircraft stand taxilane.* A portion of an apron designated as a taxiway and intended to provide access to aircraft stands only.

b) *Apron taxiway.* A portion of a taxiway system located on an apron and intended to provide a through taxi route across the apron.

c) *Rapid exit taxiway.* A taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than are achieved on other exit taxiways thereby minimizing runway occupancy times.

Threshold. The beginning of that portion of the runway usable for landing.

Touchdown and lift-off area (TLOF). A load bearing area on which a helicopter may touch down or lift off.

Touchdown zone. The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway.

Track. The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic or grid).

Transition altitude. The altitude at or below which the vertical position of an aircraft is controlled by reference to altitudes.

Way-point. A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation.

1.2 Applicability

1.2.1 The specifications in this Annex are applicable on and after 9 November 1995.

1.2.2 All charts coming within the scope of this Annex and bearing the aeronautical information date of 9 November 1995 or later shall conform to the Standards relevant to the particular chart.

1.2.2.1 **Recommendation.—** *All such charts should in addition conform to the Recommended Practices relevant to the particular chart.*

1.3 Availability

1.3.1 *Information.* A Contracting State shall on request by another Contracting State provide all information relating to its own territory that is necessary to enable the Standards of this Annex to be met.

1.3.2 *Charts.* Contracting States shall, when so specified, ensure the availability of charts in whichever of the following ways is appropriate for a particular chart or single sheet of a chart series.

1.3.2.1 For any chart or single sheet of a chart series entirely contained within the territory of a Contracting State, the State having jurisdiction over the territory shall either:

1) produce the chart or sheet itself; or

2) arrange for its production by another Contracting State or by an agency; or

3) provide another Contracting State prepared to accept an obligation to produce the chart or sheet with the data necessary for its production.

1.3.2.2 For any chart or single sheet of a chart series which includes the territory of two or more Contracting States, the States having jurisdiction over the territory so included shall determine the manner in which the chart or sheet will be made available. This determination shall be made with due regard being given to regional air navigation agreements and to any programme of allocation established by the Council of ICAO.

Note.— The phrase "regional air navigation agreements" refers to the agreements approved by the Council of ICAO normally on the advice of regional air navigation meetings.

1.3.3 Contracting States shall take all reasonable measures to ensure that the information it provides and the aeronautical charts made available are adequate and accurate and that they are maintained up to date by an adequate revision service.

1.3.4 **Recommendation.—** *To improve world-wide dissemination of information on new charting techniques and production methods, appropriate charts produced by Contracting States should be made available without charge to other Contracting States on request on a reciprocal basis.*

Note.— Guidance material on the preparation of aeronautical charts, including sample formats, is contained in the Aeronautical Chart Manual *(Doc 8697).*

CHAPTER 2. GENERAL SPECIFICATIONS

Note.— The Standards and Recommended Practices contained in this chapter are applicable to all ICAO aeronautical charts unless otherwise stated in the specifications of the chart concerned.

2.1 Operational requirements for charts

Note.— For the purposes of this Annex, the total flight is divided into the following phases:

Phase 1 — Taxi from aircraft stand to take-off point

Phase 2 — Take-off and climb to en-route ATS route structure

Phase 3 — En-route ATS route structure

Phase 4 — Descent to approach

Phase 5 — Approach to land and missed approach

Phase 6 — Landing and taxi to aircraft stand.

2.1.1 Each type of chart shall provide information relevant to the function of the chart.

2.1.2 Each type of chart shall provide information appropriate to the phase of flight, to ensure the safe and expeditious operation of the aircraft.

2.1.3 The presentation of information shall be accurate, free from distortion and clutter, unambiguous, and be readable under all normal operating conditions.

2.1.4 Colours or tints and type size used shall be such that the chart can be easily read and interpreted by the pilot in varying conditions of natural and artificial light.

2.1.5 The information shall be in a form which enables the pilot to acquire it in a reasonable time consistent with workload and operating conditions.

2.1.6 The presentation of information provided on each type of chart shall permit smooth transition from chart to chart as appropriate to the phase of flight.

2.1.7 **Recommendation.—** *The charts should be True North orientated.*

2.1.8 **Recommendation.—** *The basic sheet size of the charts should be 210 × 148 mm (8.27 × 5.82 in) (A5).*

2.2 Titles

The title of a chart or chart series prepared in accordance with the specifications contained in this Annex and intended to satisfy the function of the chart, shall be that of the relevant chapter heading as modified by application of any Standard contained therein, except that such title shall not include "ICAO" unless the chart conforms with all Standards specified in this Chapter 2 and any specified for the particular chart.

2.3 Miscellaneous information

2.3.1 The marginal note layout shall be as given in Appendix 1, except as otherwise specified for a particular chart.

2.3.2 The following information shall be shown on the face of each chart unless otherwise stated in the specification of the chart concerned:

1) designation or title of the chart series;

Note.— The title may be abbreviated.

2) name and reference of the sheet;

3) on each margin an indication of the adjoining sheet (when applicable).

2.3.3 A legend to the symbols and abbreviations used shall be provided. The legend shall be on the face or reverse of each chart except that, where it is impracticable for reasons of space, a legend may be published separately.

2.3.4 The name and adequate address of the producing agency shall be shown in the margin of the chart except that, where the chart is published as part of an aeronautical document, this information may be placed in the front of that document.

2.4 Symbols

Symbols used shall conform to those shown in Appendix 2 — ICAO Chart Symbols, except that where it is desired to show on an aeronautical chart special features or items of importance to civil aviation for which no ICAO symbol is at present provided, any appropriate symbol may be chosen for this purpose, provided that it does not cause confusion with any existing ICAO chart symbol or impair the legibility of the chart.

Note.— The size and prominence of symbols and the thickness and spacing of lines may be varied according to the scale and functions of the chart, with due regard to the importance of the information they convey.

2.5 Units of measurement

2.5.1 Distances shall be expressed in either kilometres and tenths thereof or nautical miles and tenths thereof or both, provided the units are clearly differentiated.

2.5.2 Altitudes, elevations and heights shall be expressed in either metres or feet or both provided the units are clearly differentiated.

2.5.3 Linear dimensions on aerodromes and short distances shall be expressed in metres.

2.5.4 The units of measurement used to express distances, altitudes, elevations and heights shall be conspicuously stated on the face of each chart.

2.5.5 Conversion scales (kilometres/nautical miles, metres/feet) shall be provided on each chart on which distances, elevations or altitudes are shown. The conversion scales shall be placed on the face of each chart.

2.6 Scale and projection

2.6.1 For charts of large areas, the name and basic parameters and scale of the projection shall be indicated.

2.6.2 For charts of small areas, a linear scale only shall be indicated.

2.7 Date of validity of aeronautical information

The date of validity of aeronautical information shall be clearly indicated on the face of each chart.

2.8 Spelling of geographical names

2.8.1 The symbols of the Roman alphabet shall be used for all writing.

2.8.2 The names of places and of geographical features in countries which officially use varieties of the Roman alphabet shall be accepted in their official spelling, including the accents and diacritical marks used in the respective alphabets.

2.8.3 Where a geographical term such as "cape", "point", "gulf", "river", is abbreviated on any particular chart, that word shall be spelt out in full in the language used by the publishing agency, in respect of the most important example of each type. Punctuation marks shall not be used in abbreviations within the body of a chart.

2.8.4 **Recommendation.—** *In areas where romanized names have not been officially produced or adopted, and outside the territory of Contracting States, names should be transliterated from the non-Roman alphabet form by the system generally used by the producing agency.*

2.9 Abbreviations

2.9.1 Abbreviations shall be used on aeronautical charts whenever they are appropriate.

2.9.2 **Recommendation.—** *Where applicable, abbreviations should be selected from the* Procedures for Air Navigation Services — ICAO Abbreviations and Codes *(Doc 8400).*

2.10 Political boundaries

2.10.1 International boundaries shall be shown, but may be interrupted if data more important to the use of the chart would be obscured.

2.10.2 Where the territory of more than one State appears on a chart, the names identifying the countries shall be indicated.

Note.— In the case of a dependent territory, the name of the sovereign State may be added in brackets.

2.11 Colours

Recommendation.— *Colours used on charts should conform to Appendix 3 — Colour Guide.*

2.12 Relief

2.12.1 Relief, where shown, shall be portrayed in a manner that will satisfy the chart users' need for:

a) orientation and identification;

b) safe terrain clearance;

c) clarity of aeronautical information when shown;

d) planning.

Note.— Relief is usually portrayed by combinations of contours, hypsometric tints, spot elevations and hill shading, the choice of method being affected by the nature and scale of the chart and its intended use.

2.12.2 **Recommendation.—** *Where relief is shown by hypsometric tints, the tints used should be based on those shown in the Hypsometric Tint Guide in Appendix 4.*

2.12.3 Where spot elevations are used they shall be shown for selected critical points.

2.12.3.1 The value of spot elevations of doubtful accuracy shall be followed by the sign ±.

2.13 Prohibited, restricted and danger areas

When prohibited, restricted or danger areas are shown, the reference or other identification shall be included, except that the nationality letters may be omitted.

Note.— Nationality letters are those contained in Doc 7910 — Location Indicators.

2.14 Air traffic services airspaces

2.14.1 When ATS airspace is shown on a chart, the class of airspace shall be indicated.

2.14.2 **Recommendation.—** *On charts used for visual flight, those parts of the ATS Airspace Classifications table in Annex 11 applicable to the airspace depicted on the chart should be on the face or reverse of each chart.*

2.15 Magnetic variation

2.15.1 True North and magnetic variation shall be indicated.

2.15.2 **Recommendation.—** *When magnetic variation is shown on a chart, the values shown should be those for the year nearest to the date of publication that is divisible by 5, i.e. 1980, 1985, etc. In exceptional cases where the current value would be more than one degree different, after applying the calculation for annual change, an interim date and value should be quoted.*

Note.— The date and the annual change may be shown.

2.16 Typography

Note.— Samples of type suitable for use on aeronautical charts are included in the Aeronautical Chart Manual *(Doc 8697).*

2.17 Geographical coordinates

2.17.1 Applicable as of 1 January 1998, geographical coordinates indicating latitude and longitude shown on a chart shall be expressed in terms of the World Geodetic System — 1984 (WGS-84) geodetic reference datum. Geographical coordinates which have been transformed into WGS-84 coordinates but whose accuracy of original field work does not meet the requirements in Annex 11, Chapter 2 and Annex 14, Volumes I and II, Chapter 2, shall be identified by an asterisk.

2.17.2 The order of resolution of geographical coordinates shall be that as specified for a particular chart.

Note.— Specifications governing the determination and reporting of WGS-84 coordinates are given in Annex 11, Chapter 2 and Annex 14, Volumes I and II, Chapter 2.

CHAPTER 3. AERODROME OBSTACLE CHART — ICAO TYPE A (OPERATING LIMITATIONS)

3.1 Function

This chart, in combination with the Aerodrome Obstacle Chart — ICAO Type C or with the relevant information published in the AIP, shall provide the data necessary to enable an operator to comply with the operating limitations of Annex 6, Parts I and II, Chapter 5, and Part III, Chapter 3.

3.2 Applicability

3.2.1 Aerodrome Obstacle Charts — ICAO Type A (Operating Limitations) shall be made available in the manner prescribed in 1.3.2 for all aerodromes regularly used by international civil aviation, except for those aerodromes where there are no significant obstacles in the take-off flight path areas.

3.2.2 Where a chart is not required because no significant obstacles exist in the take-off flight path area, a notification to this effect shall be published.

3.3 Units of measurement

3.3.1 Elevations shall be shown to the nearest half-metre or to the nearest foot.

3.3.2 Linear dimensions shall be shown to the nearest half-metre.

3.4 Coverage and scale

3.4.1 The extent of each plan shall be sufficient to cover all significant obstacles.

Note.— Isolated distant significant obstacles that would unnecessarily increase the sheet size may be indicated by the appropriate symbol and an arrow, provided that the distance and bearing from the end of the runway farthest removed and the elevation are given.

3.4.2 The horizontal scale shall be within the range of 1:10 000 to 1:15 000.

3.4.3 **Recommendation.—** *The horizontal scale should be 1:10 000.*

Note.— When the production of the charts would be expedited thereby, a scale of 1:20 000 may be used.

3.4.4 The vertical scale shall be ten times the horizontal scale.

3.4.5 *Linear scales.* Horizontal and vertical linear scales showing both metres and feet shall be included in the charts.

3.5 Format

3.5.1 The charts shall depict a plan and profile of each runway, any associated stopway or clearway, the take-off flight path area, and significant obstacles.

3.5.2 The profile for each runway, stopway, clearway and the obstacles in the take-off flight path area shall be shown above its corresponding plan. The profile of an alternative take-off flight path area shall comprise a linear projection of the full take-off flight path and shall be disposed above its corresponding plan in the manner most suited to the ready interpretation of the information.

3.5.3 A profile grid shall be ruled over the entire profile area exclusive of the runway. The zero for vertical coordinates shall be mean sea level. The zero for horizontal coordinates shall be the end of the runway furthest from the take-off flight path area concerned. Graduation marks indicating the sub-divisions of intervals shall be shown along the base of the grid and along the vertical margins.

3.5.3.1 **Recommendation.—** *The vertical grid should have intervals of 30 m (100 ft) and the horizontal grid should have intervals of 300 m (1 000 ft).*

3.5.4 The chart shall include:

a) a box for recording the operational data specified in 3.8.3;

b) a box for recording amendments and dates thereof.

3.6 Identification

The chart shall be identified by the name of the country in which the aerodrome is located, the name of the city or town, or area, which the aerodrome serves, the name of the aerodrome and the designator(s) of the runway(s).

3.7 Magnetic variation

The magnetic variation to the nearest degree and date of information shall be indicated.

3.8 Aeronautical data

3.8.1 Obstacles

3.8.1.1 Obstacles in the take-off flight path area which project above a plane surface having a 1.2 per cent slope and having a common origin with the take-off flight path area, shall be regarded as significant obstacles, except that significant obstacles lying wholly below the shadow of other significant obstacles as defined in 3.8.1.2 need not be shown. Mobile obstacles such as boats, trains, trucks, etc., which may project above the 1.2 per cent plane shall be considered significant obstacles but shall not be considered as being capable of creating a shadow.

3.8.1.2 The shadow of an obstacle is considered to be a plane surface originating at a horizontal line passing through the top of the obstacle at right angles to the centre line of the take-off flight path area. The plane covers the complete width of the take-off flight path area and extends to the plane defined at 3.8.1.1 or to the next higher significant obstacle if it occurs first. For the first 300 m (1 000 ft) of the take-off flight path area, the shadow planes are horizontal and beyond this point such planes have an upward slope of 1.2 per cent.

3.8.1.3 If the significant obstacle creating a shadow is likely to be removed, objects that would become significant obstacles by its removal shall be shown.

3.8.2 Take-off flight path area

3.8.2.1 The take-off flight path area consists of a quadrilateral area on the surface of the earth lying directly below, and symmetrically disposed about, the take-off flight path. This area has the following characteristics:

a) it commences at the end of the area declared suitable for take-off (i.e. at the end of the runway or clearway as appropriate);

b) its width at the point of origin is 180 m (600 ft) and this width increases at the rate of 0.25D to a maximum of 1 800 m (6 000 ft), where D is the distance from the point of origin;

c) it extends to the point beyond which no significant obstacles exist or to a distance of 10.0 km (5.4 NM), whichever is the lesser.

3.8.2.2 For runways serving aircraft having operating limitations which do not preclude the use of a take-off flight path gradient of less than 1.2 per cent, the extent of the take-off flight path area specified in 3.8.2.1 c) shall be increased to not less than 12.0 km (6.5 NM) and the slope of the plane surface specified in 3.8.1.1 and 3.8.1.2 shall be reduced to 1.0 per cent or less.

Note.— When a 1.0 per cent survey plane touches no obstacles, this plane may be lowered until it touches the first obstacle.

3.8.3 Declared distances

3.8.3.1 The following information for each direction of each runway shall be entered in the space provided:

a) take-off run available;

b) accelerate-stop distance available;

c) take-off distance available;

d) landing distance available.

Note.— In Annex 14, Volume I, Attachment A, Section 3, guidance is given on declared distances.

3.8.3.2 **Recommendation.—** *Where a declared distance is not provided because a runway is usable in one direction only, that runway should be identified as "not usable for take-off, landing, or both".*

3.8.4 Plan and profile views

3.8.4.1 The plan view shall show:

a) the outline of the runways by a solid line, including the length and width, the magnetic bearing to the nearest degree, and the runway number;

b) the outline of the clearways by a broken line, including the length and identification as such;

c) take-off flight path areas by a dashed line and the centre line by a fine line consisting of short and long dashes;

d) alternative take-off flight path areas. When alternative take-off flight path areas not centred on the extension of the runway centre line are shown, notes shall be provided explaining the significance of such areas;

e) obstacles, including:

1) the exact location of each significant obstacle together with a symbol indicative of its type;

2) the elevation and identification of each significant obstacle;

3) the limits of penetration of significant obstacles of large extent in a distinctive manner identified in the legend.

Note.— This does not exclude the necessity for indicating critical spot elevations within the take-off flight path area.

3.8.4.1.1 **Recommendation.—** *The nature of the runway and stopway surfaces should be indicated.*

3.8.4.1.2 **Recommendation.—** *Stopways should be identified as such and should be shown by a broken line.*

3.8.4.1.3 When stopways are shown, the length of each stopway shall be indicated.

3.8.4.2 The profile view shall show:

a) the profile of the centre line of the runway by a solid line and the profile of the centre line of any associated stopways and clearways by a broken line;

b) the elevation of the runway centre line at each end of the runway, at the stopway and at the origin of each take-off flight path area, and at each significant change in slope of runway and stopway;

c) obstacles, including:

1) each significant obstacle by a solid vertical line extending from a convenient grid line over at least one other grid line to the elevation of the top of the obstacle;

2) identification of each significant obstacle;

3) the limits of penetration of significant obstacles of large extent in a distinctive manner identified in the legend.

Note.— An obstacle profile consisting of a line joining the tops of each significant obstacle and representing the shadow created by successive significant obstacles may be shown.

3.9 Accuracy

3.9.1 The order of accuracy attained shall be shown on the chart.

3.9.2 **Recommendation.—** *The horizontal dimensions and the elevations of the runway, stopway and clearway to be printed on the chart should be determined to the nearest 0.5 m (1 ft).*

3.9.3 **Recommendation.—** *The order of accuracy of the field work and the precision of chart production should be such that measurements in the take-off flight path areas can be taken from the chart within the following maximum deviations:*

1) horizontal distances: 5 m (15 ft) at a point of origin increasing at a rate of 1 per 500;

2) vertical distances: 0.5 m (1.5 ft) in the first 300 m (1 000 ft) and increasing at a rate of 1 per 1 000.

3.9.4 *Datum.* Where no accurate datum for vertical reference is available, the elevation of the datum used shall be stated and shall be identified as assumed.

CHAPTER 4. AERODROME OBSTACLE CHART — ICAO TYPE B

4.1 Function

This chart shall provide information to satisfy the following functions:

a) the determination of minimum safe altitudes/heights including those for circling procedures;

b) the determination of procedures for use in the event of an emergency during take-off or landing;

c) the application of obstacle clearing and marking criteria; and

d) the provision of source material for aeronautical charts.

4.2 Applicability

4.2.1 **Recommendation.**— *Aerodrome Obstacle Charts — ICAO Type B should be made available, in the manner prescribed in 1.3.2, for all aerodromes regularly used by international civil aviation.*

4.2.2 When a chart combining the specifications of Chapters 3 and 4 is made available, it shall be called the Aerodrome Obstacle Chart — ICAO (Comprehensive).

4.3 Units of measurement

4.3.1 Elevations shall be shown to the nearest half-metre or to the nearest foot.

4.3.2 Linear dimensions shall be shown to the nearest half-metre.

4.4 Coverage and scale

4.4.1 The extent of each plan shall be sufficient to cover all significant obstacles.

Note.— Isolated distant obstacles that would unnecessarily increase the sheet size may be indicated by the appropriate symbol and an arrow, provided that the distance and bearing from the aerodrome reference point and elevation are given.

4.4.2 The horizontal scale shall be within the range of 1:10 000 to 1:20 000.

4.4.3 A horizontal linear scale showing both metres and feet shall be included in the chart. When necessary, a linear scale for kilometres and a linear scale for nautical miles shall also be shown.

4.5 Format

The charts shall include:

a) any necessary explanation of the projection used;

b) any necessary identification of the grid used;

c) a notation indicating that obstacles are those which penetrate the surfaces specified in Annex 14, Volume I, Chapter 4;

d) a box for recording amendments and dates thereof;

e) outside the neat line, every minute of latitude and longitude marked in degrees and minutes.

Note.— Lines of latitude and longitude may be shown across the face of the chart.

4.6 Identification

The chart shall be identified by the name of the country in which the aerodrome is located, the name of the city or town, or area, which the aerodrome serves and the name of the aerodrome.

4.7 Culture and topography

4.7.1 Drainage and hydrographic details shall be kept to a minimum.

4.7.2 Buildings and other salient features associated with the aerodrome shall be shown. Wherever possible, they shall be shown to scale.

4.7.3 All objects, either cultural or natural, that project above the take-off and approach surfaces specified in 4.7 or the clearing and marking surfaces specified in Annex 14, Volume I, Chapter 4 shall be shown.

4.7.4 Roads and railroads within the take-off and approach area, and less than 600 m (2 000 ft) from the end of the runway or runway extensions, shall be shown.

Note.— Geographical names of features may be shown if of significance.

4.8 Magnetic variation

The chart shall show a compass rose orientated to the True North, or a North point, showing the magnetic variation to the nearest degree with the date of magnetic information and annual change.

4.9 Aeronautical data

4.9.1 The charts shall show:

a) the aerodrome reference point and its geographical coordinates in degrees, minutes and seconds;

b) the outline of the runways by a solid line;

c) the length and width of the runway;

d) the magnetic bearing to the nearest degree of the runway and the runway number;

e) the elevation of the runway centre line at each end of the runway, at the stopway, at the origin of each take-off and approach area, and at each significant change of slope of runway and stopway;

f) taxiways, aprons and parking areas identified as such, and the outlines by a solid line;

g) stopways identified as such and depicted by a broken line;

h) the length of each stopway;

i) clearways identified as such and depicted by a broken line;

j) the length of each clearway;

k) take-off and approach surfaces identified as such and depicted by a broken line;

l) take-off and approach areas;

Note.— The take-off area is described in 3.8.2.1. The approach area consists of an area on the surface of the earth lying directly below the approach surface as specified in Annex 14, Volume I, Chapter 4.

m) significant obstacles at their exact location, including:

1) a symbol indicative of their type;

2) elevation;

3) identification;

4) limits of penetration of large extent in a distinctive manner identified in the legend;

Note.— This does not exclude the necessity for indicating critical spot elevations within the take-off and approach areas.

n) any additional obstacles, as determined by 3.8.1.1 including the obstacles in the shadow of a significant obstacle, which would otherwise be exempted.

Note.— The specifications in Annex 14, Volume I, Chapter 4, are minimum requirements. Where the competent authority has established lower surfaces, they may be used in the determination of significant obstacles.

4.9.1.1 **Recommendation.—** *The nature of the runway and stopway surfaces should be given.*

4.9.1.2 **Recommendation.—** *Wherever practicable the highest object or obstacle between adjacent approach areas within a radius of 5 000 m (15 000 ft) from the aerodrome reference point should be indicated in a prominent manner.*

4.9.1.3 **Recommendation.—** *The extent of tree areas and relief features, part of which constitute significant obstacles, should be shown.*

4.10 Accuracy

4.10.1 The order of accuracy attained shall be shown on the chart.

4.10.2 **Recommendation.—** *The horizontal dimensions and the elevations of the movement area, stopways and clearways to be printed on the chart should be determined to the nearest 0.5 m (1 ft).*

4.10.3 **Recommendation.—** *The order or accuracy of the field work and the precision of chart production should be such that the resulting data will be within the maximum deviations indicated herein:*

a) Take-off and approach areas:

1) horizontal distances: 5 m (15 ft) at point of origin increasing at a rate of 1 per 500;

2) vertical distances: 0.5 m (1.5 ft) in the first 300 m (1 000 ft) and increasing at a rate of 1 per 1 000.

b) Other areas:

1) horizontal distances: 5 m (15 ft) within 5 000 m (15 000 ft) of the aerodrome reference point and 12 m (40 ft) beyond that area;

2) vertical distances: 1 m (3 ft) within 1 500 m (5 000 ft) of the aerodrome reference point increasing at a rate of 1 per 1 000.

4.10.4 *Datum.* Where no accurate datum for vertical reference is available, the elevation of the datum used shall be stated and identified as assumed.

CHAPTER 5. AERODROME OBSTACLE CHART — ICAO TYPE C

5.1 Function

When produced, this chart shall provide the obstacle data necessary to enable an operator to develop procedures to comply with the operating limitations of Annex 6, Parts I and II, Chapter 5, and Part III, Chapter 3, with particular reference to information on obstacles that limit the maximum permissible take-off mass, and also to:

a) determine minimum safe heights including those for circling procedures;

b) determine procedures for use in the event of an emergency during take-off or landing;

c) provide source material for aeronautical charts.

Note.— An explanation of the intended purpose and use of this chart is given in the Aeronautical Chart Manual *(Doc 8697).*

5.2 Applicability

This chart is not required where:

a) the obstacle data specified in 5.1 are published in the AIP; or

b) no significant obstacles exist and notification of this is published in the AIP.

5.3 Coverage and scale

5.3.1 The extent of each chart shall be sufficient:

a) to cover all significant obstacles, including obstacles in the shadow of a significant obstacle, in the take-off flight path area which project above a plane surface having a 1.2 per cent slope and having a common origin with the take-off flight path area. Account shall be taken of mobile obstacles such as boats, trains, trucks, etc., which may project above the 1.2 per cent plane;

b) to cover all obstacles exceeding 120 m (400 ft) above the lowest elevation on the runway(s) which may influence the maximum permissible take-off mass or the choice of the aircraft's flight profile both straight ahead and in all areas where turning departures may occur;

c) to provide topographical information covering a distance of approximately 45 km (24 NM) from the aerodrome reference point.

5.3.2 The horizontal scale shall be within the range of 1:20 000 to 1:100 000.

Note.— A scale of 1:50 000 is preferred.

5.4 Format

The chart shall include:

a) any necessary explanation of the projection used;

b) any necessary identification of the grid used;

c) a box for recording amendments and dates thereof;

d) a box for recording the declared distances specified in 5.8.2;

e) graduation marks at consistent intervals outside the neat line, at least every 10 minutes of latitude and longitude and marked in degrees and minutes.

Note 1.— Lines of latitude and longitude may be shown across the face of the chart.

Note 2.— Aerodrome Obstacle Chart — ICAO Type C may consist of any suitable topographical chart or series of charts available, overprinted with the necessary aeronautical data in a distinctive colour.

5.5 Identification

The chart shall be identified by the name of the country in which the aerodrome is located, the name of the city or town which the aerodrome serves, and the name of the aerodrome.

5.6 Magnetic variation

Recommendation.— *The chart should show the magnetic variation to the nearest degree with the date and annual change.*

5.7 Units of measurement

5.7.1 Elevations shall be shown to the nearest metre or to the nearest foot.

5.7.2 Linear dimensions shall be shown to the nearest metre.

5.8 Aeronautical data

5.8.1 The chart shall show:

a) the aerodrome reference point and its geographical coordinates in degrees, minutes and seconds;

b) the runways and the extended runway centre lines;

c) significant obstacles as specified in 5.3.1 a) and b); the extent of each plan shall be sufficient to cover all significant obstacles except that isolated distant obstacles that would unnecessarily increase the sheet size may be indicated by an arrow, provided that the distance and bearing from a reference point and elevation are given;

d) the exact location of each significant obstacle by a symbol;

e) the elevation of each significant obstacle;

f) an indication of the type of each significant obstacle;

Note.— The obstacle type may be given in textual form or in areas where excessive clutter would ensue, the obstacle may be identified by a number on the chart and the number and type tabulated in the margin or on a separate sheet.

g) the limits of penetration of significant obstacles of large extent in a distinctive manner identified in the legend;

Note.— This does not exclude the necessity for indicating critical spot elevations within such an area.

h) the positions of all radio navigation aids.

5.8.2 Declared distances

5.8.2.1 The following information for each direction of each runway shall be entered in the space provided:

a) take-off run available;

b) accelerate-stop distance available;

c) take-off distance available;

d) landing distance available.

Note.— In Annex 14, Volume I, Attachment A, guidance is given on declared distances.

5.8.2.2 **Recommendation.—** *Where a declared distance is not provided because a runway direction cannot be used for take-off or landing or both, then this should be indicated and the words "not usable" or the abbreviation "NU" entered.*

5.9 Accuracy

5.9.1 The order of accuracy attained shall be shown on the chart.

5.9.2 **Recommendation.—** *The order of accuracy of the field work and the precision of chart production should be such that the resulting data will be within the maximum deviations indicated herein:*

1) horizontal distances: 50 m (150 ft);

2) vertical distances: 10 m (30 ft).

Note.— These accuracies are satisfactory for normal use. In cases where more precise information on horizontal and/or vertical distances is needed it is assumed that this will be obtained by other means.

CHAPTER 6. PRECISION APPROACH TERRAIN CHART — ICAO

6.1 Function

The chart shall provide detailed terrain profile information within a defined portion of the final approach so as to enable aircraft operating agencies to assess the effect of the terrain on decision height determination by the use of radio altimeters.

6.2 Applicability

6.2.1 The Precision Approach Terrain Chart — ICAO shall be made available for all precision approach runways Categories II and III at aerodromes used by international civil aviation.

6.2.2 The Precision Approach Terrain Chart — ICAO shall be revised whenever any significant change occurs.

6.3 Scale

6.3.1 **Recommendation.—** *The horizontal scale should be 1:2 500, and the vertical scale 1:500.*

6.3.2 **Recommendation.—** *When the chart includes a profile of the terrain to a distance greater than 900 m (3 000 ft) from the runway threshold, the horizontal scale should be 1:5 000.*

6.4 Identification

The chart shall be identified by the name of the country in which the aerodrome is located, the name of the city or town, or area, which the aerodrome serves, the name of the aerodrome and the designator of the runway.

6.5 Plan and profile information

6.5.1 The chart shall include:

1) a plan showing contours at 1 m (3 ft) intervals in the area 60 m (200 ft) on either side of the extended centre line of the runway, to the same distance as the profile, the contours to be related to the runway threshold;

2) an indication where the terrain or any object thereon, within the plan defined in 1) above, differs by ± 3 m (10 ft) in height from the centre line profile and is likely to affect a radio altimeter;

3) a profile of the terrain to a distance of 900 m (3 000 ft) from the threshold along the extended centre line of the runway.

6.5.2 **Recommendation.—** *Where the terrain at a distance greater than 900 m (3 000 ft) from the runway threshold is mountainous or otherwise significant to users of the chart, the profile of the terrain should be shown to a distance not exceeding 2 000 m (6 500 ft) from the runway threshold.*

6.5.3 **Recommendation.—** *The chart should include an indication of the height of the ILS reference datum.*

CHAPTER 7. ENROUTE CHART — ICAO

7.1 Function

This chart shall provide flight crews with information to facilitate navigation along ATS routes in compliance with air traffic services procedures.

Note.— Simplified versions of these charts are appropriate for inclusion in Aeronautical Information Publications to complement the tabulation of radio communication and navigation facilities.

7.2 Applicability

7.2.1 The Enroute Chart — ICAO shall be made available in the manner prescribed in 1.3.2 for all areas where flight information regions have been established.

Note.— Under certain conditions, an Area Chart — ICAO may have to be provided. (See Chapter 8.)

7.2.2 Where different air traffic services routes, position reporting requirements or lateral limits of flight information regions or control areas exist in different layers of airspace and cannot be shown with sufficient clarity on one chart, separate charts shall be provided.

7.3 Coverage and scale

Note 1.— A uniform scale for charts of this type cannot be specified due to the varying degree of congestion of information in certain areas.

Note 2.— A linear scale based on the mean scale of the chart may be shown.

7.3.1 **Recommendation.—** *Layout of sheet lines should be determined by the density and pattern of the ATS route structure.*

7.3.2 Large variations of scale between adjacent charts showing a continuous route structure shall be avoided.

7.3.3 An adequate overlap of charts shall be provided to ensure continuity of navigation.

7.4 Projection

7.4.1 **Recommendation.—** *A conformal projection on which a straight line approximates a great circle should be used.*

7.4.2 Parallels and meridians shall be shown at suitable intervals.

7.4.3 Graduation marks shall be placed at consistent intervals along selected parallels and meridians.

7.5 Identification

Each sheet shall be identified by chart series and number.

7.6 Culture and topography

7.6.1 Generalized shore lines of all open water areas, large lakes and rivers shall be shown except where they conflict with data more applicable to the function of the chart.

7.6.2 Within each quadrilateral formed by the parallels and meridians the Area Minimum Altitude shall be shown, except as provided for in 7.6.3.

7.6.3 **Recommendation.—** *In areas of high latitude where it is determined by the appropriate authority that True North orientation of the chart is impractical, the Area Minimum Altitude should be shown within each quadrilateral formed by reference lines of the graticule (grid) used.*

7.6.4 Where charts are not True North orientated this fact and the selected orientation used shall be clearly indicated.

7.7 Magnetic variation

Recommendation.— *Isogonals should be indicated and the date of the isogonic information given.*

7.8 Bearings, tracks and radials

7.8.1 Bearings, tracks and radials shall be magnetic, except as provided for in 7.8.2.

7.8.2 **Recommendation.—** *In areas of high latitude where it is determined by the appropriate authority that reference to Magnetic North is impractical, another suitable reference, i.e. True North or Grid North, should be used.*

7.8.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used its reference grid meridian shall be identified.

7.9 Aeronautical data

7.9.1 Aerodromes

All aerodromes used by international civil aviation to which an instrument approach can be made shall be shown.

Note.— Other aerodromes may be shown.

7.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas relevant to the layer of airspace, shall be depicted with their identification and vertical limits.

7.9.3 Air traffic services system

7.9.3.1 Where appropriate, the components of the established air traffic services system shall be shown.

7.9.3.1.1 The components shall include the following:

1) the radio navigation aids associated with the air traffic services system together with their names, identifications, frequencies and geographical coordinates in degrees, minutes and seconds;

2) in respect of DME, additionally the elevation of the DME site to the nearest 30 m (100 ft);

3) an indication of all designated airspace, including lateral and vertical limits and the appropriate class of airspace;

4) all ATS routes for en-route flight including route designators, required navigation performance (RNP) types, the track in both directions along each segment of the routes and, where applicable, the direction of traffic flow;

5) all significant points which define the ATS routes and are not marked by the site of a radio navigation aid, together with their name-codes and geographical coordinates in degrees, minutes and seconds;

6) in respect of way-points defining VOR/DME area navigation routes, additionally,

   a) the station identification and radio frequency of the reference VOR/DME;

   b) the bearing to the nearest tenth of a degree and the distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference VOR/DME, if the way-point is not collocated with it;

7) an indication of all compulsory and "on-request" reporting points and ATS/MET reporting points;

8) the distances between significant points constituting turning points or reporting points;

   Note.— Over-all distances between radio navigation aids may also be shown.

9) change-over points on route segments defined by reference to very high frequency omnidirectional radio ranges, indicating the distances to the navigation aids;

   Note.— Change-over points established at the mid-point between two aids, or at the intersection of two radials in the case of a route which changes direction between the aids, need not be shown for each route segment if a general statement regarding their existence is made.

10) minimum flight altitudes on ATS routes (see Annex 11, 2.21);

11) radio communication facilities listed with their frequencies.

7.9.4 Supplementary information

7.9.4.1 Details of departure and arrival routes and associated holding patterns in terminal areas shall be shown unless they are shown on an Area Chart, a Standard Departure Chart — Instrument (SID) — ICAO or a Standard Arrival Chart — Instrument (STAR) — ICAO.

Note 1.— For specifications of these charts see Chapters 8, 9 and 10.

Note 2.— Departure routes normally originate at the end of a runway; arrival routes normally terminate at the point where an instrument approach is initiated.

7.9.4.2 Where established, altimeter setting regions shall be shown and identified.

9/11/95

CHAPTER 8. AREA CHART — ICAO

8.1 Function

This chart shall provide the flight crew with information to facilitate the following phases of instrument flight:

a) the transition between the en-route phase and approach to an aerodrome;

b) the transition between take-off/missed approach and en-route phase of flight; and

c) flights through areas of complex ATS routes or airspace structure.

Note.— The function described in 8.1 c) may be satisfied by a separate chart or an inset on an Enroute Chart — ICAO.

8.2 Applicability

8.2.1 The Area Chart — ICAO shall be made available in the manner prescribed in 1.3.2 where the air traffic services routes or position reporting requirements are complex and cannot be adequately shown on an Enroute Chart — ICAO.

8.2.2 Where air traffic services routes or position reporting requirements are different for arrivals and for departures, and these cannot be shown with sufficient clarity on one chart, separate charts shall be provided.

Note.— Under certain conditions a Standard Departure Chart — Instrument (SID) — ICAO and a Standard Arrival Chart — Instrument (STAR) — ICAO may have to be provided (see Chapters 9 and 10).

8.3 Coverage and scale

8.3.1 The coverage of each chart shall extend to points that effectively show departure and arrival routes.

8.3.2 The chart shall be drawn to scale and a scale-bar shown.

8.4 Projection

8.4.1 **Recommendation.—** *A conformal projection on which a straight line approximates a great circle should be used.*

8.4.2 **Recommendation.—** *Parallels and meridians should be shown at suitable intervals.*

8.4.3 Graduation marks shall be placed at consistent intervals along the neat lines.

8.5 Identification

Each sheet shall be identified by a name associated with the airspace portrayed.

Note.— The name may be that of the air traffic services centre, the name of the largest city or town situated in the area covered by the chart or the name of the city which the aerodrome serves. Where more than one aerodrome serves the city or town, the name of the aerodrome on which the procedures are based should be added.

8.6 Culture and topography

8.6.1 Generalized shore lines of all open water areas, large lakes and rivers shall be shown except where they conflict with data more applicable to the function of the chart.

8.6.2 Area Minimum Altitudes shall be shown in a manner best suited to the particular function of the chart and the elevation characteristics of the area portrayed.

8.7 Magnetic variation

The average magnetic variation of the area covered by the chart shall be shown.

8.8 Bearings, tracks and radials

8.8.1 Bearings, tracks and radials shall be magnetic, except as provided for in 8.8.2.

8.8.2 **Recommendation.—** *In areas of high latitude, where it is determined by the appropriate authority that reference to Magnetic North is impractical, another suitable reference, i.e. True North or Grid North, should be used.*

8.8.3 Where bearings, tracks and radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used its reference grid meridian shall be identified.

8.9 Aeronautical data

8.9.1 Aerodromes

All aerodromes which affect the terminal routings shall be shown. Where appropriate a runway pattern symbol shall be used.

8.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas shall be depicted with their identification and vertical limits.

8.9.3 Air traffic services system

8.9.3.1 The components of the established relevant air traffic services system shall be shown.

8.9.3.1.1 The components shall include the following:

1) the radio navigation aids associated with the air traffic services system together with their names, identifications, frequencies and geographical coordinates in degrees, minutes and seconds;

2) in respect of DME, additionally the elevation of the DME site to the nearest 30 m (100 ft);

3) terminal radio aids which are required for outbound and inbound traffic and for holding patterns;

4) the lateral and vertical limits of all designated airspace and the appropriate class of airspace;

5) holding patterns and terminal routings, together with the route designators, and the track along each segment of the prescribed airways and terminal routings;

6) all significant points which define the terminal routings and are not marked by the site of a radio navigation aid, together with their name-codes and geographical coordinates in degrees, minutes and seconds;

7) in respect of way-points defining VOR/DME area navigation routes, additionally,

   a) the station identification and radio frequency of the reference VOR/DME;

   b) the bearing to the nearest tenth of a degree and the distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference VOR/DME, if the way-point is not collocated with it;

8) an indication of all compulsory and "on-request" reporting points;

9) the distances between significant points constituting turning points or reporting points;

   Note.— Over-all distances between radio navigation aids may also be shown.

10) change-over points on route segments defined by reference to very high frequency omnidirectional radio ranges, indicating the distances to the radio navigation aids;

   Note.— Change-over points established at mid-point between two aids, or at the intersection of two radials in the case of a route which changes direction between the aids, need not be shown for each route segment if a general statement regarding their existence is made.

11) minimum flight altitudes on ATS routes (see Annex 11, 2.21);

12) established minimum altitudes where radar vectoring on departure or arrival is provided, clearly identified;

   Note.— Where radar procedures are used to vector aircraft to or from a significant point on a published standard departure or arrival route, these may be depicted on the Area Chart — ICAO unless excessive chart clutter will result.

13) area speed and level/altitude restrictions where established;

14) radio communication facilities listed with their frequencies.

CHAPTER 9. STANDARD DEPARTURE CHART — INSTRUMENT (SID) — ICAO

9.1 Function

This chart shall provide the flight crew with information to enable it to comply with the designated standard departure route — instrument from take-off phase to the en-route phase.

Note 1.— Provisions governing the identification of standard departure routes are in Annex 11, Appendix 3; guidance material relating to the establishment of such routes is contained in the Air Traffic Services Planning Manual *(Doc 9426).*

Note 2.— Provisions governing obstacle clearance criteria and details of the minimum information to be published are contained in PANS-OPS, Volume II, Part II (Doc 8168).

9.2 Applicability

The Standard Departure Chart — Instrument (SID) — ICAO shall be made available wherever a standard departure route — instrument has been established and cannot be shown with sufficient clarity on the Area Chart — ICAO.

9.3 Coverage and scale

9.3.1 The coverage of the chart shall be sufficient to indicate the point where the departure route begins and the specified significant point at which the en-route phase of flight along a designated air traffic services route can be commenced.

Note.— The departure route normally originates at the end of a runway.

9.3.2 **Recommendation.—** *The chart should be drawn to scale.*

9.3.3 If the chart is drawn to scale, a scale-bar shall be shown.

9.3.4 When the chart is not drawn to scale the annotation "NOT TO SCALE" shall be shown and the symbol for scale-break shall be used on tracks and other aspects of the chart which are too large to be drawn to scale.

9.4 Projection

9.4.1 **Recommendation.—** *A conformal projection on which a straight line approximates a great circle should be used.*

9.4.2 **Recommendation.—** *When the chart is drawn to scale, parallels and meridians should be shown at suitable intervals.*

9.4.3 Graduation marks shall be placed at consistent intervals along the neat lines, as appropriate.

9.5 Identification

Each sheet shall be identified by the name of the city or town, or area, which the aerodrome serves, the name of the aerodrome, and where appropriate, the runway designator(s) and the designator(s) of the standard departure route(s) — instrument.

9.6 Culture and topography

9.6.1 Information essential to safe compliance with the standard departure route — instrument shall be shown.

9.6.2 **Recommendation.—** *Significant topographical and cultural features should be shown where this will facilitate the transition from visual flight to instrument flight.*

9.6.3 Area Minimum Altitudes shall be shown in a manner best suited to the particular function of the chart and to the elevation characteristics of the area portrayed.

9.7 Magnetic variation

Magnetic variation used in determining the magnetic bearings, tracks and radials shall be shown.

9.8 Bearings, tracks and radials

9.8.1 Bearings, tracks and radials shall be magnetic, except as provided for in 9.8.2.

Note.— A note to this effect may be included on the chart.

9.8.2 **Recommendation.—** *In areas of high latitude, where it is determined by the appropriate authority that reference to Magnetic North is impractical, another suitable reference, i.e. True North or Grid North, should be used.*

9.8.3 Where bearings, tracks and radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used its reference grid meridian shall be identified.

9.9 Aeronautical data

9.9.1 Aerodromes

9.9.1.1 The aerodrome of departure shall be shown by the runway pattern.

9.9.1.2 All aerodromes which affect the designated standard departure route — instrument shall be shown and identified. Where appropriate the aerodrome runway patterns shall be shown.

9.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas which may affect the execution of the procedures shall be shown with their identification and vertical limits.

9.9.3 Air traffic services system

9.9.3.1 The components of the relevant air traffic services system shall be shown.

9.9.3.1.1 The components shall comprise the following:

1) a graphic portrayal of each standard departure route — instrument, including:

   a) route designator;

   b) significant points defining the route;

   c) track or radial along each segment of the route(s);

   d) distances between significant points;

   e) minimum flight altitudes along the route or route segments;

   f) altitude/flight level restrictions, where established;

   Note.— Where radar procedures are used to vector aircraft to or from a significant point on a standard departure route, they may be shown.

2) the radio navigation aid(s) associated with the route(s) including:

   a) plain language name;

   b) identification;

   c) frequency;

   d) geographical coordinates in degrees, minutes and seconds;

   e) for DME, the channel and the elevation of the DME site to the nearest 30 m (100 ft);

3) the name-codes of the significant points not marked by the site of a radio navigation aid, their geographical coordinates in degrees, minutes and seconds and the bearing to the nearest tenth of a degree and distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference radio navigation aid;

4) applicable holding patterns;

5) transition altitude/height;

6) terrain clearance information, where appropriate. A note shall be included whenever close-in obstacles penetrating obstacle identification surface (OIS) exist but which were not considered for the published procedure design gradient;

   Note.— For close-in obstacles see PANS-OPS, Volume II, Figure II-3-11.

7) area speed restrictions, where established;

8) all compulsory and "on-request" reporting points;

9) radio communication procedures, including:

   a) call sign(s) of ATS unit(s);

   b) frequency;

   c) transponder setting, where appropriate.

9.9.3.2 **Recommendation.—** *A textual description of standard departure route(s) — instrument (SID) and communication failure procedures in relation to radar control should be provided and should, whenever feasible, be shown on the chart or on the same page which contains the chart.*

CHAPTER 10. STANDARD ARRIVAL CHART — INSTRUMENT (STAR) — ICAO

10.1 Function

This chart shall provide the flight crew with information to enable it to comply with the designated standard arrival route — instrument from the en-route phase to the approach phase.

Note 1.— Standard arrival routes — instrument are to be interpreted as including "standard descent profiles", "continuous descent approach", and other non-standard descriptions. In the case of a standard descent profile, the depiction of a cross-section is not required.

Note 2.— Provisions governing the identification of standard arrival routes are in Annex 11, Appendix 3; guidance material relating to the establishment of such routes is contained in the Air Traffic Services Planning Manual *(Doc 9426).*

10.2 Applicability

The Standard Arrival Chart — Instrument (STAR) — ICAO shall be made available wherever a standard arrival route — instrument has been established and cannot be shown with sufficient clarity on the Area Chart.

10.3 Coverage and scale

10.3.1 The coverage of the chart shall be sufficient to indicate the points where the en-route phase ends and the approach phase begins.

10.3.2 **Recommendation.—** *The chart should be drawn to scale.*

10.3.3 If the chart is drawn to scale, a scale-bar shall be shown.

10.3.4 When the chart is not drawn to scale the annotation "NOT TO SCALE" shall be shown and the symbol for scale break shall be used on tracks and other aspects of the chart which are too large to be drawn to scale.

10.4 Projection

10.4.1 **Recommendation.—** *A conformal projection on which a straight line approximates a great circle should be used.*

10.4.2 **Recommendation.—** *When the chart is drawn to scale, parallels and meridians should be shown at suitable intervals.*

10.4.3 Graduation marks shall be placed at consistent intervals along the neat lines, as appropriate.

10.5 Identification

Each sheet shall be identified by the name of the city or town, or area, which the aerodrome serves, the name of the aerodrome, and where appropriate, the runway designator(s) and the designator(s) of the standard arrival route(s) — instrument.

10.6 Culture and topography

10.6.1 Information essential to safe compliance with the standard arrival route — instrument shall be shown.

10.6.2 **Recommendation.—** *Significant topographical and cultural features should be shown where this will facilitate the transition from instrument flight to visual flight.*

10.6.3 Area Minimum Altitudes shall be shown in a manner best suited to the particular function of the chart and to the elevation characteristics of the area portrayed.

10.7 Magnetic variation

Magnetic variation used in determining the magnetic bearings, tracks and radials shall be shown.

10.8 Bearings, tracks and radials

10.8.1 Bearings, tracks and radials shall be magnetic, except as provided for in 10.8.2.

Note.— A note to this effect may be included on the chart.

10.8.2 **Recommendation.—** *In areas of high latitude, where it is determined by the appropriate authority that reference to Magnetic North is impractical, another suitable reference, i.e. True North or Grid North, should be used.*

10.8.3 Where bearings, tracks and radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used its reference grid meridian shall be identified.

10.9 Aeronautical data

10.9.1 Aerodromes

10.9.1.1 The aerodrome of landing shall be shown by the runway pattern.

10.9.1.2 All aerodromes which affect the designated standard arrival route — instrument shall be shown and identified. Where appropriate the aerodrome runway patterns shall be shown.

10.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas which may affect the execution of the procedures shall be shown with their identification and vertical limits.

10.9.3 Air traffic services system

10.9.3.1 The components of the relevant air traffic services system shall be shown.

10.9.3.1.1 The components shall comprise the following:

1) a graphic portrayal of each standard arrival route — instrument, including:

   a) route designator;

   b) significant points defining the route;

   c) track or radial along each segment of the route;

   d) distances between significant points;

   e) minimum flight altitudes along the route or route segments;

   f) altitude/flight level restrictions, where applicable;

   Note.— Where radar procedures are used to vector aircraft to or from a significant point on a standard arrival route they may be shown.

2) the radio navigation aid(s) associated with the route(s) including:

   a) plain language name;

   b) identification;

   c) frequency;

   d) geographical coordinates in degrees, minutes and seconds;

   e) for DME, the channel and the elevation of the DME site to the nearest 30 m (100 ft);

3) the name-codes of the significant points not marked by the site of a radio navigation aid, their geographical coordinates in degrees, minutes and seconds and the bearing to the nearest tenth of a degree and distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference radio navigation aid;

4) applicable holding patterns;

5) transition altitude/height;

6) terrain clearance information, where appropriate;

7) area speed restrictions, where established;

8) all compulsory and "on-request" reporting points;

9) radio communication procedures, including:

   a) call sign(s) of ATS unit(s);

   b) frequency;

   c) transponder setting, where appropriate.

10.9.3.2 **Recommendation.—** *A textual description of standard arrival route(s) — instrument (STAR) and communication failure procedures in relation to radar control, should be provided and should whenever feasible, be shown on the chart or on the same page which contains the chart.*

CHAPTER 11. INSTRUMENT APPROACH CHART — ICAO

11.1 Function

This chart shall provide flight crews with information which will enable them to perform an approved instrument approach procedure to the runway of intended landing including the missed approach procedure and where applicable, associated holding patterns.

Note.— Detailed criteria for the establishment of instrument approach procedures are contained in the Procedures for Air Navigation Services — Aircraft Operations *(Doc 8168), Vol. II.*

11.2 Applicability

11.2.1 Instrument Approach Charts — ICAO shall be made available for all aerodromes used by international civil aviation where instrument approach procedures have been established by the State concerned.

11.2.2 A separate Instrument Approach Chart — ICAO shall normally be provided for each precision approach procedure established by the State.

11.2.3 A separate Instrument Approach Chart — ICAO shall normally be provided for each non-precision approach procedure established by the State.

Note.— A single precision or non-precision approach procedure chart may be provided to portray more than one approach procedure when the procedures for the intermediate approach, final approach and missed approach segments are identical.

11.2.4 When the values for track, time or altitude differ between categories of aircraft on other than the final approach segment of the instrument approach procedures and the listing of these differences on a single chart could cause clutter or confusion, more than one chart shall be provided.

Note.— For categories of aircraft, see Procedures for Air Navigation Services — Aircraft Operations *(Doc 8168), Vol. II, Part III, Chapter 1.*

11.2.5 Instrument Approach Charts — ICAO shall be revised whenever information essential to safe operation becomes out of date.

11.3 Coverage and scale

11.3.1 The coverage of the chart shall be sufficient to include all segments of the instrument approach procedure and such additional areas as may be necessary for the type of approach intended.

11.3.2 The scale selected shall ensure optimum legibility consistent with:

1) the procedure shown on the chart;

2) sheet size.

11.3.3 A scale indication shall be given.

11.3.3.1 Except where this is not practicable, a distance circle with a radius of 20 km (10 NM) centred on a DME located on or close to the aerodrome, or on the aerodrome reference point where no suitable DME is available, shall be shown; its radius shall be indicated on the circumference.

11.3.3.2 **Recommendation.—** *A distance scale should be shown directly below the profile.*

11.4 Format

Recommendation.— *The sheet size should be 210 × 148 mm (8.27 × 5.82 in).*

11.5 Projection

11.5.1 A conformal projection on which a straight line approximates a great circle shall be used.

11.5.2 **Recommendation.—** *Graduation marks should be placed at consistent intervals along the neat lines.*

11.6 Identification

11.6.1 The chart shall be identified by the name of the city or town, or area, which the aerodrome serves, the name of the aerodrome, the abbreviation of the type of radio navigation aid(s) on which the instrument approach procedure or the visual manoeuvring (circling) procedure is established and the designator of the runway where applicable.

11.6.2 Where the instrument approach procedure is limited to certain categories of aircraft this shall be shown in parentheses at the end of the identification.

11.7 Culture and topography

11.7.1 Topographical information pertinent to the safe execution of the instrument approach procedure, including the missed approach procedure, associated holding procedures and visual manoeuvring (circling) procedure when established, shall be shown. Such topographical information shall be named, only when necessary, to facilitate the understanding of such procedures. When shown, the minimum shall be a delineation of land masses and significant lakes and rivers.

11.7.2 Relief shall be shown in a manner best suited to the particular elevation characteristics of the area, except as provided for in 11.10.2.6.

11.8 Magnetic variation

11.8.1 **Recommendation.—** *The magnetic variation should be shown.*

11.8.2 When shown the value of the variation shall agree with that used in determining magnetic bearings, tracks and radials.

11.9 Bearings, tracks and radials

11.9.1 Bearings, tracks and radials shall be magnetic except as provided for in 11.9.2.

Note.— A note to this effect may be included on the chart.

11.9.2 **Recommendation.—** *In areas of high latitude where it is determined by the appropriate authority that reference to Magnetic North is impractical, another suitable reference, i.e. True North or Grid North, should be used.*

11.9.3 Where bearings, tracks and radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used its reference grid meridian shall be identified.

11.10 Aeronautical data

11.10.1 Aerodromes

11.10.1.1 All aerodromes which show a distinctive pattern from the air shall be shown by the appropriate symbol. Abandoned aerodromes shall be identified as abandoned.

11.10.1.2 The runway pattern, at a scale sufficiently large to show it clearly, shall be shown for:

1) the aerodrome on which the procedure is based;

2) aerodromes affecting the traffic pattern or so situated as to be likely, under adverse weather conditions, to be mistaken for the aerodrome of intended landing.

11.10.1.3 The aerodrome elevation shall be shown in a prominent position on the chart.

11.10.1.4 The threshold elevation shall be shown or, where applicable, the highest elevation of the touchdown zone.

11.10.2 Obstacles

11.10.2.1 Significant obstacles shall be shown, except as provided for in 11.10.2.6.

11.10.2.2 **Recommendation.—** *If one or more obstacles are the determining factor of an obstacle clearance altitude/height, those obstacles should be identified.*

11.10.2.3 The elevation of the top of obstacles shall be shown to the nearest (next higher) metre or foot.

11.10.2.4 **Recommendation.—** *The heights of obstacles above a datum other than mean sea level (see 11.10.2.3) should be shown. When shown, they should be given in parentheses on the chart.*

11.10.2.5 When the heights of obstacles above a datum other than mean sea level are shown, the datum shall be the aerodrome elevation except that, at aerodromes having an instrument runway (or runways) with a threshold elevation more than 2 m (7 ft) below the aerodrome elevation, the chart datum shall be the threshold elevation of the runway to which the instrument approach is related.

11.10.2.6 **Recommendation.—** *As provided for under and as an alternative to the provisions in 11.7.2 and 11.10.2.1 the information on relief and significant obstacles should be combined with the area minimum altitude and portrayed on an area basis as appropriate.*

11.10.2.7 Where a datum other than mean sea level is used, it shall be stated in a prominent position on the chart.

11.10.2.8 Where an obstacle free zone has been established for a precision approach runway category I, this shall be indicated or described.

11.10.3 Prohibited, restricted and danger areas

Prohibited areas, restricted areas, and danger areas which may affect the execution of the procedures shall be shown with their identification and vertical limits.

11.10.4 Radio communication facilities and navigation aids

11.10.4.1 Radio navigation aids required for the procedures together with their frequencies, identifications and track-defining characteristics, if any, shall be shown.

11.10.4.2 The final approach fix (or final approach point for an ILS approach procedure) and other essential fixes or points comprising the procedure shall be shown and identified.

11.10.4.3 **Recommendation.—** *The final approach fix (or final approach point for an ILS approach procedure) should be identified with its geographical coordinates in degrees, minutes, seconds and hundredths of seconds.*

11.10.4.4 Radio navigation aids that might be used in diversionary procedures together with their track-defining characteristics, if any, shall be shown or indicated on the chart.

11.10.4.5 Radio communication frequencies, including call signs, that are required for the execution of the procedures shall be shown.

11.10.4.6 When required by the procedures, the distance to the aerodrome from each radio navigation aid concerned with the final approach shall be shown. When no track-defining aid indicates the bearing of the aerodrome, the bearing shall also be shown.

11.10.5 Minimum sector altitude

The minimum sector altitude established by the competent authority shall be shown, with a clear indication of the sector to which it applies.

11.10.6 Portrayal of procedure tracks

11.10.6.1 The plan view shall show the following information in the manner indicated:

a) the approach procedure track by an arrowed continuous line indicating the direction of flight;

b) the missed approach procedure track by an arrowed broken line;

c) any additional procedure track, other than those specified in a) and b), by an arrowed dotted line;

d) bearings, tracks, radials and distances or times required for the procedure;

e) where no track-defining aid is available, the magnetic bearing to the aerodrome from the radio navigation aids concerned with the final approach;

f) the boundaries of any sector in which visual manoeuvring (circling) is prohibited;

g) where specified the holding pattern and minimum holding altitude/height associated with the approach and missed approach;

h) caution notes where required, prominently displayed on the face of the chart.

11.10.6.2 **Recommendation.—** *The plan view should show the distance to the aerodrome from each radio navigation aid concerned with the final approach.*

11.10.6.3 A profile shall be provided normally below the plan view showing the following data:

a) the aerodrome by a solid block at aerodrome elevation;

b) the approach procedure track by an arrowed continuous line indicating the direction of flight;

c) the missed approach procedure track by an arrowed broken line and a description of the procedure;

d) any additional procedure track, other than those specified in b) and c) by an arrowed dotted line;

e) bearings, tracks, radials and distances or times required for the procedure;

f) altitude/heights required by the procedures, including transition altitude, where established;

g) limiting distance on procedure turn, when specified;

h) the intermediate approach fix or point, on procedures where no course reversal is authorized.

11.10.6.4 **Recommendation.—** *Heights required by procedures should be shown in parentheses, using the height datum selected in accordance with 11.10.2.5.*

Note 1.— A ground profile may be shown, and a line representing the aerodrome elevation extended across the whole width of the chart.

Note 2.— The ground profile may depict the highest points of elevation occurring within the procedure approach areas. In addition, significant obstacles which occur within 0.9 km (0.5 NM) outside these approach areas may be shown on the profile by a dashed line in addition to the normal line of the profile.

11.10.7 Aerodrome operating minima

11.10.7.1 Aerodrome operating minima when established by the State shall be shown.

11.10.7.2 The obstacle clearance altitudes/heights as appropriate shall be shown.

11.10.8 Supplementary information

11.10.8.1 When the missed approach point is defined by:

— a distance from the final approach fix, or

— a facility or a fix and the corresponding distance from the final approach fix,

the distance and a table showing ground speeds and times from the final approach fix to the missed approach point shall be shown.

11.10.8.2 **Recommendation.—** *When DME is available for use in the final approach segment, a table showing altitudes/heights for each 2 km or 1 NM as appropriate should be shown.*

Note.— For procedures in which DME is not required for use in the final approach segment but where a suitably located DME is available to provide advisory descent profile information, a table showing the altitudes/heights may be included.

11.10.8.3 **Recommendation.—** *A rate of descent table should be shown.*

11.10.8.4 Final approach descent gradient for VOR and NDB procedures with a final approach fix shall be shown.

11.10.8.5 On charts depicting ILS approach procedures the height of the ILS reference datum and the glide path angle shall be shown.

CHAPTER 12. VISUAL APPROACH CHART — ICAO

12.1 Function

This chart shall provide flight crews with information which will enable them to transit from the en-route/descent to approach phases of flight to the runway of intended landing by means of visual reference.

12.2 Applicability

The Visual Approach Chart — ICAO shall be made available in the manner prescribed in 1.3.2 for all aerodromes used by international civil aviation where:

1) only limited navigation facilities are available; or

2) radio communication facilities are not available; or

3) no adequate aeronautical charts of the aerodrome and its surroundings at 1:500 000 or greater scale are available; or

4) visual approach procedures have been established.

12.3 Scale

12.3.1 The scale shall be sufficiently large to permit depiction of significant features and indication of the aerodrome layout.

12.3.2 **Recommendation.—** *The scale should not be smaller than 1:500 000.*

Note.— A scale of 1:250 000 or 1:200 000 is preferred.

12.3.3 **Recommendation.—** *When an Instrument Approach Chart is available for a given aerodrome, the Visual Approach Chart should be drawn to the same scale.*

12.4 Format

Recommendation.— *The sheet size should be 210 × 148 mm (8.27 × 5.82 in).*

Note.— It would be advantageous to print the charts in several colours, selected to provide maximum legibility in varying degrees and kinds of light.

12.5 Projection

12.5.1 A conformal projection on which a straight line approximates a great circle shall be used.

12.5.2 **Recommendation.—** *Graduation marks should be placed at consistent intervals along the neat lines.*

12.6 Identification

The chart shall be identified by the name of the city or town which the aerodrome serves and the name of the aerodrome.

12.7 Culture and topography

12.7.1 Natural and cultural landmarks shall be shown (e.g. bluffs, cliffs, sand dunes, cities, towns, roads, railroads, isolated lighthouses, etc.).

12.7.1.1 **Recommendation.—** *Geographical place names should be included only when they are required to avoid confusion or ambiguity.*

12.7.2 Shore lines, lakes, rivers and streams shall be shown.

12.7.3 Relief shall be shown in a manner best suited to the particular elevation and obstacle characteristics of the area covered by the chart.

12.7.4 **Recommendation.—** *When shown, spot elevations should be carefully selected.*

Note.— The value of certain spot elevations/heights in relation to both mean sea level and aerodrome elevation may be given.

12.7.5 The figures relating to different reference levels shall be clearly differentiated in their presentation.

12.8 Magnetic variation

The magnetic variation shall be shown.

12.9 Bearings, tracks and radials

12.9.1 Bearings, tracks and radials shall be magnetic except as provided for in 12.9.2.

12.9.2 **Recommendation.—** *In areas of high latitude where it is determined by the appropriate authority that reference to Magnetic North is impractical another suitable reference, i.e. True North or Grid North, should be used.*

12.9.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used its reference grid meridian shall be identified.

12.10 Aeronautical data

12.10.1 Aerodromes

12.10.1.1 All aerodromes shall be shown by the runway pattern. Restrictions on the use of any landing direction shall be indicated. Where there is any risk of confusion between two neighbouring aerodromes this shall be indicated. Abandoned aerodromes shall be identified as abandoned.

12.10.1.2 The aerodrome elevation shall be shown in a prominent position on the chart.

12.10.2 Obstacles

12.10.2.1 Significant obstacles shall be shown and identified.

12.10.2.2 The elevation of the top of obstacles shall be shown to the nearest (next higher) metre or foot.

12.10.2.3 **Recommendation.—** *The heights of obstacles above the aerodrome elevation should be shown.*

12.10.2.3.1 When the heights of obstacles are shown, the height datum shall be stated in a prominent position on the chart and the heights shall be given in parentheses on the chart.

12.10.3 Prohibited, restricted and danger areas

Prohibited areas, restricted areas, and danger areas shall be depicted with their identification and vertical limits.

12.10.4 Designated airspace

Where applicable, control zones and aerodrome traffic zones shall be depicted with their vertical limits and the appropriate class of airspace.

12.10.5 Visual approach information

12.10.5.1 Visual approach procedures shall be shown where applicable.

12.10.5.2 Visual aids for navigation shall be shown as appropriate.

12.10.5.3 Location and type of the visual approach slope indicator systems with their nominal approach slope angle(s), minimum eye height(s) over the threshold of the on-slope signal(s), and where the axis of the system is not parallel to the runway centre line, the angle and direction of displacement, i.e. left or right, shall be shown.

12.10.6 Supplementary information

12.10.6.1 Radio navigation aids together with their frequencies and identifications shall be shown as appropriate.

12.10.6.2 Radio communication facilities with their frequencies shall be shown as appropriate.

CHAPTER 13. AERODROME/HELIPORT CHART — ICAO

13.1 Function

This chart shall provide flight crews with information which will facilitate the ground movement of aircraft:

a) from the aircraft stand to the runway; and

b) from the runway to the aircraft stand;

and helicopter movement:

a) from the helicopter stand to the touchdown and lift-off area and to the final approach and take-off area;

b) from the final approach and take-off area to the touchdown and lift-off area and to the helicopter stand;

c) along helicopter ground and air taxiways; and

d) along air transit routes;

it shall also provide essential operational information at the aerodrome/heliport.

13.2 Applicability

13.2.1 The Aerodrome/Heliport Chart — ICAO shall be made available in the manner prescribed in 1.3.2 for all aerodromes/heliports regularly used by international civil aviation.

13.2.2 **Recommendation.—** *The Aerodrome/Heliport Chart — ICAO should be made available also, in the manner prescribed in 1.3.2, for all other aerodromes/heliports available for use by international civil aviation.*

Note.— Under certain conditions an Aerodrome Ground Movement Chart — ICAO and an Aircraft Parking/Docking Chart — ICAO may have to be provided (see Chapters 14 and 15); in which case, the elements portrayed on these supplementary charts need not be duplicated on the Aerodrome/Heliport Chart — ICAO.

13.3 Coverage and scale

13.3.1 The coverage and scale shall be sufficiently large to show clearly all the elements listed in 13.6.1.

13.3.2 A linear scale shall be shown.

13.4 Identification

The chart shall be identified by the name of the city or town, or area, which the aerodrome/heliport serves and the name of the aerodrome/heliport.

13.5 Magnetic variation

True and Magnetic North arrows and annual change of the magnetic variation shall be shown.

13.6 Aerodrome/heliport data

13.6.1 This chart shall show:

a) geographical coordinates in degrees, minutes and seconds for the aerodrome/heliport reference point;

b) elevations of the aerodrome/heliport, runway thresholds, highest point of touchdown zones and apron (pre-flight altimeter check locations) where applicable;

c) all runways including those under construction with designation number, length, width, bearing strength, displaced thresholds, stopways, clearways, runway directions to the nearest degree magnetic, type of surface, and runway markings;

Note.— Bearing strengths may be shown in tabular form on the face or verso of the chart.

d) all aprons, with aircraft/helicopter stands, lighting, markings and other visual guidance and control aids, where applicable, including location and type of visual docking guidance systems, type of surface for heliports, and bearing strengths or aircraft type restrictions where the bearing strength is less than that of the associated runways;

Note.— Bearing strengths or aircraft type restrictions may be shown in tabular form on the face or verso of the chart.

e) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for thresholds geometric centre of touchdown and lift-off area and/or thresholds of the final approach and take-off area (where appropriate) and aircraft stands;

f) all taxiways, helicopter air and ground taxiways with type of surface, helicopter air transit routes, with designations, width, lighting, markings, including taxi holding positions and stop bars, other visual guidance and control aids, and bearing strength or aircraft type restrictions where the bearing strength is less than that of the associated runways;

Note.— Bearing strengths or aircraft type restrictions may be shown in tabular form on the face or verso of the chart.

g) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for appropriate taxiway centre line points;

h) where established, standard routes for taxiing aircraft with their designators;

i) the boundaries of the air traffic control service;

j) position of transmissometers;

k) approach and runway lighting;

l) location and type of the visual approach slope indicator systems with their nominal approach slope angle(s), minimum eye height(s) over the threshold of the on-slope signal(s), and where the axis of the system is not parallel to the runway centre line, the angle and direction of the displacement, i.e. left or right;

m) radio communication facilities;

n) significant obstacles to taxiing;

o) aircraft servicing areas and buildings of operational significance;

p) VOR check-point and radio frequency of the aid concerned;

q) any part of the depicted movement area permanently unsuitable for aircraft, clearly identified as such.

13.6.2 In addition to the items in 13.6.1 relating to heliports, the chart shall show:

a) heliport type;

Note.— Heliport types are identified in Annex 14, Volume II as surface-level, elevated or helideck.

b) touchdown and lift-off area including dimensions, slope, type of surface and bearing strength in tonnes;

c) final approach and take-off area including type, true bearing, designation number (where appropriate), length, width, slope and type of surface;

d) safety area including length, width and type of surface;

e) helicopter clearway including length and ground profile;

f) significant obstacles including type and elevation of the top of the obstacles to the nearest (next higher) metre or foot;

g) visual aids for approach procedures, marking and lighting of final approach and take-off area, and of touchdown and lift-off area;

h) declared distances for heliports, where relevant, including:

1) take-off distance available;

2) rejected take-off distance available;

3) landing distance available.

CHAPTER 14. AERODROME GROUND MOVEMENT CHART — ICAO

14.1 Function

This supplementary chart shall provide flight crews with detailed information to facilitate the ground movement of aircraft to and from the aircraft stands and the parking/docking of aircraft.

14.2 Applicability

Recommendation.— *The Aerodrome Ground Movement Chart — ICAO should be made available in the manner prescribed in 1.3.2 where, due to congestion of information, details necessary for the ground movement of aircraft along the taxiways to and from the aircraft stands cannot be shown with sufficient clarity on the Aerodrome/Heliport Chart — ICAO.*

14.3 Coverage and scale

14.3.1 The coverage and scale shall be sufficiently large to show clearly all the elements listed in 14.6.1.

14.3.2 **Recommendation.**— *A linear scale should be shown.*

14.4 Identification

The chart shall be identified by the name of the city or town which the aerodrome serves and the name of the aerodrome.

14.5 Magnetic variation

14.5.1 A True North arrow shall be shown.

14.5.2 **Recommendation.**— *Magnetic variation and its annual change should be shown.*

Note.— This chart need not be True North orientated.

14.6 Aerodrome data

This chart shall show in a similar manner all the information on the Aerodrome/Heliport Chart — ICAO relevant to the area depicted, including:

a) apron elevation;

b) aprons, with aircraft stands, bearing strengths or aircraft type restrictions, lighting, marking and other visual guidance and control aids, where applicable, including location and type of visual docking guidance systems;

c) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for aircraft stands;

d) taxiways with designations, width, bearing strength or aircraft type restrictions where applicable, lighting, markings, including taxi holding positions and stop bars and other visual guidance and control aids;

e) where established, standard routes for taxiing aircraft, with their designators;

f) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for appropriate taxiway centre line points;

g) the boundaries of the air traffic control service;

h) relevant radio communication facilities listed with their frequencies;

i) significant obstacles to taxiing;

j) aircraft servicing areas and buildings of operational significance;

k) VOR check-point and radio frequency of the aid concerned;

l) any part of the depicted movement area permanently unsuitable for aircraft, clearly identified as such.

CHAPTER 15. AIRCRAFT PARKING/DOCKING CHART — ICAO

15.1 Function

This supplementary chart shall provide flight crews with detailed information to facilitate the ground movement of aircraft between the taxiways and the aircraft stands and the parking/docking of aircraft.

15.2 Applicability

Recommendation.— *The Aircraft Parking/ Docking Chart — ICAO should be made available in the manner prescribed in 1.3.2 where, due to the complexity of the terminal facilities, the information cannot be shown with sufficient clarity on the Aerodrome/Heliport Chart — ICAO or on the Aerodrome Ground Movement Chart — ICAO.*

15.3 Coverage and scale

15.3.1 The coverage and scale shall be sufficiently large to show clearly all the elements listed in 15.6.

15.3.2 **Recommendation.—** *A linear scale should be shown.*

15.4 Identification

The chart shall be identified by the name of the city or town which the aerodrome serves and the name of the aerodrome.

15.5 Magnetic variation

15.5.1 A True North arrow shall be shown.

15.5.2 **Recommendation.—** *Magnetic variation and its annual change should be shown.*

Note.— This chart need not be True North orientated.

15.6 Aerodrome data

This chart shall show in a similar manner all the information on the Aerodrome/Heliport Chart — ICAO and the Aerodrome Ground Movement Chart — ICAO relevant to the area depicted, including:

a) apron elevation;

b) aprons with aircraft stands, bearing strengths or aircraft type restrictions, lighting, marking and other visual guidance and control aids, where applicable, including location and type of visual docking guidance systems;

c) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for aircraft stands;

d) taxiway entries with designations, including taxi holding positions and stop bars;

e) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for appropriate taxiway centre line points;

f) the boundaries of the air traffic control service;

g) relevant radio communication facilities listed with their frequencies;

h) significant obstacles to taxiing;

i) aircraft servicing areas and buildings of operational significance;

j) VOR check-point and radio frequency of the aid concerned;

k) any part of the depicted movement area permanently unsuitable for aircraft clearly identified as such.

CHAPTER 16. WORLD AERONAUTICAL CHART — ICAO 1:1 000 000

16.1 Function

This chart shall provide information to satisfy the requirements of visual air navigation.

Note.— This chart may also serve:

1) as a basic aeronautical chart:

a) when highly specialized charts lacking visual information do not provide essential data;

b) to provide complete world coverage at a constant scale with a uniform presentation of planimetric data;

c) in the production of other charts required by international civil aviation;

2) as a pre-flight planning chart.

16.2 Applicability

16.2.1 The World Aeronautical Chart — ICAO 1:1 000 000 shall be made available in the manner prescribed in 1.3.2 for all areas delineated in Appendix 5.

Note.— When operational or chart production considerations indicate that operational requirements can be effectively satisfied by Aeronautical Charts — ICAO 1:500 000 or Aeronautical Navigation Charts — ICAO Small Scale, either of these charts may be made available instead of the basic 1:1 000 000 chart.

16.2.2 **Recommendation.—** *To ensure complete coverage of all land areas and adequate continuity in any one co-ordinated series, the selection of a scale of other than 1:1 000 000 should be determined by regional agreement.*

16.3 Scales

16.3.1 Linear scales for kilometres and nautical miles arranged in the following order:

— kilometres,

— nautical miles,

with their zero points in the same vertical line shall be shown in the margin.

16.3.1.1 **Recommendation.—** *The length of the linear scales should represent at least 200 km (110 NM).*

16.3.2 A conversion scale (metres/feet) shall be shown in the margin.

16.4 Format

16.4.1 **Recommendation.—** *The title and marginal notes should be in one of the ICAO working languages.*

Note.— The language of the publishing country may be used in addition to the ICAO working language.

16.4.2 The information regarding the number of the adjoining sheets and the unit of measurement to express elevations shall be so located as to be clearly visible when the sheet is folded.

16.4.3 **Recommendation.—** *The method of folding should be as follows:*

Fold the chart on the long axis, near the mid-parallel of latitude, face out; with the bottom half of the chart face upward, fold inwards near the meridian, and fold both halves backward in accordion folds.

16.4.4 **Recommendation.—** *Whenever practicable, the sheet lines should conform with those shown in the index in Appendix 5.*

Note 1.— The area covered by a sheet may vary from the lines shown to satisfy particular requirements.

Note 2.— The value of adopting identical sheet lines for ICAO 1:1 000 000 Charts and the corresponding sheet of the International Map of the World (IMW), provided aeronautical requirements are not compromised, is recognized.

16.4.5 The sheet lines used shall be notified to ICAO for publication in the ICAO *Aeronautical Chart Catalogue* (Doc 7101).

16.4.6 **Recommendation.—** *Overlaps should be provided by extending the chart area on the top and right side beyond the area given on the index. This overlap area should contain all aeronautical, topographical, hydrographical and cultural information. The overlap should extend up to 28 km (15 NM) if possible but in any case from the limiting parallels and meridians of each chart to the neat line.*

16.5 Projection

16.5.1 The projections shall be as follows:

1) between the Equator and 80° latitude: the Lambert conformal conic projection, in separate bands for each tier of charts. The standard parallels for each 4° band shall be 40′ south of the northern parallel and 40′ north of the southern parallel;

2) between 80° and 90° latitude: the Polar stereographic projection with scale matching that of the Lambert conformal conic projection at latitude 80°, except that in the northern hemisphere the Lambert conformal conic projection may be used between 80° and 84° latitude and the Polar stereographic projection between 84° and 90° with the scales matching at 84° North.

16.5.2 Graticules and graduations shall be shown as follows:

1) Parallels:

Latitude	*Distance between parallels*	*Graduations on parallels*
0° to 72°	30′	1′
72° to 84°	30′	5′
84° to 89°	30′	1°
89° to 90°	30′	5° (Only on degree parallels from 72° to 89°)

2) Meridians:

Latitude	*Interval between meridians*	*Graduations on meridians*
0° to 52°	30′	1′
52° to 72°	30′	1′ (Only on even numbered meridians)
72° to 84°	1°	1′
84° to 89°	5°	1′
89° to 90°	15°	1′ (Only on every fourth meridian)

16.5.3 The graduation marks at 1′ and 5′ intervals shall extend away from the Greenwich Meridian and from the Equator. Each 10′ interval shall be shown by a mark on both sides of the graticule line.

16.5.3.1 **Recommendation.—** *The length of the graduation marks should be approximately 1.3 mm (0.05 in) for the 1′ intervals, and 2 mm (0.08 in) for the 5′ intervals and 2 mm (0.08 in) extending on both sides of the graticule line for the 10′ intervals.*

16.5.4 All meridians and parallels shall be numbered in the borders of the charts. In addition, each parallel shall be numbered within the body of the chart in such a manner that the parallel can be readily identified when the chart is folded.

Note.— Meridians may be numbered within the body of the chart.

16.5.5 The name and basic parameters of the projection shall be indicated in the margin.

16.6 Identification

Sheet numbering shall be in conformity with the index in Appendix 5.

Note.— The corresponding International Map of the World (IMW) sheet number may also be shown.

16.7 Culture and topography

16.7.1 Built-up areas

16.7.1.1 Cities, towns and villages shall be selected and shown according to their relative importance to visual air navigation.

16.7.1.2 **Recommendation.—** *Cities and towns of sufficient size should be indicated by the outline of their built-up areas and not of their established city limits.*

16.7.2 Railroads

16.7.2.1 All railroads having landmark value shall be shown.

Note 1.— In congested areas, some railroads may be omitted in the interest of legibility.

Note 2.— Railroads may be named where space permits.

16.7.2.2 **Recommendation.—** *Important tunnels should be shown.*

Note.— A descriptive note may be added.

16.7.3 Highways and roads

16.7.3.1 Road systems shall be shown in sufficient detail to indicate significant patterns from the air.

16.7.3.2 **Recommendation.—** *Roads should not be shown in built-up areas unless they can be distinguished from the air as definite landmarks.*

Note.— The numbers or names of important highways may be shown.

16.7.4 Landmarks

Recommendation.— *Natural and cultural landmarks, such as bridges, prominent transmission lines, permanent cable car installations, mine structures, forts, ruins, levees, pipelines, and rocks, bluffs, cliffs, sand dunes, isolated lighthouses, lightships, etc., when considered to be of importance for visual air navigation, should be shown.*

Note.— Descriptive notes may be added.

16.7.5 Political boundaries

International boundaries shall be shown. Undemarcated and undefined boundaries shall be distinguished by descriptive notes.

16.7.6 Hydrography

16.7.6.1 All water features compatible with the scale of the chart comprising shore lines, lakes, rivers and streams (including those non-perennial in nature), salt lakes, glaciers and ice caps shall be shown.

16.7.6.2 **Recommendation.—** *The tint covering large open water areas should be kept very light.*

Note.— A narrow band of darker tone may be used along the shore line to emphasize this feature.

16.7.6.3 **Recommendation.—** *Reefs and shoals including rocky ledges, tidal flats, isolated rocks, sand, gravel, stone and all similar areas should be shown by symbols when of significant landmark value.*

Note.— Groups of rocks may be shown by a few representative rock symbols within the area.

16.7.7 Contours

16.7.7.1 Contours shall be shown. The selection of intervals shall be governed by the requirement to depict clearly the relief features required in air navigation.

16.7.7.2 The values of the contours used shall be shown.

16.7.8 Hypsometric tints

16.7.8.1 When hypsometric tints are used the range of elevations for the tints shall be shown.

16.7.8.2 The scale of the hypsometric tints used on the chart shall be shown in the margin.

16.7.9 Spot elevations

16.7.9.1 Spot elevations shall be shown at selected critical points. The elevations selected shall always be the highest in the immediate vicinity and shall generally indicate the top of a peak, ridge, etc. Elevations in valleys and at lake surface levels which are of special value to the aviator shall be shown. The position of each selected elevation shall be indicated by a dot.

16.7.9.2 The elevation (in metres or feet) of the highest point on the chart and its geographical position to the nearest five minutes shall be indicated in the margin.

16.7.9.3 **Recommendation.—** *The spot elevation of the highest point in any sheet should be cleared of hypsometric tinting.*

16.7.10 Incomplete or unreliable relief

16.7.10.1 Areas that have not been surveyed for contour information shall be labelled "Relief data incomplete".

16.7.10.2 Charts on which spot elevations are generally unreliable shall bear a warning note prominently displayed on the face of the chart in the colour used for aeronautical information, as follows:

"Warning — The reliability of relief information on this chart is doubtful and elevations should be used with caution."

16.7.11 Escarpments

Recommendation.— *Escarpments should be shown when they are prominent landmarks or when cultural detail is very sparse.*

16.7.12 Wooded areas

16.7.12.1 **Recommendation.—** *Wooded areas should be shown.*

Note.— On high latitude charts, the approximate extreme northern or southern limits of tree growth may be shown.

16.7.12.2 Where shown, the approximate extreme northern or southern limits of tree growth shall be indicated by a dashed black line and shall be appropriately labelled.

16.7.13 Date of topographic information

The date of latest information shown on the topographic base shall be indicated in the margin.

16.8 Magnetic variation

16.8.1 Isogonic lines shall be shown.

16.8.2 The date of the isogonic information shall be indicated in the margin.

16.9 Aeronautical data

16.9.1 Aeronautical data shown shall be kept to a minimum consistent with the use of the chart for visual navigation and the revision cycle (see 16.9.6).

16.9.2 Aerodromes

16.9.2.1 Land and water aerodromes and heliports shall be shown with their names, to the extent that they do not produce undesirable congestion on the chart, priority being given to those of greatest aeronautical significance.

16.9.2.2 The aerodrome elevation, the lighting available, the type of runway surface and the length of the longest runway or channel, shown in abbreviated form for each aerodrome in conformity with the example given in Appendix 2, provided they do not cause undesirable clutter on the chart, shall be indicated.

16.9.2.3 Abandoned aerodromes which are still recognizable as aerodromes from the air shall be shown and identified as abandoned.

16.9.3 Obstacles

16.9.3.1 Significant obstacles shall be shown.

Note.— Obstacles of a height of 100 m (300 ft) or more above ground are normally regarded as significant obstacles.

16.9.3.2 When considered of importance to visual flight, prominent transmission lines and permanent cable car installations, which are significant obstacles, shall be shown.

16.9.4 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas shall be shown.

16.9.5 Air traffic services system

Significant elements of the air traffic services system including, where practicable, control zones, aerodrome traffic zones, control areas, flight information regions and other airspaces in which VFR flights operate shall be shown together with the appropriate class of airspace.

16.9.6 Radio navigation aids

Radio navigation aids shall be shown by the appropriate symbol and named, but excluding their frequencies, coded designators, times of operation and other characteristics unless any or all of this information which is shown is kept up to date by means of new editions of the chart.

16.9.7 Supplementary information

16.9.7.1 Aeronautical ground lights together with their characteristics or their identifications or both shall be shown.

16.9.7.2 Marine lights on outer prominent coastal or isolated features of not less than 28 km (15 NM) visibility range shall be shown:

1) where they are not less distinguishable than more powerful marine lights in the vicinity;

2) where they are readily distinguishable from other marine or other types of lights in the vicinity of built-up coastal areas;

3) where they are the only lights of significance available.

CHAPTER 17. AERONAUTICAL CHART — ICAO 1:500 000

17.1 Function

This chart shall provide information to satisfy the requirements of visual air navigation for low speed, short- or medium-range operations at low and intermediate altitudes.

Note 1.— This chart may be used:

a) to serve as a basic aeronautical chart;

b) to provide a suitable medium for basic pilot and navigation training;

c) to supplement highly specialized charts which do not provide essential visual information;

d) in pre-flight planning.

Note 2.— It is intended that these charts be provided for land areas where charts of this scale are required for civil air operations employing visual air navigation independently or in support of other forms of air navigation.

Note 3.— Where States produce charts of this series covering their national territories, the entire area being portrayed is usually treated on a regional basis.

17.2 Applicability

Recommendation.— *The Aeronautical Chart — ICAO 1:500 000 should be made available in the manner prescribed in 1.3.2 for all areas delineated in Appendix 5.*

Note.— The selection of this scale as an alternative to the World Aeronautical Chart — ICAO 1:1 000 000 is covered by 16.2.1 and 16.2.2.

17.3 Scales

17.3.1 Linear scales for kilometres and nautical miles arranged in the following order:

— kilometres,

— nautical miles,

with their zero points in the same vertical line shall be shown in the margin.

17.3.1.1 **Recommendation.—** *The length of the linear scale should be not less than 200 mm (8 in).*

17.3.2 A conversion scale (metres/feet) shall be shown in the margin.

17.4 Format

17.4.1 The title and marginal notes shall be in one of the working languages of ICAO.

Note.— The language of the publishing country or any other language may be used in addition to the ICAO working language.

17.4.2 The information regarding the number of the adjoining sheets and the unit of measurement used to express elevation shall be so located as to be clearly visible when the sheet is folded.

17.4.3 **Recommendation.—** *The method of folding should be as follows:*

Fold the chart on the long axis near the mid-parallel of latitude, face out, with the bottom part of the chart face upward. Fold inwards near the meridian and fold both halves backward in accordion folds.

17.4.4 **Recommendation.—** *Whenever practicable, sheets should be quarter sheets of the World Aeronautical Chart — ICAO 1:1 000 000. An appropriate index to adjacent sheets, showing the relationship between the two chart series should be included on the face of the chart or on the reverse side.*

Note.— Sheet lines may be varied to satisfy particular requirements.

17.4.5 **Recommendation.—** *Overlaps should be provided by extending the chart area on the top and right side beyond the area given on the index. This overlap area should contain all aeronautical, topographical, hydrographical and cultural information. The overlap should extend up to 15 km (8 NM), if possible, but in any case from the limiting parallels and meridians of each chart to the neat line.*

17.5 Projection

17.5.1 A conformal (orthomorphic) projection shall be used.

17.5.2 **Recommendation.—** *The projection of the World Aeronautical Chart — ICAO 1:1 000 000 should be used.*

17.5.3 Parallels shall be shown at intervals of 30′.

17.5.3.1 Meridians shall normally be shown at intervals of 30′.

Note.— At high latitudes this interval may be increased.

17.5.4 Graduation marks shall be shown at 1′ intervals along each whole degree meridian and parallel, extending away from the Greenwich Meridian and from the Equator. Each 10′ interval shall be shown by a mark on both sides of the graticule line.

17.5.4.1 **Recommendation.—** *The length of the graduation marks should be approximately 1.3 mm (0.05 in) for the 1′ intervals, and 2 mm (0.08 in) for the 5′ intervals and 2 mm (0.08 in) extending on both sides of the graticule line for the 10′ intervals.*

17.5.5 All meridians and parallels shown shall be numbered in the borders of the chart.

17.5.5.1 **Recommendation.—** *Each meridian and parallel should be numbered within the body of the chart whenever this data is required operationally.*

17.5.6 The name and basic parameters of the projection shall be indicated in the margin.

17.6 Identification

17.6.1 Each sheet shall be identified by a name which should be that of the principal town or of a main geographical feature appearing on the sheet.

17.6.1.1 **Recommendation.—** *Where applicable, sheets should also be identified by the reference number of the corresponding World Aeronautical Chart — ICAO 1:1 000 000, with the addition of one or more of the following letter suffixes indicating the quadrant or quadrants:*

Letter	Chart quadrant
A	*North-West*
B	*North-East*
C	*South-East*
D	*South-West*

17.7 Culture and topography

17.7.1 Built-up areas

17.7.1.1 Cities, towns and villages shall be selected and shown according to their relative importance to visual air navigation.

17.7.1.2 **Recommendation.—** *Cities and towns of sufficient size should be shown by the outline of their built-up areas and not of their established city limits.*

17.7.2 Railroads

17.7.2.1 All railroads having landmark value shall be shown.

Note 1.— In congested areas, some railroads may be omitted in the interest of legibility.

Note 2.— Railroads may be named.

Note 3.— Rail stations may be shown.

17.7.2.2 Tunnels shall be shown when they serve as prominent landmarks.

Note.— A descriptive note may be added, if necessary, to accentuate this feature.

17.7.3 Highways and roads

17.7.3.1 Road systems shall be shown in sufficient detail to indicate significant patterns from the air.

Note.— Roads under construction may be shown.

17.7.3.2 **Recommendation.—** *Roads should not be shown in built-up areas unless they can be distinguished from the air as definite landmarks.*

Note.— The numbers or names of important highways may be shown.

17.7.4 Landmarks

Recommendation.— *Natural and cultural landmarks, such as bridges, mine structures, lookout towers, forts, ruins, levees, pipelines, prominent transmission lines, permanent cable car installations, and rocks, bluffs, cliffs, sand dunes, isolated lighthouses, lightships, etc., when considered to be of importance for visual air navigation, should be shown.*

Note.— Descriptive notes may be added.

17.7.5 Political boundaries

International boundaries shall be shown. Undemarcated or undefined boundaries shall be distinguished by descriptive notes.

Note.— Other boundaries may be shown.

17.7.6 Hydrography

17.7.6.1 All water features compatible with the scale of the chart comprising shore lines, lakes, rivers and streams (including those non-perennial in nature), salt lakes, glaciers and ice caps shall be shown.

17.7.6.2 **Recommendation.—** *The tint covering large open water areas should be kept very light.*

Note.— A narrow band of darker tone may be used along the shore line to emphasize this feature.

17.7.6.3 **Recommendation.—** *Reefs and shoals, including rocky ledges, tidal flats, isolated rocks, sand, gravel, stone and all similar areas should be shown by symbols when of significant landmark value.*

Note.— Groups of rocks may be shown by a few representative rock symbols within the area.

17.7.7 Contours

17.7.7.1 Contours shall be shown. The selection of intervals shall be governed by the requirement to depict clearly the relief features required in air navigation.

17.7.7.2 The values of the contours used shall be shown.

17.7.8 Hypsometric tints

17.7.8.1 When hypsometric tints are used, the range of elevations for the tints shall be shown.

17.7.8.2 The scale of the hypsometric tints used on the chart shall be shown in the margin.

17.7.9 Spot elevations

17.7.9.1 Spot elevations shall be shown at selected critical points. The elevation shall always be the highest in the immediate vicinity and shall generally indicate the top of a peak, ridge, etc. Selected elevations in valleys and at lake surface levels which are of navigational value shall be shown. The position of each selected elevation shall be indicated by a dot.

17.7.9.2 The elevation (in metres or feet) of the highest point on the chart and its geographical position to the nearest five minutes shall be indicated in the margin.

17.7.9.3 **Recommendation.—** *The spot elevation of the highest point on any sheet should be cleared of hypsometric tinting.*

17.7.10 Incomplete or unreliable relief

17.7.10.1 Areas that have not been surveyed for contour information shall be labelled "Relief data incomplete".

17.7.10.2 Charts on which spot elevations are generally unreliable shall bear a warning note prominently displayed on the face of the chart in the colour used for aeronautical information, as follows:

> "Warning — The reliability of relief information on this chart is doubtful and elevations should be used with caution."

17.7.11 Escarpments

Recommendation.— *Escarpments should be shown when they are prominent landmarks or when cultural detail is very sparse.*

17.7.12 Wooded areas

17.7.12.1 **Recommendation.—** *Wooded areas should be shown.*

Note.— On high latitude charts the approximate extreme northern or southern limits of tree growth may be shown.

17.7.12.2 Where shown, the approximate northern or southern limits of tree growth shall be indicated by a dashed black line and shall be appropriately labelled.

17.7.13 Date of topographic information

The date of latest information shown on the topographic base shall be indicated in the margin.

17.8 Magnetic variation

17.8.1 Isogonic lines shall be shown.

17.8.2 The date of the isogonic information shall be indicated in the margin.

17.9 Aeronautical data

17.9.1 Aeronautical information shall be shown consistent with the use of the chart and the revision cycle.

17.9.2 Aerodromes

17.9.2.1 Land and water aerodromes and heliports shall be shown with their names, to the extent that they do not produce undesirable congestion on the chart, priority being given to those of greatest aeronautical significance.

17.9.2.2 The aerodrome elevation, the lighting available, the type of runway surface and the length of the longest runway or channel, shown in abbreviated form for each aerodrome in conformity with the example given in Appendix 2, provided they do not cause undesirable clutter on the chart, shall be indicated.

17.9.2.3 Abandoned aerodromes which are still recognizable as aerodromes from the air shall be shown and identified as abandoned.

17.9.3 Obstacles

17.9.3.1 Significant obstacles shall be shown.

Note.— Obstacles of a height of 100 m (300 ft) or more above ground are normally regarded as significant obstacles.

17.9.3.2 When considered of importance to visual flight, prominent transmission lines and permanent cable car installations, which are significant obstacles, shall be shown.

17.9.4 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas shall be shown.

17.9.5 Air traffic services system

Significant elements of the air traffic services system including, where practicable, control zones, aerodrome traffic zones, control areas, flight information regions and other airspaces in which VFR flights operate shall be shown together with the appropriate class of airspace.

17.9.6 Radio navigation aids

Radio navigation aids shall be shown by the appropriate symbol and named, but excluding their frequencies, coded designators, times of operation and other characteristics unless any or all of this information which is shown is kept up to date by means of new editions of the chart.

17.9.7 Supplementary information

17.9.7.1 Aeronautical ground lights together with their characteristics or their identifications or both shall be shown.

17.9.7.2 Marine lights on outer prominent coastal or isolated features of not less than 28 km (15 NM) visibility range shall be shown:

1) where they are not less distinguishable than more powerful marine lights in the vicinity;

2) where they are readily distinguishable from other marine or other types of lights in the vicinity of built-up coastal areas;

3) where they are the only lights of significance available.

CHAPTER 18. AERONAUTICAL NAVIGATION CHART — ICAO SMALL SCALE

18.1 Function

This chart shall:

1) serve as an air navigation aid for flight crews of long range aircraft at high altitudes;

2) provide selective check-points over extensive ranges for identification at high altitudes and speeds, which are required for visual confirmation of position;

3) provide for continuous visual reference to the ground during long range flights over areas lacking radio or other electronic navigation aids, or over areas where visual navigation is preferred or becomes necessary;

4) provide a general purpose chart series for long range flight planning and plotting.

18.2 Applicability

Recommendation.— *The Aeronautical Navigation Chart — ICAO Small Scale should be made available in the manner prescribed in 1.3.2 for all areas delineated in Appendix 5.*

Note.— The selection of this scale as an alternative to the World Aeronautical Chart — ICAO 1:1 000 000 is covered by 16.2.1 and 16.2.2.

18.3 Coverage and scale

18.3.1 **Recommendation.—** *The Aeronautical Navigation Chart — ICAO Small Scale should provide, as a minimum, complete coverage of the major land masses of the world.*

Note 1.— A sheet layout for this series is contained in the Aeronautical Chart Manual *(Doc 8697).*

Note 2.— The sheet size may represent the maximum press size available to the producing agency.

18.3.2 The scale shall be in the range of 1:2 000 000 to 1:5 000 000.

18.3.3 The scale of the chart shall be substituted in the title for the words "Small Scale".

18.3.4 Linear scales for kilometres and nautical miles arranged in the following order:

— kilometres,

— nautical miles,

with their zero points in the same vertical line shall be shown in the margin.

18.3.5 **Recommendation.—** *The length of the linear scale should be not less than 200 mm (8 in).*

18.3.6 A conversion scale (metres/feet) shall be shown in the margin.

18.4 Format

18.4.1 The title and marginal notes shall be in one of the working languages of ICAO.

Note.— The language of the publishing country or any other language may be used in addition to the ICAO working language.

18.4.2 The information regarding the number of the adjoining sheets and the unit of measurement to express elevations shall be so located as to be clearly visible when the sheet is folded.

Note.— There is no internationally agreed sheet numbering.

18.5 Projection

18.5.1 A conformal (orthomorphic) projection shall be used.

18.5.1.1 The name and basic parameters of the projection shall be shown in the margin.

18.5.2 Parallels shall be shown at intervals of 1°.

18.5.2.1 Graduations on the parallels shall be shown at sufficiently close intervals compatible with the latitude and the scale of the chart.

18.5.3 Meridians shall be shown at intervals compatible with the latitude and the scale of the chart.

18.5.3.1 Graduations on the meridians shall be shown at intervals not exceeding 5′.

18.5.4 The graduation marks shall extend away from the Greenwich Meridian and from the Equator.

18.5.5 All meridians and parallels shown shall be numbered in the borders of the chart. In addition, when required, meridians and parallels shall be numbered within the body of the chart in such a manner that they can be readily identified when the chart is folded.

18.6 Culture and topography

18.6.1 Built-up areas

18.6.1.1 Cities, towns and villages shall be selected and shown according to their relative importance to visual air navigation.

18.6.1.2 **Recommendation.—** *Cities and towns of sufficient size should be indicated by the outline of their built-up areas and not of their established city limits.*

18.6.2 Railroads

18.6.2.1 All railroads having landmark value shall be shown.

Note.— In congested areas, some railroads may be omitted in the interest of legibility.

18.6.2.2 **Recommendation.—** *Important tunnels should be shown.*

Note.— A descriptive note may be added.

18.6.3 Highways and roads

18.6.3.1 Road systems shall be shown in sufficient detail to indicate significant patterns from the air.

18.6.3.2 **Recommendation.—** *Roads should not be shown in built-up areas unless they can be distinguished from the air as definite landmarks.*

18.6.4 Landmarks

Recommendation.— *Natural and cultural landmarks, such as bridges, prominent transmission lines, permanent cable car installations, mine structures, forts, ruins, levees, pipelines and rocks, bluffs, cliffs, sand dunes, isolated lighthouses, lightships, etc., when considered to be of importance for visual air navigation, should be shown.*

Note.— Descriptive notes may be added.

18.6.5 Political boundaries

International boundaries shall be shown. Undemarcated and undefined boundaries shall be distinguished by descriptive notes.

18.6.6 Hydrography

18.6.6.1 All water features compatible with the scale of the chart comprising shore lines, lakes, rivers and streams (including those non-perennial in nature), salt lakes, glaciers and ice caps shall be shown.

18.6.6.2 **Recommendation.—** *The tint covering large open water areas should be kept very light.*

Note.— A narrow band of darker tone may be used along the shore line to emphasize this feature.

18.6.6.3 **Recommendation.—** *Reefs and shoals including rocky ledges, tidal flats, isolated rocks, sand, gravel, stone and all similar areas should be shown by a symbol when of significant landmark value.*

18.6.7 Contours

18.6.7.1 Contours shall be shown. The selection of intervals shall be governed by the requirement to depict clearly the relief features required in air navigation.

18.6.7.2 The values of the contours used shall be shown.

18.6.8 Hypsometric tints

18.6.8.1 When hypsometric tints are used the range of elevations for the tints shall be shown.

18.6.8.2 The scale of the hypsometric tints used on the chart shall be shown in the margin.

18.6.9 Spot elevations

18.6.9.1 Spot elevations shall be shown at selected critical points. The elevations selected shall always be the highest in the immediate vicinity, and shall generally indicate the top of a peak, ridge, etc. Elevations in valleys and at lake surface levels which are of value to visual air navigation shall be shown. The position of each selected elevation shall be indicated by a dot.

18.6.9.2 The elevation (in metres or feet) of the highest point on the chart and its geographical position to the nearest five minutes shall be indicated in the margin.

18.6.9.3 **Recommendation.—** *The spot elevation of the highest point in any sheet should be cleared of hypsometric tinting.*

18.6.10 Incomplete or unreliable relief

18.6.10.1 Areas that have not been surveyed for contour information shall be labelled "Relief data incomplete".

18.6.10.2 Charts on which spot elevations are generally unreliable shall bear a warning note prominently displayed on the face of the chart in the colour used for aeronautical information, as follows:

"Warning — The reliability of relief information on this chart is doubtful and elevations should be used with caution."

18.6.11 Escarpments

Recommendation.— *Escarpments should be shown when they are prominent landmarks or when cultural detail is very sparse.*

18.6.12 Wooded areas

Recommendation.— *Wooded areas of large extent should be shown.*

18.6.13 Date of topographic information

The date of latest information shown on the topographic base shall be indicated in the margin.

18.6.14 Colours

18.6.14.1 **Recommendation.—** *Subdued colours should be used for the chart background to facilitate plotting.*

18.6.14.2 **Recommendation.—** *Good colour contrast should be ensured to emphasize features important to visual air navigation.*

18.7 Magnetic variation

18.7.1 Isogonic lines shall be shown.

18.7.2 The date of isogonic information shall be indicated in the margin.

18.8 Aeronautical data

18.8.1 Aerodromes

Land and water aerodromes and heliports shall be shown with their names, to the extent that they do not produce undesirable congestion on the chart, priority being given to those of greatest aeronautical significance.

18.8.2 Obstacles

Significant obstacles shall be shown.

18.8.3 Prohibited, restricted and danger areas

Recommendation.— *Prohibited, restricted and danger areas should be shown when considered to be of importance to air navigation.*

18.8.4 Air traffic services system

Recommendation.— *Significant elements of the air traffic services system should be shown when considered to be of importance to air navigation.*

18.8.5 Radio navigation aids

Note.— Radio aids to navigation may be shown by the appropriate symbol and named.

CHAPTER 19. PLOTTING CHART — ICAO

19.1 Function

This chart shall provide a means of maintaining a continuous flight record of the aircraft position by various fixing methods and dead reckoning in order to maintain an intended flight path.

19.2 Applicability

Recommendation.— *This chart should be made available, in the manner prescribed in 1.3.2, to cover major air routes over oceanic areas and sparsely settled areas used by international civil aviation.*

Note.— In areas where the Enroute Chart — ICAO is provided there may be no requirement for a plotting chart.

19.3 Coverage and scale

19.3.1 **Recommendation.—** *Where practicable, the chart for a particular region should cover major air routes and their terminals on a single sheet.*

19.3.2 **Recommendation.—** *The scale should be governed by the area to be covered.*

Note.— Normally the scale will range from 1:3 000 000 to 1:7 500 000.

19.4 Format

Recommendation.— *The sheet should be of a size that can be adapted for use on a navigator's plotting table.*

19.5 Projection

19.5.1 **Recommendation.—** *A conformal projection on which a straight line approximates a great circle should be used.*

19.5.2 Parallels and meridians shall be shown.

19.5.2.1 **Recommendation.—** *The intervals should be arranged to permit accurate plotting to be carried out with a minimum of time and effort.*

19.5.2.2 Graduation marks shall be shown at consistent intervals along an appropriate number of parallels and meridians. The interval selected shall, regardless of scale, minimize the amount of interpolation required for accurate plotting.

19.5.2.3 **Recommendation.—** *Parallels and meridians should be numbered so that a number appears at least once every 15 cm (6 in) on the face of the chart.*

19.5.2.4 If a navigational grid is shown on charts covering the higher latitudes, it shall comprise lines parallel to the Meridian or anti-Meridian of Greenwich.

19.6 Identification

Each sheet shall be identified by chart series and number.

19.7 Culture and topography

19.7.1 Generalized shore lines of all open water areas, large lakes and rivers shall be shown.

19.7.2 Spot elevations for selected features constituting a hazard to air navigation shall be shown.

19.7.3 **Recommendation.—** *Particularly hazardous or prominent relief features should be emphasized.*

Note.— Large cities and towns may be shown.

19.8 Magnetic variation

19.8.1 Isogonals or, in higher latitudes, isogrivs, or both, shall be shown at consistent intervals throughout the chart. The interval selected shall, regardless of scale, minimize the amount of interpolation required.

19.8.2 The date of the isogonic information shall be shown.

19.9 Aeronautical data

19.9.1 The following aeronautical data shall be shown:

1) aerodromes regularly used by international commercial air transport together with their names;

2) selected radio aids to navigation that will contribute to position-finding together with their names and identifications;

3) lattices of long-range electronic aids to navigation, as required;

4) boundaries of flight information regions, control areas and control zones necessary to the function of the chart;

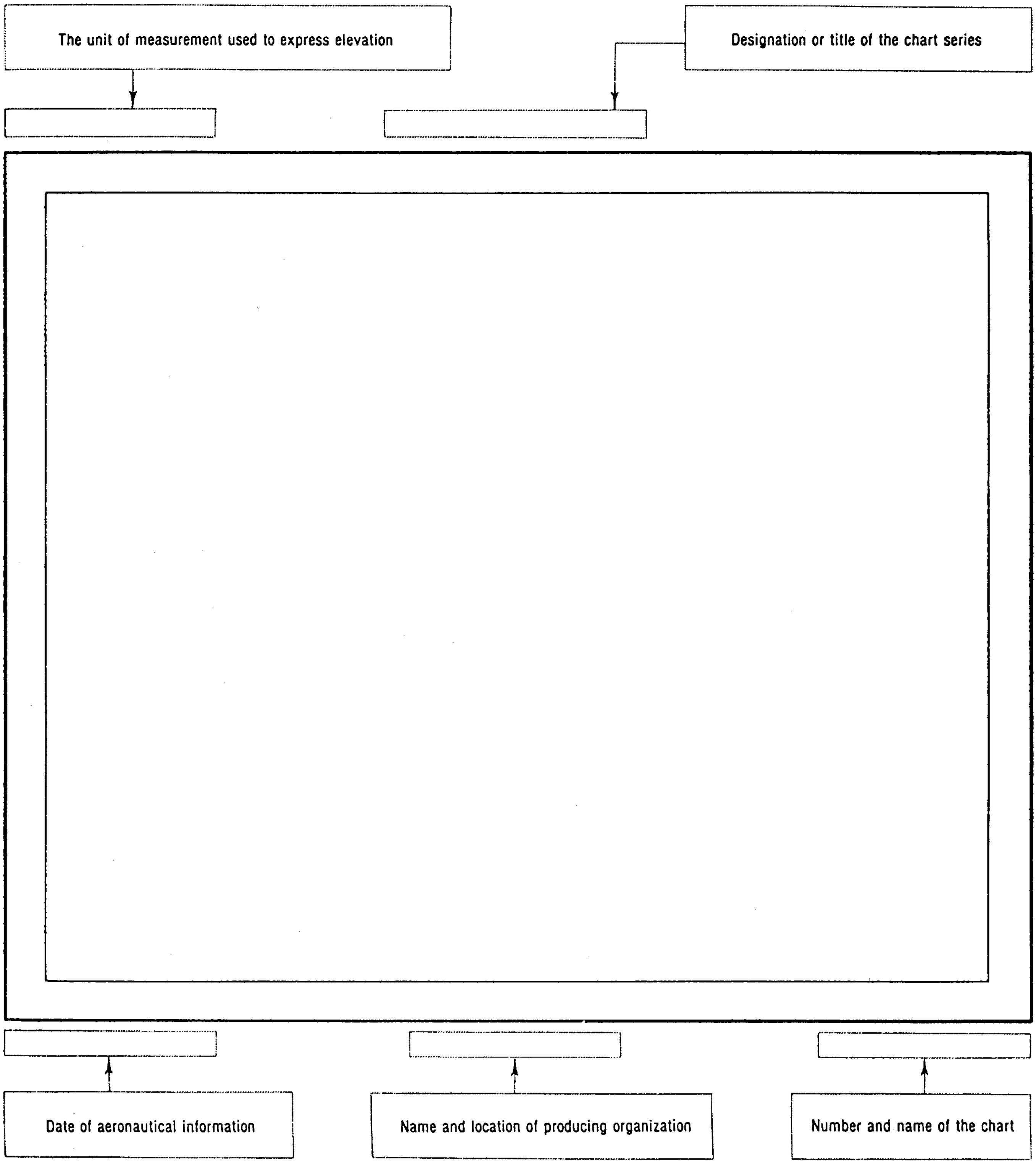
5) designated reporting points necessary to the function of the chart;

6) ocean station vessels.

Note.— Other aeronautical data may be shown provided that they do not detract from the legibility of essential information.

19.9.2 **Recommendation.—** *Aeronautical ground lights and marine lights useful for air navigation should be shown where other means of navigation are non-existent.*

APPENDIX 1. MARGINAL NOTE LAYOUT



APPENDIX 2. ICAO CHART SYMBOLS

9/11/95

TOPOGRAPHY

1 Contours (5000)

2 Approximate contours (5500)

3 Relief shown by hachures

4 Bluff, cliff or escarpment

5 Lava flow

6 Sand dunes

7 Sand area

8 Gravel

9 Levee or esker (Alternative)

10 Unusual land features appropriately labelled (Many Small Volcanoes; Rock Outcrop)

Active volcano

11 Mountain pass (5395)

12 Highest elevation on chart (Alternative: 17456; .17456)

13 Spot elevation (.6397; .8975)

14 Spot elevation (of doubtful accuracy) (.637c ±)

15 Coniferous trees

16 Other trees

17 Palms

18 Areas not surveyed for contour information or relief data incomplete — Caution

HYDROGRAPHY

19 Shore line (reliable)

20 Shore line (unreliable)

21 Tidal flats

22 Coral reefs and ledges

23 Large river (perennial)

24 Small river (perennial)

25 Rivers and streams (non-perennial) (Alternative)

26 Rivers and streams (unsurveyed)

27 Rapids

28 Falls

29 Canal

30 Abandoned canal
Note.— Dry canal having landmark value.

31 Lakes (perennial)

32 Lakes (non-perennial) (Alternative)

33 Salt lake

34 Salt pans (evaporator)

35 Swamp

36 Rice field (Alternative)

37 Spring, well or water hole — perennial; intermittent

38 Reservoir (Reservoir)

39 Dry lake bed (Alternative)

40 Wash (Alternative)

41 Shoals

42 Glaciers and ice caps

43 Danger line (2 m or one fathom line)

44 Charted isolated rock

45 Rock awash

46 Unusual water features appropriately labelled

CULTURE

BUILT-UP AREAS

47 City or large town

48 Town

49 Village

50 Buildings

RAILROADS

51 Railroad (single track)

52 Railroad (two or more tracks)

53 Railroad (under construction)

54 Railroad bridge

55 Railroad tunnel

56 Railroad station

HIGHWAYS AND ROADS

57 Dual highway

58 Primary road

59 Secondary road

60 Trail

61 Road bridge

62 Road tunnel

MISCELLANEOUS

63 Boundaries (international)

64 Other boundaries

65 Fence

66 Telegraph or telephone line (when a landmark)

67 Dam

68 Ferry

MISCELLANEOUS (Cont'd)

69 Pipeline

70 Oil or gas field

71 Tank farms

72 Coast guard station

73 Lookout tower

74 Mine

75 Forest ranger station

76 Race track or stadium

77 Ruins

78 Fort

79 Church

80 Mosque

81 Pagoda

82 Temple

AERODROMES

83 Civil Land

84 Civil Water

85 Military Land

86 Military Water

87 Joint civil and military Land

88 Joint civil and military Water

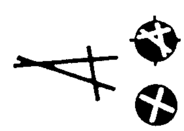
89 Emergency aerodrome or aerodrome with no facilities

90 Sheltered anchorage

91 Aerodrome for use on charts on which aerodrome classification is not required e.g. Enroute Charts

92 Heliport
Note.- Aerodrome for the exclusive use of helicopters

93 *Note.— Where required by the function of the chart, the runway pattern of the aerodrome may be shown in lieu of the aerodrome symbol, for example:*



AERODROMES *(Cont.)*

AERODROME DATA IN ABBREVIATED FORM WHICH MAY BE IN ASSOCIATION WITH AERODROME SYMBOLS

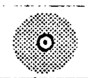
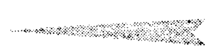
(Reference: 16.9.2.2 and 17.9.2.2)

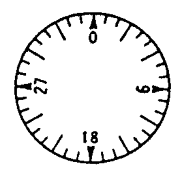
94	Name of aerodrome Elevation given in the units of measurement (metres or feet) selected for use on the chart Length of longest runway in hundreds of metres or feet (whichever unit is selected for use on the chart) LIVINGSTONE 357 L H 95 Minimum lighting — obstacles, boundary or runway lights and lighted wind indicator or landing direction indicator Runway hard surfaced, normally all-weather *Note.— A dash (—) is to be inserted where L or H do not apply.*

AERODROME SYMBOLS FOR APPROACH CHARTS

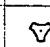
95	Aerodromes affecting the traffic pattern on the aerodrome on which the procedure is based	
96	The aerodrome on which the procedure is based	

RADIO NAVIGATION AIDS*

97	Basic radio navigation aid symbol *Note.— This symbol may be used with or without a box to enclose the data.*		
98	Non-directional radio beacon	NDB	
99	VHF omnidirectional radio range	VOR	
100	Distance measuring equipment	DME	
101	Collocated VOR and DME radio navigation aids	VOR/DME	
102	DME distance	Distance in kilometres (nautical miles) to DME Identification of radio navigation aid	15 km KAV
103	VOR radial	Radial bearing from, and identification of, VOR	R 090 KAV
104	UHF tactical air navigation aid	TACAN	
105	Collocated VOR and TACAN radio navigation aids	VORTAC	
106	Instrument landing system	ILS	 PLAN VIEW  PROFILE

107	Radio marker beacon	Elliptical	
		Bone Shape	
	Note.— Marker beacons may be shown by outline, or stipple, or both.		
108	Compass rose To be orientated on the chart in accordance with the alignment of the station (normally Magnetic North)		

Compass rose to be used as appropriate in combination with the following symbols:

VOR	
VOR/DME	
TACAN	
VORTAC	

Note.— Additional points of compass may be added as required

Note.— Guidance material on the presentation of radio navigation aid data is given in the Aeronautical Chart Manual *(Doc 8697).*

AIR TRAFFIC SERVICES

109	Flight information region	FIR	
110	Aerodrome traffic zone	ATZ	
111	Control area Airway Controlled route	CTA AWY	Alternative
112	Uncontrolled route		
113	Advisory airspace	ADA	
114	Control zone	CTR	
115	Advisory route	ADR	Alternative
116	Scale-break (on ATS route)		Alternative
117	Reporting point	REP	Compulsory / On request
118	Change-over point To be superimposed on the appropriate route symbol at right angles to the route.	COP	26 / 36
119	ATS/MET reporting point	MRP	Compulsory / On request
120	Way-point	WPT	

AIRSPACE RESTRICTIONS

121	Restricted airspace (prohibited, restricted or danger area)	Common boundary of two areas
	Note.— The angle and density of rulings may be varied according to scale and the size, shape and orientation of the area.	
122	International boundary closed to passage of aircraft except through air corridor	

OBSTACLES

123	Obstacle	127	Exceptionally high obstacle (optional symbol)
124	Lighted obstacle	128	Exceptionally high obstacle — lighted (optional symbol)
125	Group obstacles		*Note.— For obstacles having a height of the order of 300 m (1 000 ft) above terrain.*
126	Lighted group obstacles	129	Elevation of top (italics) *52* (15) Height above specified datum (upright type in parentheses)

MISCELLANEOUS

130	Prominent transmission line	131	Isogonic line or isogonal — 3° E —	132	Ocean station vessel (normal position)

VISUAL AIDS

133	Marine light F	*Note 1.— Marine alternating lights are red and white unless otherwise indicated. Marine lights are white unless colours are stated.*
	Note 2.— Characteristics are to be indicated as follows:	Alt Alternating; B Blue; F Fixed; Fl Flashing; G Green; Gp Group; Occ Occulting; R Red; SEC Sector; sec Second; (U) Unwatched; W White
134	Aeronautical ground light	135 Lightship

9/11/95

SYMBOLS FOR AERODROME/HELIPORT CHARTS

136	Hard surface runway		
137	Unpaved runway		
138	Stopway	SWY	
139	Taxiways and parking areas		
140	Helicopter alighting area on an aerodrome		Ⓗ
141	Aerodrome reference point	ARP	
142	VOR check-point		
143	Runway visual range (RVR) observation site		

144	Pierced steel plank or steel mesh runway		
145	Point light		● / ○
146	Obstacle light		
147	Landing direction indicator (lighted)		
148	Landing direction indicator (unlighted)		T
149	Stop bar		•••
150	Taxi holding position	Pattern A	
		Pattern B	

Note.— For application, see Annex 14, Volume I, paragraph 5.2.9

SYMBOLS FOR AERODROME OBSTACLE CHARTS — TYPE A, B AND C

		Plan	Profile
151	Tree or shrub	✳	Identification number
152	Pole, tower, spire, antenna, etc.	⊙	
153	Building or large structure	■	
154	Railroad		
155	Transmission line or overhead cable	—T—T—	

		Plan	Profile
156	Terrain penetrating obstacle plane		
157	Escarpment		
158	Stopway SWY		
159	Clearway CWY		

APPENDIX 3. COLOUR GUIDE

(Ref. 2.11.1)

CHART SYMBOLS

Culture, except highways and roads; outlines of large cities, grids and graticules; spot elevations; danger lines and off-shore rocks; names and lettering except for aeronautical and hydrographic features		BLACK
Built-up areas of cities		BLACK Stipple
Highways and roads	Optional colours	BLACK Half-tone
		RED
Built-up areas for cities (alternative to black stipple)		YELLOW
Contours and topographic features: Items 1 through 10 of Appendix 2. Hydrographic features: Items 39 through 41 of Appendix 2		BROWN
Shore lines, drainage, rivers, lakes, bathymetric contours and other hydrographic features including their names or description		BLUE
Open water areas		BLUE Half-tone
Salt lakes and salt pans		BLUE Stipple
Large non-perennial rivers and non-perennial lakes		BLUE Stipple
Aeronautical data, except for Enroute and Area Charts - ICAO, where different colours may be required. Both colours may be used on the same sheet but, where only one colour is used, dark blue is preferred	Optional colours	MAGENTA
		DARK BLUE

CHART SYMBOLS *(Cont.)*

Symbol		Colour
Woods		GREEN
Area minimum altitude envelopes		GREEN
Areas which have not been surveyed for contour information or relief data are incomplete	Optional colours	GOLDEN BUFF
		WHITE

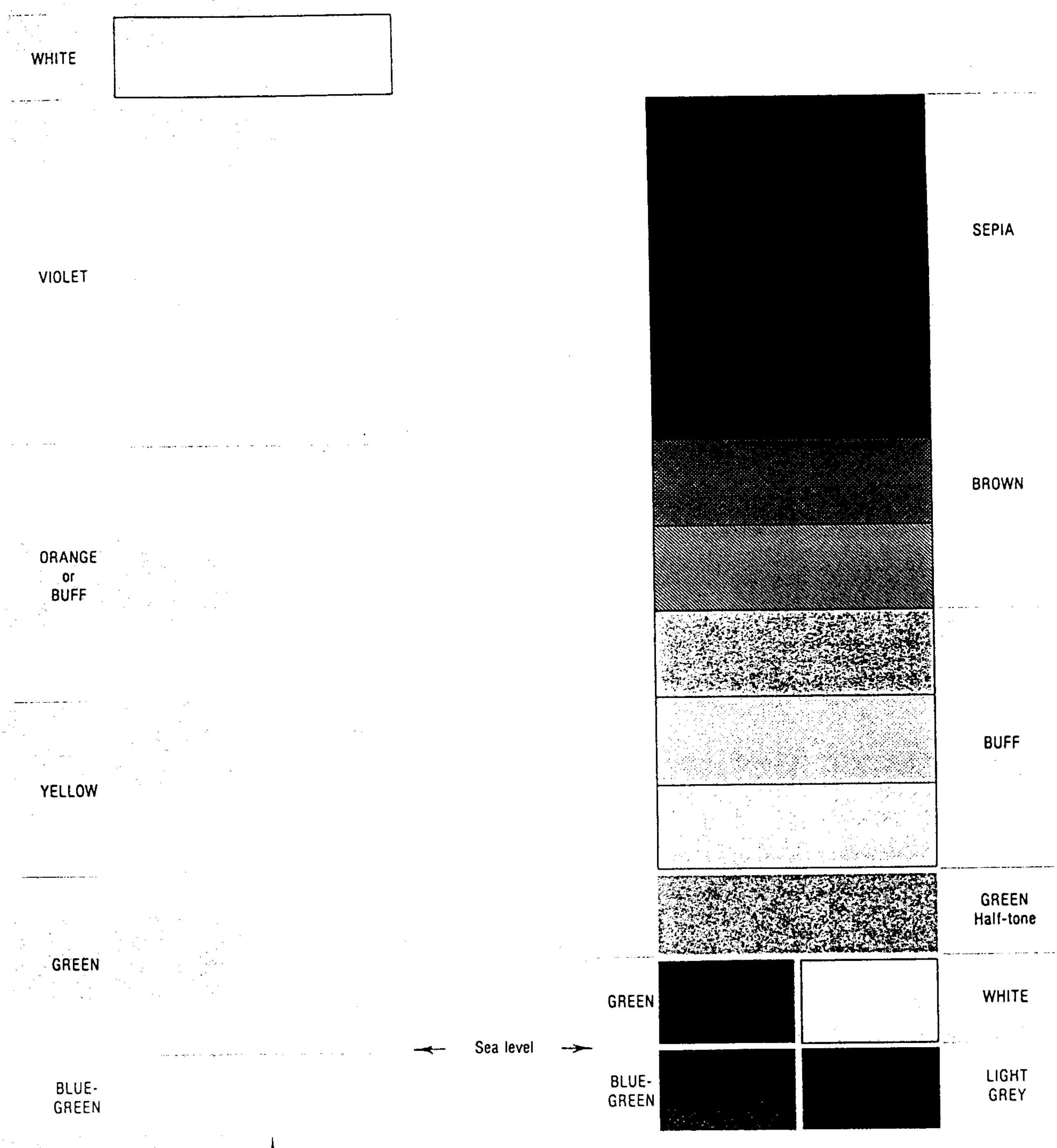
HYPSOMETRIC TINTS

Colour	Description		Colour
WHITE	Tint for extreme elevations		SEPIA
VIOLET			
ORANGE or BUFF	Tint for higher range elevations		BROWN
YELLOW	Tint for middle range elevations		BUFF
GREEN	Tint for lower range elevations	Optional colours	GREEN
			WHITE
BLUE GREEN	Tint for areas below sea level	Optional colours	BLUE-GREEN
			LIGHT GREY

Note.— Basic tints are identical to those specified for the International Map of the World

APPENDIX 4. HYPSOMETRIC TINT GUIDE

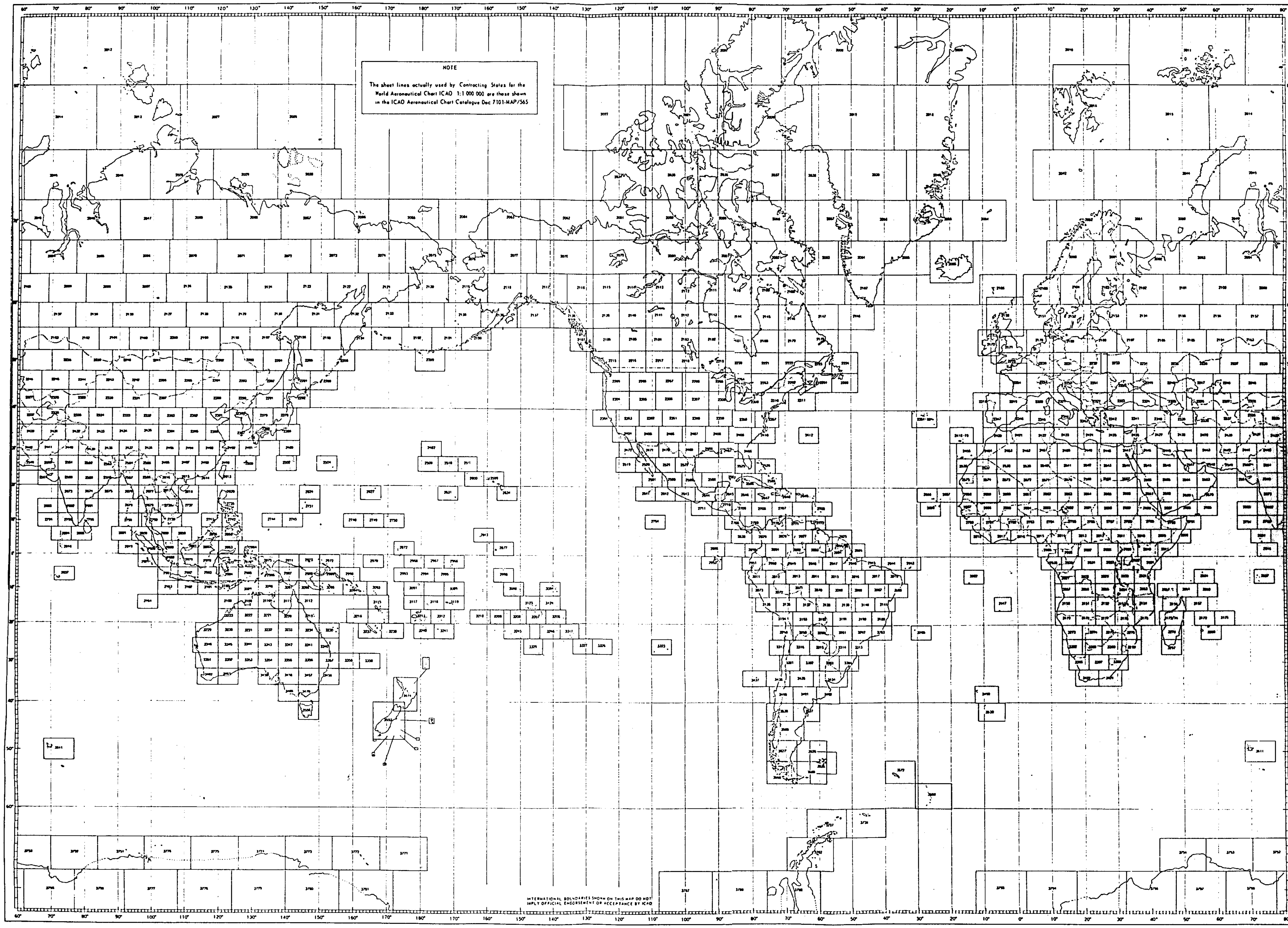
(Alternative systems, reference 2.12.2)



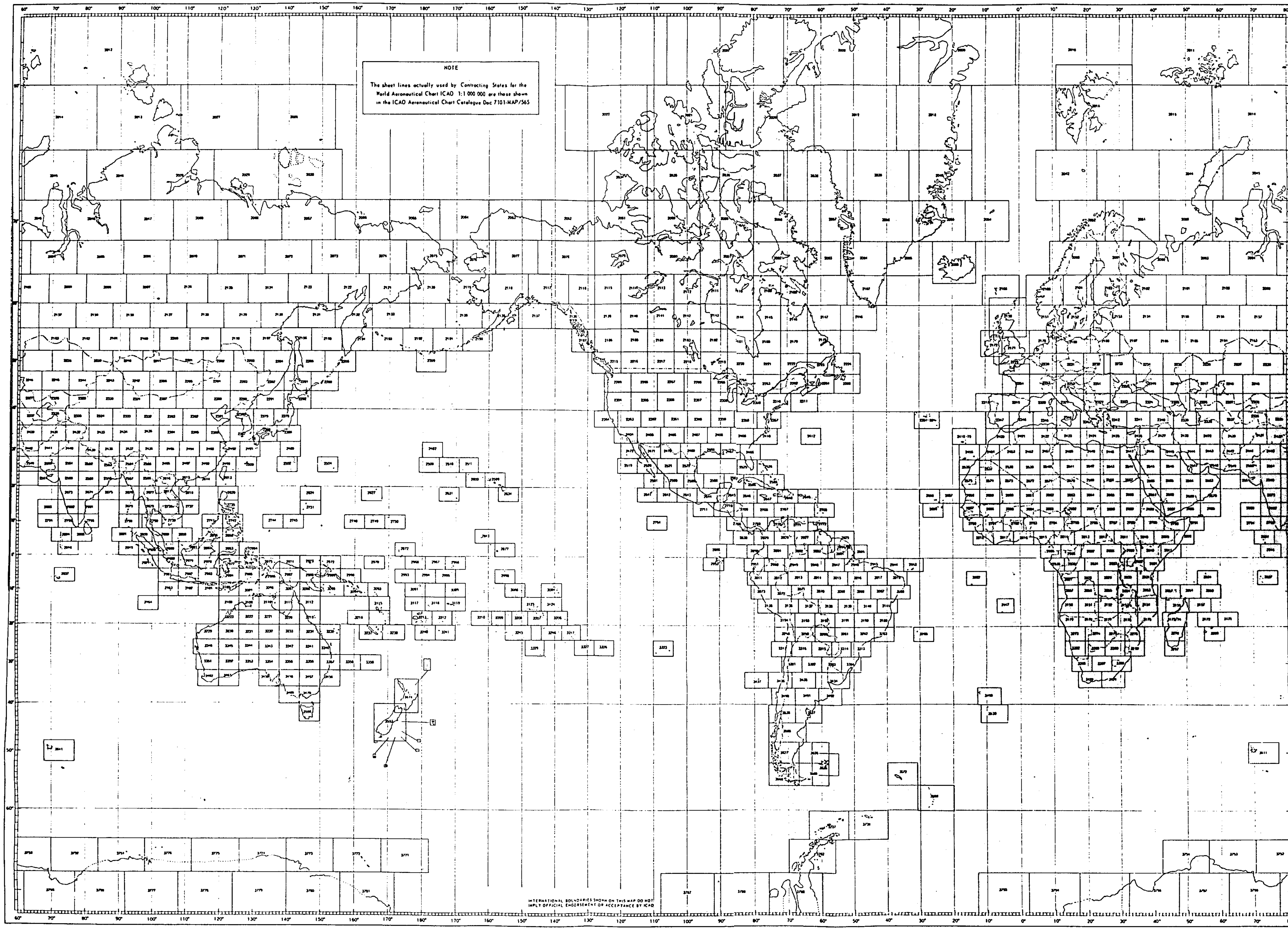
Note 1.— These tints are identical to those specified for the International Map of the World

Note 2.— Elevations have not been associated with tints of either system in order to allow for flexibility in their selection.

APPENDIX 5. SHEET LAYOUT INDEX FOR THE WORLD AERONAUTICAL CHART — ICAO 1:1 000 000



APPENDIX 5. SHEET LAYOUT INDEX FOR THE WORLD AERONAUTICAL CHART — ICAO 1:1 000 000



INTERNATIONAL STANDARDS

UNITS OF MEASUREMENT TO BE USED IN AIR AND GROUND OPERATIONS

ANNEX 5

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

FOURTH EDITION – JULY 1979

This edition incorporates all amendments adopted by the Council prior to 24 March 1979 and supersedes on 26 November 1981 all previous editions of Annex 5.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Bulletin* and in the monthly *Supplement to the Catalogue of ICAO Publications*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-13	Incorporated in this edition		
14	22/11/84		ICAO
15	19/11/87		ICAO

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

FOREWORD

Historical Background

International Standards and Recommended Practices for Dimensional Units to be used in Air-Ground Communications were first adopted by the Council on 16 April 1948 pursuant to Article 37 of the Convention on International Civil Aviation (Chicago, 1944) and were designated as Annex 5 to the Convention. They became effective on 15 September 1948 and became applicable on 1 January 1949.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Status of Annex Components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables and Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of Language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial Practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note.*

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A.—Amendments to Annex 5

Amendment(s)	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
1st Edition	Council action in pursuance of Assembly Resolution A1-35		16 April 1948 15 September 1948 1 January 1949
1 to 11 (2nd Edition)	Air Navigation Commission	Reduction of the number of unit tables from five tables to two tables.	11 December 1951 1 May 1952 1 September 1952
12 (3rd Edition)	Air Navigation Commission	Provision for identical units in the ICAO Table and the Blue Table except in respect of those units for measurement of altitudes, elevations, heights and vertical speed.	8 December 1961 1 April 1962 1 July 1964
13 (4th Edition)	Council action in pursuance of Assembly Resolution A22-18, Appendix F	Change in the title of the Annex and increase in the scope to cover all aspects of air and ground operations; provision of standardized system of units based on the SI; identification of non-SI units permitted for use in international civil aviation; provision for termination of the use of certain non-SI units.	23 March 1979 23 July 1979 26 November 1981
14	Air Navigation Commission study	Establishment of a firm date for the termination of the unit bar and introduction of guidance material relating to Co-ordinated Universal Time (UTC) and the method of referencing date and time.	27 February 1984 30 July 1984 22 November 1984
15	Air Navigation Commission	New definition of the metre; introduction of the special name "sievert"; deletion of references to temporary non-SI units no longer to be used.	24 November 1986 19 April 1987 19 November 1987

INTERNATIONAL STANDARDS

CHAPTER 1. DEFINITIONS

When the following terms are used in the Standards concerning the units of measurement to be used in all aspects of international civil aviation air and ground operations, they have the following meanings:

Ampere (A). The ampere is that constant electric current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 metre apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length.

Becquerel (Bq). The activity of a radionuclide having one spontaneous nuclear transition per second.

Candela (cd). The luminous intensity, in the perpendicular direction, of a surface of 1/600 000 square metre of black body at the temperature of freezing platinum under a pressure of 101 325 newtons per square metre.

Celsius temperature ($t°_C$). The Celsius temperature is equal to the difference $t°_C = T - T_0$ between two thermodynamic temperatures T and T_0 where T_0 equals 273.15 kelvin.

Coulomb (C). The quantity of electricity transported in 1 second by a current of 1 ampere.

Degree Celsius (°C). The special name for the unit kelvin for use in stating values of Celsius temperature.

Farad (F). The capacitance of a capacitor between the plates of which there appears a difference of potential of 1 volt when it is charged by a quantity of electricity equal to 1 coulomb.

Foot (ft). The length equal to 0.304 8 metre exactly.

Gray (Gy). The energy imparted by ionizing radiation to a mass of matter corresponding to 1 joule per kilogram.

Henry (H). The inductance of a closed circuit in which an electromotive force of 1 volt is produced when the electric current in the circuit varies uniformly at a rate of 1 ampere per second.

Hertz (Hz). The frequency of a periodic phenomenon of which the period is 1 second.

Joule (J). The work done when the point of application of a force of 1 newton is displaced a distance of 1 metre in the direction of the force.

Kelvin (K). A unit of thermodynamic temperature which is the fraction 1/273.16 of the thermodynamic temperature of the triple point of water.

Kilogram (kg). The unit of mass equal to the mass of the international prototype of the kilogram.

Knot (kt). The speed equal to 1 nautical mile per hour.

Litre (L). A unit of volume restricted to the measurement of liquids and gases which is equal to 1 cubic decimetre.

Lumen (lm). The luminous flux emitted in a solid angle of 1 steradian by a point source having a uniform intensity of 1 candela.

Lux (lx). The illuminance produced by a luminous flux of 1 lumen uniformly distributed over a surface of 1 square metre.

Metre (m). The distance travelled by light in a vacuum during 1/299 792 458 of a second.

Mole (mol). The amount of substance of a system which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon-12.

Note.— *When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles or specified groups of such particles.*

Nautical mile (NM). The length equal to 1 852 metres exactly.

Newton (N). The force which, when applied to a body having a mass of 1 kilogram gives it an acceleration of 1 metre per second squared.

Ohm (Ω). The electric resistance between two points of a conductor when a constant difference of potential of 1 volt, applied between these two points, produces in this conductor a current of 1 ampere, this conductor not being the source of any electromotive force.

Pascal (Pa). The pressure or stress of 1 newton per square metre.

Radian (rad). The plane angle between two radii of a circle which cut off on the circumference an arc equal in length to the radius.

Second (s). The duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom.

Siemens (S). The electric conductance of a conductor in which a current of 1 ampere is produced by an electric potential difference of 1 volt.

Sievert (Sv). The unit of radiation dose equivalent corresponding to 1 joule per kilogram.

Steradian (sr). The solid angle which, having its vertex in the centre of a sphere, cuts off an area of the surface of the sphere equal to that of a square with sides of length equal to the radius of the sphere.

Tesla (T). The magnetic flux density given by a magnetic flux of 1 weber per square metre.

Tonne (t). The mass equal to 1 000 kilograms.

Volt (V). The unit of electric potential difference and electromotive force which is the difference of electric potential between two points of a conductor carrying a constant current of 1 ampere, when the power dissipated between these points is equal to 1 watt.

Watt (W). The power which gives rise to the production of energy at the rate of 1 joule per second.

Weber (Wb). The magnetic flux which, linking a circuit of one turn, produces in it an electromotive force of 1 volt as it is reduced to zero at a uniform rate in 1 second.

No. 15
19/11/87

CHAPTER 2. APPLICABILITY

Introductory Note.—This Annex contains specifications for the use of a standardized system of units of measurement in international civil aviation air and ground operations. This standardized system of units of measurement is based on the International System of Units (SI) and certain non-SI units considered necessary to meet the specialized requirements of international civil aviation. See Attachment A for details concerning the development of the SI.

2.1 Applicability

The Standards contained in this Annex shall be applicable to all aspects of international civil aviation air and ground operations.

CHAPTER 3. STANDARD APPLICATION OF UNITS OF MEASUREMENT

3.1 SI Units

3.1.1 The International System of Units developed and maintained by the General Conference of Weights and Measures (CGPM) shall, subject to the provisions of 3.2 and 3.3, be used as the standard system of units of measurement for all aspects of international civil aviation air and ground operations.

3.1.2 Prefixes

The prefixes and symbols listed in Table 3-1 shall be used to form names and symbols of the decimal multiples and sub-multiples of SI units.

Note 1.—As used herein the term SI unit is meant to include base units and derived units as well as their multiples and sub-multiples.

Note 2.—See Attachment B for guidance on the general application of prefixes.

3.2 Non-SI Units

3.2.1 Non-SI units for permanent use with the SI

The non-SI units listed in Table 3-2 shall be used either in lieu of, or in addition to, SI units as primary units of measurement but only as specified in Table 3-4.

Table 3-1. SI unit prefixes

Multiplication factor		*Prefix*	*Symbol*
1 000 000 000 000 000 000	= 10^{18}	exa	E
1 000 000 000 000 000	= 10^{15}	peta	P
1 000 000 000 000	= 10^{12}	tera	T
1 000 000 000	= 10^{9}	giga	G
1 000 000	= 10^{6}	mega	M
1 000	= 10^{3}	kilo	k
100	= 10^{2}	hecto	h
10	= 10^{1}	deca	da
0.1	= 10^{-1}	deci	d
0.01	= 10^{-2}	centi	c
0.001	= 10^{-3}	milli	m
0.000 001	= 10^{-6}	micro	μ
0.000 000 001	= 10^{-9}	nano	n
0.000 000 000 001	= 10^{-12}	pico	p
0.000 000 000 000 001	= 10^{-15}	femto	f
0.000 000 000 000 000 001	= 10^{-18}	atto	a

26/11/81

Table 3-2. Non-SI units for permanent use with the SI

Specific quantities in Table 3-4 related to	*Unit*	*Symbol*	*Definition (in terms of SI units)*
mass	tonne	t	$1\ t = 10^3\ kg$
plane angle	degree	°	$1° = (\pi/180)\ rad$
	minute	′	$1' = (1/160)° = (\pi/10\ 800)\ rad$
	second	″	$1'' = (1/60)' = (\pi/648\ 000)\ rad$
temperature	degree Celsius	°C	1 unit °C = 1 unit K[a)]
time	minute	min	1 min = 60 s
	hour	h	1 h = 60 min = 3 600 s
	day	d	1 d = 24 h = 86 400 s
	week, month, year	—	
volume	litre	L	$1\ L = 1\ dm^3 = 10^{-3} m^3$

a) See Attachment C, Table C-2 for conversion.

Table 3-3. Non-SI alternative units permitted for temporary use with the SI

Specific quantities in Table 3-4 related to	*Unit*	*Symbol*	*Definition (in terms of SI units)*
distance (long)	nautical mile	NM	1 NM = 1 852 m
distance (vertical)[a]	foot	ft	1 ft = 0.304 8 m
speed	knot	kt	1 kt = 0.514 444 m/s

a) altitude, elevation, height, vertical speed.

3.2.2 Non-SI alternative units permitted for temporary use with the SI

The non-SI units listed in Table 3-3 shall be permitted for temporary use as alternative units of measurement but only for those specific quantities listed in Table 3-4.

Note.—It is intended that the use of the non-SI alternative units listed in Table 3-3 and applied as indicated in Table 3-4 will eventually be discontinued in accordance with individual unit termination dates established by the Council. Termination dates, when established, will be given in Chapter 4.

3.3 Application of specific units

The application of units of measurement for certain quantities used in international civil aviation air and ground operations shall be in accordance with Table 3-4.

Note.— Table 3-4 is intended to provide standardization of units (including prefixes) for those quantities commonly used in air and ground operations. Basic Annex provisions apply for units to be used for quantities not listed.

Table 3-4. Standard application of specific units of measurement

Ref. No.	*Quantity*	*Primary unit (symbol)*	*Non-SI alternative unit (symbol)*
1.	*Direction/Space/Time*		
1.1	altitude	m	ft
1.2	area	m^2	
1.3	distance (long)[a]	km	NM
1.4	distance (short)	m	
1.5	elevation	m	ft
1.6	endurance	h and min	
1.7	height	m	ft
1.8	latitude	° ′ ″	
1.9	length	m	
1.10	longitude	° ′ ″	
1.11	plane angle (when required, decimal subdivisions of the degree shall be used)	°	
1.12	runway length	m	
1.13	runway visual range	m	

Table 3-4 *(cont.)*

Ref. No.	*Quantity*	*Primary unit (symbol)*	*Non-SI alternative unit (symbol)*
1.14	tank capacities (aircraft)[b)]	L	
1.15	time	s	
		min	
		h	
		d	
		week	
		month	
		year	
1.16	visibility[c)]	km	
1.17	volume	m^3	
1.18	wind direction (wind directions other than for a landing and take-off shall be expressed in degrees true; for landing and take-off wind directions shall be expressed in degrees magnetic)	°	
2.	***Mass-related***		
2.1	air density	kg/m^3	
2.2	area density	kg/m^2	
2.3	cargo capacity	kg	
2.4	cargo density	kg/m^3	
2.5	density (mass density)	kg/m^3	
2.6	fuel capacity (gravimetric)	kg	
2.7	gas density	kg/m^3	
2.8	gross mass or payload	kg	
		t	
2.9	hoisting provisions	kg	
2.10	linear density	kg/m	
2.11	liquid density	kg/m^3	
2.12	mass	kg	
2.13	moment of inertia	$kg \cdot m^2$	
2.14	moment of momentum	$kg \cdot m^2/s$	
2.15	momentum	$kg \cdot m/s$	
3.	***Force-related***		
3.1	air pressure (general)	kPa	
3.2	altimeter setting	hPa	
3.3	atmospheric pressure	hPa	
3.4	bending moment	$kN \cdot m$	
3.5	force	N	
3.6	fuel supply pressure	kPa	

Table 3-4 *(cont.)*

Ref. No.	*Quantity*	*Primary unit (symbol)*	*Non-SI alternative unit (symbol)*
3.7	hydraulic pressure	kPa	
3.8	modulus of elasticity	MPa	
3.9	pressure	kPa	
3.10	stress	MPa	
3.11	surface tension	mN/m	
3.12	thrust	kN	
3.13	torque	N·m	
3.14	vacuum	Pa	
4. Mechanics			
4.1	airspeed[d)]	km/h	kt
4.2	angular acceleration	rad/s^2	
4.3	angular velocity	rad/s	
4.4	energy or work	J	
4.5	equivalent shaft power	kW	
4.6	frequency	Hz	
4.7	ground speed	km/h	kt
4.8	impact	J/m^2	
4.9	kinetic energy absorbed by brakes	MJ	
4.10	linear acceleration	m/s^2	
4.11	power	kW	
4.12	rate of trim	°/s	
4.13	shaft power	kW	
4.14	velocity	m/s	
4.15	vertical speed	m/s	ft/min
4.16	wind speed	km/h	kt
5. Flow			
5.1	engine airflow	kg/s	
5.2	engine waterflow	kg/h	
5.3	fuel consumption (specific)		
	piston engines	kg/(kW·h)	
	turbo-shaft engines	kg/(kW·h)	
	jet engines	kg/(kN·h)	
5.4	fuel flow	kg/h	
5.5	fuel tank filling rate (gravimetric)	kg/min	
5.6	gas flow	kg/s	
5.7	liquid flow (gravimetric)	g/s	
5.8	liquid flow (volumetric)	L/s	
5.9	mass flow	kg/s	
5.10	oil consumption		
	gas turbine	kg/h	
	piston engines (specific)	g/(kW·h)	

Table 3-4 *(cont.)*

Ref. No.	*Quantity*	*Primary unit (symbol)*	*Non-SI alternative unit (symbol)*
5.11	oil flow	g/s	
5.12	pump capacity	L/min	
5.13	ventilation airflow	m^3/min	
5.14	viscosity (dynamic)	Pa·s	
5.15	viscosity (kinematic)	m^2/s	
6. Thermodynamics			
6.1	coefficient of heat transfer	$W/(m^2 \cdot K)$	
6.2	heat flow per unit area	J/m^2	
6.3	heat flow rate	W	
6.4	humidity (absolute)	g/kg	
6.5	coefficient of linear expansion	$°C^{-1}$	
6.6	quantity of heat	J	
6.7	temperature	°C	
7. Electricity and Magnetism			
7.1	capacitance	F	
7.2	conductance	S	
7.3	conductivity	S/m	
7.4	current density	A/m^2	
7.5	electric current	A	
7.6	electric field strength	C/m^2	
7.7	electric potential	V	
7.8	electromotive force	V	
7.9	magnetic field strength	A/m	
7.10	magnetic flux	Wb	
7.11	magnetic flux density	T	
7.12	power	W	
7.13	quantity of electricity	C	
7.14	resistance	Ω	
8. Light and Related Electromagnetic Radiations			
8.1	illuminance	lx	
8.2	luminance	cd/m^2	
8.3	luminous exitance	lm/m^2	
8.4	luminous flux	lm	
8.5	luminous intensity	cd	
8.6	quantity of light	lm·s	
8.7	radiant energy	J	
8.8	wavelength	m	

Table 3-4 *(cont.)*

Ref. No.	*Quantity*	*Primary unit (symbol)*	*Non-SI alternative unit (symbol)*
9. Acoustics			
9.1	frequency	Hz	
9.2	mass density	kg/m^3	
9.3	noise level	dB[e)]	
9.4	period, periodic time	s	
9.5	sound intensity	W/m^2	
9.6	sound power	W	
9.7	sound pressure	Pa	
9.8	sound level	dB[e)]	
9.9	static pressure (instantaneous)	Pa	
9.10	velocity of sound	m/s	
9.11	volume velocity (instantaneous)	m^3/s	
9.12	wavelength	m	
10. Nuclear Physics and Ionizing Radiation			
10.1	absorbed dose	Gy	
10.2	absorbed dose rate	Gy/s	
10.3	activity of radionuclides	Bq	
10.4	dose equivalent	Sv	
10.5	radiation exposure	C/kg	
10.6	exposure rate	C/kg·s	

a) As used in navigation, generally in excess of 4 000 m.
b) Such as aircraft fuel, hydraulic fluids, water, oil and high pressure oxygen vessels.
c) Visibility of less than 5 km may be given in m.
d) Airspeed is sometimes reported in flight operations in terms of the ratio MACH number.
e) The decibel (dB) is a ratio which may be used as a unit for expressing sound pressure level and sound power level. When used, the reference level must be specified.

CHAPTER 4. TERMINATION OF USE OF NON-SI ALTERNATIVE UNITS

Introductory Note.— The non-SI units listed in Table 3-3 have been retained temporarily for use as alternative units because of their wide-spread use and to avoid potential safety problems which could result from the lack of international co-ordination concerning the termination of their use. As termination dates are established by the Council, they will be reflected as Standards contained in this Chapter. It is expected that the establishment of such dates will be well in advance of actual termination. Any special procedures associated with specific unit termination will be circulated to all States separately from this Annex.

4.1 The use in international civil aviation operations of the alternative non-SI units listed in Table 3-3 shall be terminated on the dates listed in Table 4-1.

Table 4-1. Termination dates for non-SI alternative units

Non-SI alternative unit	*Termination date*
Knot Nautical mile	not established[a)]
Foot	not established[b)]

a) No termination date has yet been established for use of nautical mile and knot. For planning purposes any termination date for these units will not be before 31 December 1990.
b) No termination date has yet been established for use of the foot.

ATTACHMENTS TO ANNEX 5

ATTACHMENT A. DEVELOPMENT OF THE INTERNATIONAL SYSTEM OF UNITS (SI)

1. Historical background

1.1 The name SI is derived from "Système International d'Unités". The system has evolved from units of length and mass (metre and kilogram) which were created by members of the Paris Academy of Sciences and adopted by the French National Assembly in 1795 as a practical measure to benefit industry and commerce. The original system became known as the metric system. Physicists realized the advantages of the system and it was soon adopted in scientific and technical circles.

1.2 International standardization began with an 1870 meeting of 15 States in Paris that led to the International Metric Convention in 1875 and the establishment of a permanent International Bureau of Weights and Measures. A General Conference on Weights and Measures (CGPM) was also constituted to handle all international matters concerning the metric system. In 1889 the first meeting of the CGPM legalized the old prototype of the metre and the kilogram as the international standard for unit of length and unit of mass respectively. Other units were agreed in subsequent meetings and by its 10th Meeting in 1954, the CGPM had adopted a rationalized and coherent system of units based on the metre-kilogram-second-ampere (MKSA) system which had been developed earlier, plus the addition of the kelvin as the unit of temperature and the candela as the unit of luminous intensity. The 11th CGPM, held in 1960 and in which 36 States participated, adopted the name International System of Units (SI) and laid down rules for the prefixes, the derived and supplementary units and other matters, thus establishing comprehensive specifications for international units of measurement. The 12th CGPM in 1964 made some refinements in the system, and the 13th CGPM in 1967 redefined the second, renamed the unit of temperature as the kelvin (K) and revised the definition of the candela. The 14th CGPM in 1971 added a seventh base unit, the mole (mol) and approved the pascal (Pa) as a special name for the SI unit of pressure or stress, the newton (N) per square metre (m^2) and the siemens (S) as a special name for the unit of electrical conductance. In 1975 the CGPM adopted the becquerel (Bq) as the unit of the activity of radionuclides and the gray (Gy) as the unit for absorbed dose.

2. International Bureau of Weights and Measures

2.1 The Bureau International des Poids et Mesures (BIPM) was set up by the Metre Convention signed in Paris on 20 May 1875 by 17 States during the final session of the Diplomatic Conference of the Metre. This Convention was amended in 1921. BIPM has its headquarters near Paris and its upkeep is financed by the Member States of the Metre Convention. The task of BIPM is to ensure world-wide unification of physical measurements; it is responsible for:

— establishing the fundamental standards and scales for measurement of the principal physical quantities and maintaining the international prototypes;

— carrying out comparisons of national and international standards;

— ensuring the co-ordination of corresponding measuring techniques;

— carrying out and co-ordinating the determinations relating to the fundamental physical constants.

2.2 BIPM operates under the exclusive supervision of the International Committee of Weights and Measures (CIPM), which itself comes under the authority of the General Conference of Weights and Measures (CGPM). The International Committee consists of 18 members each belonging to a different State; it meets at least once every two years. The officers of this Committee issue an Annual Report on the administrative and financial position of BIPM to the Governments of the Member States of the Metre Convention.

2.3 The activities of BIPM, which in the beginning were limited to the measurements of length and mass and to metrological studies in relation to these quantities, have been extended to standards of measurement for electricity (1927), photometry (1937) and ionizing radiations (1960). To this end the original laboratories, built in 1876-78, were enlarged in 1929 and two new buildings were constructed in 1963-64 for the ionizing radiation laboratories. Some 30 physicists or technicians work in the laboratories of BIPM. They do metrological research, and also undertake measurement and certification of material standards of the above-mentioned quantities.

2.4 In view of the extension of the work entrusted to BIPM, CIPM has set up since 1927, under the name of Consultative Committees, bodies designed to provide it with information on matters which it refers to them for study and advice. These Consultative Committees, which may form temporary or permanent working groups to study special subjects, are responsible for co-ordinating the international work carried out in their respective fields and proposing recommendations concerning the amendment to be made to the definitions and values of units. In order to ensure world-wide uniformity in units of measurement, the International Committee accordingly acts directly or submits proposals for sanction by the General Conference.

2.5 The Consultative Committees have common regulations (*Procès-Verbaux CIPM,* 1963, 31, 97). Each Consultative Committee, the chairman of which is normally a member of CIPM, is composed of a delegate from each of the large metrology laboratories and specialized institutes, a list of which is drawn up by CIPM, as well as individual members also appointed by CIPM and one representative of BIPM. These Committees hold their meetings at irregular intervals; at present there are seven of them in existence as follows:

1. The Consultative Committee for Electricity (CCE), set up in 1927.

2. The Consultative Committee for Photometry and Radiometry (CCPR), which is the new name given in 1971 to the Consultative Committee for Photometry set up in 1933 (between 1930 and 1933 the preceding committee (CCE) dealt with matters concerning photometry).

3. The Consultative Committee for Thermometry (CCT), set up in 1937.

4. The Consultative Committee for the Definition of the Metre (CCDM), set up in 1952.

5. The Consultative Committee for the Definition of the Second (CCDS), set up in 1956.

6. The Consultative Committee for the Standards of Measurement of Ionizing Radiations (CCEMRI), set up in 1958. Since 1969 this Consultative Committee has consisted of four sections: Section I (measurement of X- and γ-rays); Section II (measurement of radionuclides); Section III (neutron measurements); Section IV (α-energy standards).

7. The Consultative Committee for Units (CCU), set up in 1964.

The proceedings of the General Conference, the International Committee, the Consultative Committees and the International Bureau are published under the auspices of the latter in the following series:

— *Comptes rendus des séances de la Conférence Générale des Poids et Mesures;*

— *Procès-Verbaux des séances du Comité International des Poids et Mesures;*

— *Sessions des Comités Consultatifs;*

— *Recueil de Travaux du Bureau International des Poids et Mesures* (this compilation brings together articles published in scientific and technical journals and books, as well as certain work published in the form of duplicated reports).

2.6 From time to time BIPM publishes a report on the development of the metric system throughout the world, entitled *Les récents progrès du Système Métrique*. The collection of the *Travaux et Mémoires du Bureau International des Poids et Mesures* (22 volumes published between 1881 and 1966) ceased in 1966 by a decision of the CIPM. Since 1965 the international journal *Metrologia,* edited under the auspices of CIPM, has published articles on the more important work on scientific metrology carried out throughout the world, on the improvement in measuring methods and standards, of units, etc, as well as reports concerning the activities, decisions and recommendations of the various bodies created under the Metre Convention.

3. International Organization for Standardization

The International Organization for Standardization (ISO) is a world-wide federation of national standards institutes which, although not a part of the BIPM, provides recommendations for the use of SI and certain other units. ISO Document 1000 and the ISO Recommendation R31 series of documents provide extensive detail on the application of the SI units. ICAO maintains liaison with ISO regarding the standardized application of SI units in aviation.

ATTACHMENT B. GUIDANCE ON THE APPLICATION OF THE SI

1. Introduction

1.1 The International System of Units is a complete, coherent system which includes three classes of units:

a) base units;

b) supplementary units; and

c) derived units.

1.2 The SI is based on seven units which are dimensionally independent and are listed in Table B-1.

Table B-1. SI base units

Quantity	*Unit*	*Symbol*
amount of a substance	mole	mol
electric current	ampere	A
length	metre	m
luminous intensity	candela	cd
mass	kilogram	kg
thermodynamic temperature	kelvin	K
time	second	s

1.3 The supplementary units of the SI are listed in Table B-2 and may be regarded either as base units or as derived units.

Table B-2. SI supplementary units

Quantity	*Unit*	*Symbol*
plane angle	radian	rad
solid angle	steradian	sr

1.4 Derived units of the SI are formed by combining base units, supplementary units and other derived units according to the algebraic relations linking the corresponding quantities. The symbols for derived units are obtained by means of the mathematical signs for multiplication, division and the use of exponents. Those derived SI units which have special names and symbols are listed in Table B-3.

Note.— The specific application of the derived units listed in Table B-3 and other units common to international civil aviation operations is given in Table 3-4.

Table B-3. SI derived units with special names

Quantity	*Unit*	*Symbol*	*Derivation*
absorbed dose (radiation)	gray	Gy	J/kg
activity of radionuclides	becquerel	Bq	l/s
capacitance	farad	F	C/V
conductance	siemens	S	A/V
dose equivalent (radiation)	sievert	Sv	J/kg
electric potential, potential difference, electromotive force	volt	V	W/A
electric resistance	ohm	Ω	V/A
energy, work, quantity of heat	joule	J	N·m
force	newton	N	$kg·m/s^2$
frequency (of a periodic phenomenon)	hertz	Hz	l/s
illuminance	lux	lx	lm/m^2
inductance	henry	H	Wb/A
luminous flux	lumen	lm	cd·sr
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m^2
power, radiant flux	watt	W	J/s
pressure, stress	pascal	Pa	N/m^2
quantity of electricity, electric charge	coulomb	C	A·s

1.5 The SI is a rationalized selection of units from the metric system which individually are not new. The great advantage of SI is that there is only one unit for each physical quantity — the metre for length, kilogram (instead of gram) for mass, second for time, etc. From these elemental or base units, units for all other mechanical quantities are derived. These derived units are defined by simple relationships such as velocity equals rate of change of distance, acceleration equals rate of change of velocity, force is the product of mass and acceleration, work or energy is the product of force and distance, power is work done per unit time, etc. Some of these units have only generic names such as metre per second for velocity; others have special names such as newton (N) for force, joule (J) for work or energy, watt (W) for power. The SI units for force, energy and power are the same regardless of whether the process is mechanical, electrical, chemical or nuclear. A force of 1 newton applied for a distance of 1 metre can produce 1 joule of heat, which is identical with what 1 watt of electric power can produce in 1 second.

1.6 Corresponding to the advantages of SI, which result from the use of a unique unit for each physical quantity, are the advantages which result from the use of a unique and well-defined set of symbols and abbreviations. Such symbols and abbreviations eliminate the confusion that can arise from current practices in different disciplines such as the use of "b" for both the bar (a unit of pressure) and barn (a unit of area).

1.7 Another advantage of SI is its retention of the decimal relation between multiples and sub-multiples of the base units for each physical quantity. Prefixes are established for designating multiple and sub-multiple units from "exa" (10^{18}) down to "atto" (10^{-18}) for convenience in writing and speaking.

1.8 Another major advantage of SI is its coherence. Units might be chosen arbitrarily, but making an independent choice of a unit for each category of mutually comparable quantities would lead in general to the appearance of several additional numerical factors in the equations between the numerical values. It is possible, however, and in practice more convenient, to choose a system of units in such a way that the equations between numerical values, including the numerical factors, have exactly the same form as the corresponding equations between the quantities. A unit system defined in this way is called coherent with respect to the system of quantities and equations in question. Equations between units of a coherent unit system contain as numerical factors only the number 1. In a coherent system the product or quotient of any two unit quantities is the unit of the resulting quantity. For example, in any coherent system, unit area results when unit length is multiplied by unit length, unit velocity when unit length is divided by unit time, and unit force when unit mass is multiplied by unit acceleration.

Note.— Figure B-1 illustrates the relationship of the units of the SI.

2. Mass, force and weight

2.1 The principal departure of SI from the gravimetric system of metric engineering units is the use of explicitly distinct units from mass and force. In SI, the name kilogram is restricted to the unit of mass, and the kilogram-force (from which the suffix force was in practice often erroneously dropped) is not to be used. In its place the SI unit of force, the newton is used. Likewise, the newton rather than the kilogram-force is used to form derived units which include force, for example, pressure or stress (N/m^2 = Pa), energy (N · m = J), and power (N · m/s = W).

2.2 Considerable confusion exists in the use of the term weight as a quantity to mean either force or mass. In common use, the term weight nearly always means mass; thus, when one speaks of a person's weight, the quantity referred to is mass. In science and technology, the term weight of a body has usually meant the force that, if applied to the body, would give it an acceleration equal to the local acceleration of free fall. The adjective "local" in the phrase "local acceleration of free fall" has usually meant a location on the surface of the earth; in this context the "local acceleration of free fall" has the symbol g (sometimes referred to as "acceleration of gravity") with observed values of g differing by over 0.5 per cent at various points on the earth's surface and decreasing as distance from the earth is increased. Thus, because weight is a force = mass × acceleration due to gravity, a person's weight is conditional on his location, but mass is not. A person with a mass of 70 kg might experience a force (weight) on earth of 686 newtons (≈ 155 lbf) and a force (weight) of only 113 newtons (≈ 22 lbf) on the moon. Because of the dual use of the term weight as a quantity, the term weight should be avoided in technical practice except under circumstances in which its meaning is completely clear. When the term is used, it is important to know whether mass or force is intended and to use SI units properly by using kilograms for mass or newtons for force.

2.3 Gravity is involved in determining mass with a balance or scale. When a standard mass is used to balance the measured mass, the direct effect of gravity on the two masses is cancelled, but the indirect effect through the buoyancy of air or other fluid is generally not cancelled. In using a spring scale, mass is measured indirectly, since the instrument responds to the force of gravity. Such scales may be calibrated in mass units if the variation in acceleration of gravity and buoyancy corrections are not significant in their use.

3. Energy and torque

3.1 The vector product of force and moment arm is widely designated by the unit newton metre. This unit for bending moment or torque results in confusion with the unit for energy, which is also newton metre. If torque is expressed as newton metre per radian, the relationship to energy is clarified, since the product of torque and angular rotation is energy:

$$(N \cdot m/rad) \cdot rad = N \cdot m$$

3.2 If vectors were shown, the distinction between energy and torque would be obvious, since the orientation of force and length is different in the two cases. It is important to recognize this difference in using torque and energy, and the joule should never be used for torque.

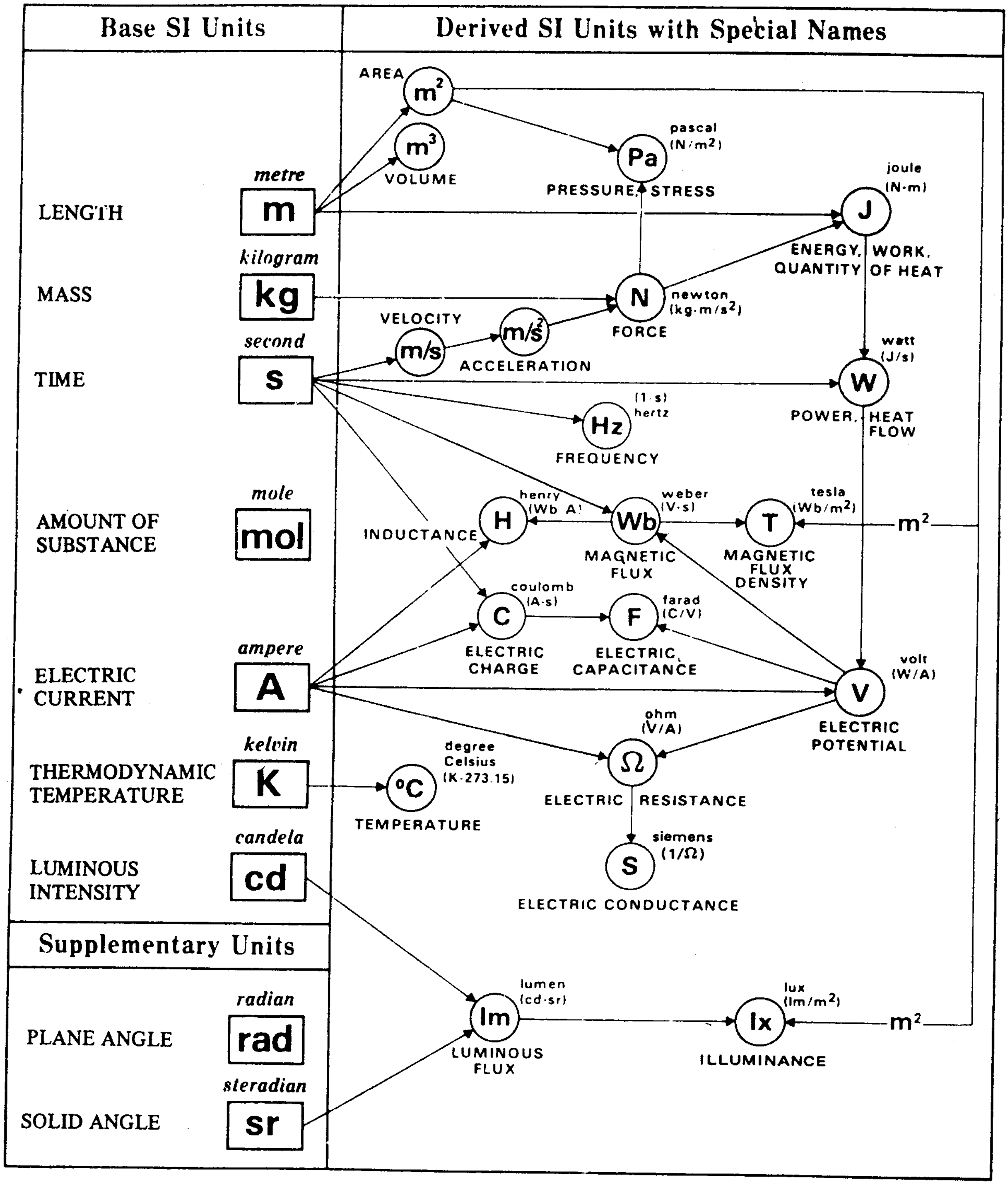


Figure B-1

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4. SI prefixes

4.1 Selection of prefixes

4.1.1 In general the SI prefixes should be used to indicate orders of magnitude, thus eliminating non-significant digits and leading zeros in decimal fractions, and providing a convenient alternative to the powers-of-ten notation preferred in computation. For example:

12 300 mm becomes 12.3 m

12.3×10^3 m becomes 12.3 km

0.00123 μA becomes 1.23 nA

4.1.2 When expressing a quantity by a numerical value and a unit, prefixes should preferably be chosen so that the numerical value lies between 0.1 and 1 000. To minimize variety, it is recommended that prefixes representing powers of 1 000 be used. However, in the following cases, deviation from the above may be indicated:

a) in expressing area and volume, the prefixes hecto, deca, deci and centi may be required: for example, square hectometre, cubic centimetre;

b) in tables of values of the same quantity, or in a discussion of such values within a given context, it is generally preferable to use the same unit multiple throughout; and

c) for certain quantities in particular applications, one particular multiple is customarily used. For example, the hectopascal is used for altimeter settings and the millimetre is used for linear dimensions in mechanical engineering drawings even when the values lie outside the range 0.1 to 1 000.

4.2 Prefixes in compound units[1]

It is recommended that only one prefix be used in forming a multiple of a compound unit. Normally the prefix should be attached to a unit in the numerator. One exception to this occurs when the kilogram is one of the units. For example:

V/m, *not* mV/mm; MJ/kg, *not* kJ/g

4.3 Compound prefixes

Compound prefixes, formed by the juxtaposition of two or more SI prefixes, are not to be used. For example:

1 nm *not* 1mμm; 1 pF *not* 1μμF

If values are required outside the range covered by the prefixes, they should be expressed using powers of ten applied to the base unit.

4.4 Powers of units

An exponent attached to a symbol containing a prefix indicates that the multiple or sub-multiple of the unit (the unit with its prefix) is raised to the power expressed by the exponent. For example:

$$1\ \mathrm{cm}^3 = (10^{-2}\ \mathrm{m})^3 = 10^{-6}\ \mathrm{m}^3$$

$$1\ \mathrm{ns}^{-1} = (10^{-9}\ \mathrm{s})^{-1} = 10^{9}\ \mathrm{s}^{-1}$$

$$1\ \mathrm{mm}^2/\mathrm{s} = (10^{-3}\ \mathrm{m})^2/\mathrm{s} = 10^{-6}\ \mathrm{m}^2/\mathrm{s}$$

5. Style and usage

5.1 Rules for writing unit symbols

5.1.1 Unit symbols should be printed in Roman (upright) type regardless of the type style used in the surrounding text.

5.1.2 Unit symbols are unaltered in the plural.

5.1.3 Unit symbols are not followed by a period except when used at the end of a sentence.

5.1.4 Letter unit symbols are written in lower case (cd) unless the unit name has been derived from a proper name, in which case the first letter of the symbol is capitalized (W, Pa). Prefix and unit symbols retain their prescribed form regardless of the surrounding typography.

5.1.5 In the complete expression for a quantity, a space should be left between the numerical value and the unit symbol. For example, write 35 mm not 35mm, and 2.37 lm, not 2.37lm. When the quantity is used in an adjectival sense, a hyphen is often used, for example, 35-mm film.

Exception: No space is left between the numerical value and the symbols for degree, minute and second of plane angle, and degree Celsius.

5.1.6 No space is used between the prefix and unit symbols.

5.1.7 Symbols, not abbreviations, should be used for units. For example, use "A", not "amp", for ampere.

5.2 Rules for writing unit names

5.2.1 Spelled-out unit names are treated as common nouns in English. Thus, the first letter of a unit name is not capitalized except at the beginning of a sentence or in capitalized material such as a title, even though the unit name may be derived from a proper name and therefore be represented as a symbol by a capital letter (see 5.1.4). For example, normally write "newton" not "Newton" even though the symbol is N.

5.2.2 Plurals are used when required by the rules of grammar and are normally formed regularly, for example, henries for the plural of henry. The following irregular plurals are recommended:

Singular	*Plural*
lux	lux
hertz	hertz
siemens	siemens

1. A compound unit is a derived unit expressed in terms of two or more units, that is, not expressed with a single special name.

5.2.3 No space or hyphen is used between the prefix and the unit name.

5.3 Units formed by multiplication and division

5.3.1 *With unit names:*

Product, use a space (preferred) or hyphen:

newton metre *or* newton-metre

in the case of the watt hour the space may be omitted, thus:

watthour.

Quotient, use the word per and not a solidus:

metre per second *not* metre/second.

Powers, use the modifier squared or cubed placed after the unit name:

metre per second squared

In the case of area or volume, a modifier may be placed before the unit name:

square millimetre, cubic metre.

This exception also applies to derived units using area or volume:

watt per square metre.

Note.— To avoid ambiguity in complicated expressions, symbols are preferred to words.

5.3.2 *With unit symbols:*

Product may be indicated in either of the following ways:

Nm *or* N · m for newton metre.

Note.— When using for a prefix a symbol which coincides with the symbol for the unit, special care should be taken to avoid confusion. The unit newton metre for torque should be written, for example, Nm *or* N · m *to avoid confusion with* mN, *the millinewton.*

An exception to this practice is made for computer printouts, automatic typewriter work, etc., where the dot half high is not possible, and a dot on the line may be used.

Quotient, use one of the following forms:

$\mathrm{m/s}$ *or* $\mathrm{m \cdot s^{-1}}$ *or* $\frac{\mathrm{m}}{\mathrm{s}}$

In no case should more than one solidus be used in the same expression unless parentheses are inserted to avoid ambiguity. For example, write:

$\mathrm{J/(mol \cdot K)}$ *or* $\mathrm{J \cdot mol^{-1} \cdot K^{-1}}$ *or* $\mathrm{(J/mol)/K}$

but *not* J/mol/K.

5.3.3 Symbols and unit names should not be mixed in the same expression. Write:

joules per kilogram *or* J/kg *or* $\mathrm{J \cdot kg^{-1}}$

but *not* joules/kilogram *or* joules/kg *or* $\mathrm{joules \cdot kg^{-1}}$.

5.4 Numbers

5.4.1 The preferred decimal marker is a point on the line (period); however, the comma is also acceptable. When writing numbers less than one, a zero should be written before the decimal marker.

5.4.2 The comma is not to be used to separate digits. Instead, digits should be separated into groups of three, counting from the decimal point towards the left and the right, and using a small space to separate the groups. For example:

73 655   7 281   2.567 321   0.133 47

The space between groups should be approximately the width of the letter "i" and the width of the space should be constant even if, as is often the case in printing, variable-width spacing is used between the words.

5.4.3 The sign for multiplication of numbers is a cross (×) or a dot half high. However, if the dot half high is used as the multiplication sign, a point on the line must not be used as a decimal marker in the same expression.

5.4.4 Attachment of letters to a unit symbol as a means of giving information about the nature of the quantity under consideration is incorrect. Thus MWe for "megawatts electrical (power)", Vac for "volts ac" and kJt for "kilojoules thermal (energy)" are not acceptable. For this reason, no attempt should be made to construct SI equivalents of the abbreviations "psia" and "psig", so often used to distinguish between absolute and gauge pressure. If the context leaves any doubt as to which is meant, the word pressure must be qualified appropriately. For example:

". . . at a gauge pressure of 13 kPa".

or " . . . at an absolute pressure of 13 kPa".

ATTACHMENT C. CONVERSION FACTORS

1. General

1.1 The list of conversion factors which is contained in this Attachment is provided to express the definitions of miscellaneous units of measure as numerical multiples of SI units.

1.2 The conversion factors are presented for ready adaptation to computer read-out and electronic data transmission. The factors are written as a number greater than 1 and less than 10 with six or less decimal places. This number is followed by the letter E (for exponent), a plus or minus symbol, and two digits which indicate the power of 10 by which the number must be multiplied to obtain the correct value. For example:

3.523 907 E−02 is 3.523 907 × 10^{-2} *or* 0.035 239 07

Similarly,

3.386 389 E+03 is 3.386 389 × 10^{3} *or* 3 386.389

1.3 An asterisk (*) after the sixth decimal place indicates that the conversion factor is exact and that all subsequent digits are zero. Where less than six decimal places are shown, more precision is not warranted.

1.4 Further examples of use of the tables:

To convert from	*to*	*Multiply by*
pound-force per square foot	Pa	4.788 026 E+01
inch	m	2.540 000*E−02

thus:

1 lbf/ft^2 = 47.880 26 Pa

1 inch = 0.025 4 m (exactly)

2. Factors not listed

2.1 Conversion factors for compound units which are not listed herein can easily be developed from numbers given in the list by the substitution of converted units, as follows.

Example: To find conversion factor of lb·ft/s to kg·m/s:

first convert
1 lb to 0.453 592 4 kg
1 ft to 0.304 8 m

then substitute:
(0.453 592 4 kg) × (0.304 8 m)/s
= 0.138 255 kg·m/s
Thus the factor is 1.382 55 E−01.

Table C-1. Conversion factors to SI units
(Symbols of SI units given in parentheses)

To convert from	*to*	*Multiply by*
abampere	ampere (A)	1.000 000*E+01
abcoulomb	coulomb (C)	1.000 000*E+01
abfarad	farad (F)	1.000 000*E+09
abhenry	henry (H)	1.000 000*E−09
abmho	siemens (S)	1.000 000*E+09
abohm	ohm (Ω)	1.000 000*E−09
abvolt	volt (V)	1.000 000*E−08
acre (U.S. survey)	square metre (m^2)	4.046 873 E+03
ampere hour	coulomb (C)	3.600 000*E+03
are	square metre (m^2)	1.000 000*E+02
atmosphere (standard)	pascal (Pa)	1.013 250*E+05
atmosphere (technical = 1 kgf/cm^2)	pascal (Pa)	9.806 650*E+04
bar	pascal (Pa)	1.000 000*E+05
barrel (for petroleum, 42 U.S. liquid gal)	cubic metre (m^3)	1.589 873*E−01

* An asterisk (*) after the sixth decimal place indicates that the conversion factor is exact and that all subsequent digits are zero. Where less than six decimal places are shown, more precision is not warranted.

Table C-1 *(cont.)*

To convert from	*to*	*Multiply by*
British thermal unit (International Table)	joule (J)	1.055 056 E+03
British thermal unit (mean)	joule (J)	1.055 87 E+03
British thermal unit (thermochemical)	joule (J)	1.054 350 E+03
British thermal unit (39°F)	joule (J)	1.059 67 E+03
British thermal unit (59°F)	joule (J)	1.054 80 E+03
British thermal unit (60°F)	joule (J)	1.054 68 E+03
Btu (International Table)·ft/h·ft²·°F (k, thermal conductivity)	watt per metre kelvin (W/m·K)	1.730 735 E+00
Btu (thermochemical)·ft/h·ft²·°F (k, thermal conductivity)	watt per metre kelvin (W/m·K)	1.729 577 E+00
Btu (International Table)·in/h·ft²·°F (k, thermal conductivity)	watt per metre kelvin (W/m·K)	1.442 279 E−01
Btu (thermochemical)·in/h·ft²·°F (k, thermal conductivity)	watt per metre kelvin (W/m·K)	1.441 314 E−01
Btu (International Table)·in/s·ft²·°F (k, thermal conductivity)	watt per metre kelvin (W/m·K)	5.192 204 E+02
Btu (thermochemical)·in/s·ft²·°F (k, thermal conductivity)	watt per metre kelvin (W/m·K)	5.188 732 E+02
Btu (International Table)/h	watt (W)	2.930 711 E−01
Btu (thermochemical)/h	watt (W)	2.928 751 E−01
Btu (thermochemical)/min	watt (W)	1.757 250 E+01
Btu (thermochemical)/s	watt (W)	1.054 350 E+03
Btu (International Table)/ft²	joule per square metre (J/m²)	1.135 653 E+04
Btu (thermochemical)/ft²	joule per square metre (J/m²)	1.134 893 E+04
Btu (thermochemical)/ft²·h	watt per square metre (W/m²)	3.152 481 E+00
Btu (thermochemical)/ft²·min	watt per square metre (W/m²)	1.891 489 E+02
Btu (thermochemical)/ft²·s	watt per square metre (W/m²)	1.134 893 E+04
Btu (thermochemical)/in²·s	watt per square metre (W/m²)	1.634 246 E+06
Btu (International Table)/h·ft²·°F (C, thermal conductance)	watt per square metre kelvin (W/m²·K)	5.678 263 E+00
Btu (thermochemical)/h·ft²·°F (C, thermal conductance)	watt per square metre kelvin (W/m²·K)	5.674 466 E+00
Btu (International Table)/s·ft²·°F	watt per square metre kelvin (W/m²·K)	2.044 175 E+04
Btu (thermochemical)/s·ft²·°F	watt per square metre kelvin (W/m²·K)	2.042 808 E+04
Btu (International Table)/lb	joule per kilogram (J/kg)	2.326 000*E+03
Btu (thermochemical)/lb	joule per kilogram (J/kg)	2.324 444 E+03
Btu (International Table)/lb·°F (c, heat capacity)	joule per kilogram kelvin (J/kg·K)	4.186 800*E+03
Btu (thermochemical)/lb·°F (c, heat capacity)	joule per kilogram kelvin (J/kg·K)	4.184 000 E+03
calibre (inch)	metre (m)	2.540 000*E−02
calorie (International Table)	joule (J)	4.186 800*E+00
calorie (mean)	joule (J)	4.190 02 E+00
calorie (thermochemical)	joule (J)	4.184 000*E+00
calorie (15°C)	joule (J)	4.185 80 E+00
calorie (20°C)	joule (J)	4.181 90 E+00
calorie (kilogram, International Table)	joule (J)	4.186 800*E+03
calorie (kilogram, mean)	joule (J)	4.190 02 E+03
calorie (kilogram, thermochemical)	joule (J)	4.184 000*E+03
cal (thermochemical)/cm²	joule per square metre (J/m²)	4.184 000*E+04

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Table C-1 *(cont.)*

To convert from	*to*	*Multiply by*
cal (International Table)/g	joule per kilogram (J/kg)	4.186 800*E+03
cal (thermochemical)/g	joule per kilogram (J/kg)	4.184 000*E+03
cal (International Table)/g·°C	joule per kilogram kelvin (J/kg·K)	4.186 800*E+03
cal (thermochemical)/g·°C	joule per kilogram kelvin (J/kg·K)	4.184 000*E+03
cal (thermochemical)/min	watt (W)	6.973 333 E−02
cal (thermochemical)/s	watt (W)	4.184 000*E+00
cal (thermochemical)/cm²·min	watt per square metre (W/m²)	6.973 333 E+02
cal (thermochemical)/cm²·s	watt per square metre (W/m²)	4.184 000*E+04
cal (thermochemical)/cm·s·°C	watt per metre kelvin (W/m·K)	4.184 000*E+02
centimetre of mercury (0°C)	pascal (Pa)	1.333 22 E+03
centimetre of water (4°C)	pascal (Pa)	9.806 38 E+01
centipoise	pascal second (Pa·s)	1.000 000*E−03
centistokes	metre squared per second (m²/s)	1.000 000*E−06
circular mil	square metre (m²)	5.067 075 E−10
clo	kelvin metre squared per watt (K·m²/W)	2.003 712 E−01
cup	cubic metre (m³)	2.365 882 E−04
curie	becquerel (Bq)	3.700 000*E+10
day (mean solar)	second (s)	8.640 000 E+04
day (sidereal)	second (s)	8.616 409 E+04
degree (angle)	radian (rad)	1.745 329 E−02
°F·h·ft²/Btu (International Table) (R, thermal resistance)	kelvin metre squared per watt (K·m²/W)	1.761 102 E−01
°F·h·ft²/Btu (thermochemical) (R, thermal resistance)	kelvin metre squared per watt (K·m²/W)	1.762 280 E−01
dyne	newton (N)	1.000 000*E−05
dyne·cm	newton metre (N·m)	1.000 000*E−07
dyne/cm²	pascal (Pa)	1.000 000*E−01
electronvolt	joule (J)	1.602 19 E−19
EMU of capacitance	farad (F)	1.000 000*E+09
EMU of current	ampere (A)	1.000 000*E+01
EMU of electric potential	volt (V)	1.000 000*E−08
EMU of inductance	henry (H)	1.000 000*E−09
EMU of resistance	ohm (Ω)	1.000 000*E−09
erg	joule (J)	1.000 000*E−07
erg/cm²·s	watt per square metre (W/m²)	1.000 000*E−03
erg/s	watt (W)	1.000 000*E−07
ESU of capacitance	farad (F)	1.112 650 E−12
ESU of current	ampere (A)	3.335 6 E−10
ESU of electric potential	volt (V)	2.997 9 E+02
ESU of inductance	henry (H)	8.987 554 E+11
ESU of resistance	ohm (Ω)	8.987 554 E+11
faraday (based on carbon-12)	coulomb (C)	9.648 70 E+04
faraday (chemical)	coulomb (C)	9.649 57 E+04
faraday (physical)	coulomb (C)	9.652 19 E+04
fathom	metre (m)	1.828 8 E+00
fermi (femtometre)	metre (m)	1.000 000*E−15
fluid ounce (U.S.)	cubic metre (m³)	2.957 353 E−05
foot	metre (m)	3.048 000*E−01

Table C-1 *(cont.)*

To convert from	*to*	*Multiply by*
foot (U.S. survey)	metre (m)	3.048 006 E−01
foot of water (39.2°F)	pascal (Pa)	2.988 98 E+03
ft^2	square metre (m^2)	9.290 304*E−02
ft^2/h (thermal diffusivity)	metre squared per second (m^2/s)	2.580 640*E−05
ft^2/s	metre squared per second (m^2/s)	9.290 304*E−02
ft^3 (volume; section modulus)	cubic metre (m^3)	2.831 685 E−02
ft^3/min	cubic metre per second (m^3/s)	4.719 474 E−04
ft^3/s	cubic metre per second (m^3/s)	2.831 685 E−02
ft^4 (moment of section)	metre to the fourth power (m^4)	8.630 975 E−03
ft·lbf	joule (J)	1.355 818 E+00
ft·lbf/h	watt (W)	3.766 161 E−04
ft·lbf/min	watt (W)	2.259 697 E−02
ft·lbf/s	watt (W)	1.355 818 E+00
ft·poundal	joule (J)	4.214 011 E−02
free fall, standard (g)	metre per second squared (m/s^2)	9.806 650*E+00
ft/h	metre per second (m/s)	8.466 667 E−05
ft/min	metre per second (m/s)	5.080 000*E−03
ft/s	metre per second (m/s)	3.048 000*E−01
ft/s^2	metre per second squared (m/s^2)	3.048 000*E−01
footcandle	lux (lx)	1.076 391 E+01
footlambert	candela per square metre (cd/m^2)	3.426 259 E+00
gal	metre per second squared (m/s^2)	1.000 000*E−02
gallon (Canadian liquid)	cubic metre (m^3)	4.546 090 E−03
gallon (U.K. liquid)	cubic metre (m^3)	4.546 092 E−03
gallon (U.S. dry)	cubic metre (m^3)	4.404 884 E−03
gallon (U.S. liquid)	cubic metre (m^3)	3.785 412 E−03
gal (U.S. liquid)/day	cubic metre per second (m^3/s)	4.381 264 E−08
gal (U.S. liquid)/min	cubic metre per second (m^3/s)	6.309 020 E−05
gal (U.S. liquid)/hp·h (SFC, specific fuel consumption)	cubic metre per joule (m^3/J)	1.410 089 E−09
gamma	tesla (T)	1.000 000*E−09
gauss	tesla (T)	1.000 000*E−04
gilbert	ampere (A)	7.957 747 E−01
grad	degree (angular)	9.000 000*E−01
grad	radian (rad)	1.570 796 E−02
gram	kilogram (kg)	1.000 000*E−03
g/cm^3	kilogram per cubic metre (kg/m^3)	1.000 000*E+03
gram-force/cm^2	pascal (Pa)	9.806 650*E+01
hectare	square metre (m^2)	1.000 000*E+04
horsepower (550 ft·lbf/s)	watt (W)	7.456 999 E+02
horsepower (electric)	watt (W)	7.460 000*E+02
horsepower (metric)	watt (W)	7.354 99 E+02
horsepower (water)	watt (W)	7.460 43 E+02
horsepower (U.K.)	watt (W)	7.457 0 E+02
hour (mean solar)	second (s)	3.600 000 E+03
hour (sidereal)	second (s)	3.590 170 E+03
hundredweight (long)	kilogram (kg)	5.080 235 E+01
hundredweight (short)	kilogram (kg)	4.535 924 E+01

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Table C-1 *(cont.)*

To convert from	*to*	*Multiply by*
inch	metre (m)	2.540 000*E−02
inch of mercury (32°F)	pascal (Pa)	3.386 38 E+03
inch of mercury (60°F)	pascal (Pa)	3.376 85 E+03
inch of water (39.2°F)	pascal (Pa)	2.490 82 E+02
inch of water (60°F)	pascal (Pa)	2.488 4 E+02
in^2	square metre (m^2)	6.451 600*E−04
in^3 (volume; section modulus)	cubic metre (m^3)	1.638 706 E−05
in^3/min	cubic metre per second (m^3/s)	2.731 177 E−07
in^4 (moment of section)	metre to the fourth power (m^4)	4.162 314 E−07
in/s	metre per second (m/s)	2.540 000*E−02
in/s^2	metre per second squared (m/s^2)	2.540 000*E−02
kilocalorie (International Table)	joule (J)	4.186 800*E+03
kilocalorie (mean)	joule (J)	4.190 02 E+03
kilocalorie (thermochemical)	joule (J)	4.184 000*E+03
kilocalorie (thermochemical)/min	watt (W)	6.973 333 E+01
kilocalorie (thermochemical)/s	watt (W)	4.184 000*E+03
kilogram-force (kgf)	newton (N)	9.806 650*E+00
kgf·m	newton metre (N·m)	9.806 650*E+00
$kgf \cdot s^2/m$ (mass)	kilogram (kg)	9.806 650*E+00
kgf/cm^2	pascal (Pa)	9.806 650*E−04
kgf/m^2	pascal (Pa)	9.806 650*E+00
kgf/mm^2	pascal (Pa)	9.806 650*E+06
km/h	metre per second (m/s)	2.777 778 E−01
kilopond	newton (N)	9.806 650*E+00
kW·h	joule (J)	3.600 000*E+06
kip (1 000 lbf)	newton (N)	4.448 222 E+03
kip/in^2 (ksi)	pascal (Pa)	6.894 757 E+06
knot (international)	metre per second (m/s)	5.144 444 E−01
lambert	candela per square metre (cd/m^2)	$1/\pi$ *E+04
lambert	candela per square metre (cd/m^2)	3.183 099 E+03
langley	joule per square metre (J/m^2)	4.184 000*E+04
$lb \cdot ft^2$ (moment of inertia)	kilogram metre squared ($kg \cdot m^2$)	4.214 011 E−02
$lb \cdot in^2$ (moment of inertia)	kilogram metre squared ($kg \cdot m^2$)	2.926 397 E−04
lb/ft·h	pascal second (Pa·s)	4.133 789 E−04
lb/ft·s	pascal second (Pa·s)	1.488 164 E+00
lb/ft^2	kilogram per square metre (kg/m^2)	4.882 428 E+00
lb/ft^3	kilogram per cubic metre (kg/m^3)	1.601 846 E+01
lb/gal (U.K. liquid)	kilogram per cubic metre (kg/m^3)	9.977 633 E+01
lb/gal (U.S. liquid)	kilogram per cubic metre (kg/m^3)	1.198 264 E+02
lb/h	kilogram per second (kg/s)	1.259 979 E−04
lb/hp·h (SFC, specific fuel consumption)	kilogram per joule (kg/J)	1.689 659 E−07
lb/in^3	kilogram per cubic metre (kg/m^3)	2.767 990 E+04
lb/min	kilogram per second (kg/s)	7.559 873 E−03
lb/s	kilogram per second (kg/s)	4.535 924 E−01
lb/yd^3	kilogram per cubic metre (kg/m^3)	5.932 764 E−01
lbf·ft	newton metre (N·m)	1.355 818 E+00
lbf·ft/in	newton metre per metre (N·m/m)	5.337 866 E+01

Table C-1 *(cont.)*

To convert from	*to*	*Multiply by*
lbf·in	newton metre (N·m)	1.129 848 E−01
lbf·in/in	newton metre per metre (N·m/m)	4.448 222 E+00
lbf·s/ft²	pascal second (Pa·s)	4.788 026 E+01
lbf/ft	newton per metre (N/m)	1.459 390 E+01
lbf/ft²	pascal (Pa)	4.788 026 E+01
lbf/in	newton per metre (N/m)	1.751 268 E+02
lbf/in² (psi)	pascal (Pa)	6.894 757 E+03
lbf/lb (thrust/weight (mass) ratio)	newton per kilogram (N/kg)	9.806 650 E+00
light year	metre (m)	9.460 55 E+15
litre	cubic metre (m³)	1.000 000*E−03
maxwell	weber (Wb)	1.000 000*E−08
mho	siemens (S)	1.000 000*E+00
microinch	metre (m)	2.540 000*E−08
micron	metre (m)	1.000 000*E−06
mil	metre (m)	2.540 000*E−05
mile (international)	metre (m)	1.609 344*E+03
mile (statute)	metre (m)	1.609 3 E+03
mile (U.S. survey)	metre (m)	1.609 347 E+03
mile (international nautical)	metre (m)	1.852 000*E+03
mile (U.K. nautical)	metre (m)	1.853 184*E+03
mile (U.S. nautical)	metre (m)	1.852 000*E+03
mi² (international)	square metre (m²)	2.589 988 E+06
mi² (U.S. survey)	square metre (m²)	2.589 998 E+06
mi/h (international)	metre per second (m/s)	4.470 400*E−01
mi/h (international)	kilometre per hour (km/h)	1.609 344*E+00
mi/min (international)	metre per second (m/s)	2.682 240*E+01
mi/s (international)	metre per second (m/s)	1.609 344*E+03
millibar	pascal (Pa)	1.000 000*E+02
millimetre of mercury (0°C)	pascal (Pa)	1.333 22 E+02
minute (angle)	radian (rad)	2.908 882 E−04
minute (mean solar)	second (s)	6.000 000 E+01
minute (sidereal)	second (s)	5.983 617 E+01
month (mean calendar)	second(s)	2.628 000 E+06
oersted	ampere per metre (A/m)	7.957 747 E+01
ohm centimetre	ohm metre (Ω·m)	1.000 000*E−02
ohm circular-mil per ft	ohm millimetre squared per metre (Ω·mm²/m)	1.662 426 E−03
ounce (avoirdupois)	kilogram (kg)	2.834 952 E−02
ounce (troy or apothecary)	kilogram (kg)	3.110 348 E−02
ounce (U.K. fluid)	cubic metre (m³)	2.841 307 E−05
ounce (U.S. fluid)	cubic metre (m³)	2.957 353 E−05
ounce-force	newton (N)	2.780 139 E−01
ozf·in	newton metre (N·m)	7.061 552 E−03
oz (avoirdupois)/gal (U.K. liquid)	kilogram per cubic metre (kg/m³)	6.236 021 E+00
oz (avoirdupois)/gal (U.S. liquid)	kilogram per cubic metre (kg/m³)	7.489 152 E+00
oz (avoirdupois)/in³	kilogram per cubic metre (kg/m³)	1.729 994 E+03
oz (avoirdupois)/ft²	kilogram per square metre (kg/m²)	3.051 517 E−01
oz (avoirdupois)/yd²	kilogram per square metre (kg/m²)	3.390 575 E−02

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Table C-1 *(cont.)*

To convert from	*to*	*Multiply by*
parsec	metre (m)	3.085 678 E+16
pennyweight	kilogram (kg)	1.555 174 E−03
perm (0°C)	kilogram per pascal second metre squared (kg/Pa·s·m²)	5.721 35 E−11
perm (23°C)	kilogram per pascal second metre squared (kg/Pa·s·m²)	5.745 25 E−11
perm·in (0°C)	kilogram per pascal second metre (kg/Pa·s·m)	1.453 22 E−12
perm·in (23°C)	kilogram per pascal second metre (kg/Pa·s·m)	1.459 29 E−12
phot	lumen per square metre (lm/m²)	1.000 000*E+04
pint (U.S. dry)	cubic metre (m³)	5.506 105 E−04
pint (U.S. liquid)	cubic metre (m³)	4.731 765 E−04
poise (absolute viscosity)	pascal second (Pa·s)	1.000 000*E−01
pound (lb avoirdupois)	kilogram (kg)	4.535 924 E−01
pound (troy or apothecary)	kilogram (kg)	3.732 417 E−01
poundal	newton (N)	1.382 550 E−01
poundal/ft²	pascal (Pa)	1.488 164 E+00
poundal·s/ft²	pascal second (Pa·s)	1.488 164 E+00
pound-force (lbf)	newton (N)	4.448 222 E+00
quart (U.S. dry)	cubic metre (m³)	1.101 221 E−03
quart (U.S. liquid)	cubic metre (m³)	9.463 529 E−04
rad (radiation dose absorbed)	gray (Gy)	1.000 000*E−02
rem	sievert (Sv)	1.000 000*E−02
rhe	1 per pascal second (1/Pa·s)	1.000 000*E+01
roentgen	coulomb per kilogram (C/kg)	2.58 E−04
second (angle)	radian (rad)	4.848 137 E−06
second (sidereal)	second (s)	9.972 696 E−01
slug	kilogram (kg)	1.459 390 E+01
slug/ft·s	pascal second (Pa·s)	4.788 026 E+01
slug/ft³	kilogram per cubic metre (kg/m³)	5.153 788 E+02
statampere	ampere (A)	3.335 640 E−10
statcoulomb	coulomb (C)	3.335 640 E−10
statfarad	farad (F)	1.112 650 E−12
stathenry	henry (H)	8.987 554 E+11
statmho	siemens (S)	1.112 650 E−12
statohm	ohm (Ω)	8.987 554 E+11
statvolt	volt (V)	2.997 925 E+02
stere	cubic metre (m³)	1.000 000*E+00
stilb	candela per square metre (cd/m²)	1.000 000*E+04
stokes (kinematic viscosity)	metre squared per second (m²/s)	1.000 000*E−04
therm	joule (J)	1.055 056 E+08
ton (assay)	kilogram (kg)	2.916 667 E−02
ton (long, 2 240 lb)	kilogram (kg)	1.016 047 E+03
ton (metric)	kilogram (kg)	1.000 000*E+03
ton (nuclear equivalent of TNT)	joule (J)	4.184 E+09
ton (refrigeration)	watt (W)	3.516 800 E+03

Table C-1 *(cont.)*

To convert from	*to*	*Multiply by*
ton (register)	cubic metre (m^3)	2.831 685 E+00
ton (short, 2 000 lb)	kilogram (kg)	9.071 847 E+02
ton (long)/yd^3	kilogram per cubic metre (kg/m^3)	1.328 939 E+03
ton (short)/h	kilogram per second (kg/s)	2.519 958 E−01
ton-force (2 000 lbf)	newton (N)	8.896 444 E+03
tonne	kilogram (kg)	1.000 000*E+03
torr (mm Hg, 0°C)	pascal (Pa)	1.333 22 E+02
unit pole	weber (Wb)	1.256 637 E−07
W·h	joule (J)	3.600 000*E+03
W·s	joule (J)	1.000 000*E+00
W/cm^2	watt per square metre (W/m^2)	1.000 000*E+04
W/in^2	watt per square metre (W/m^2)	1.550 003 E+03
yard	metre (m)	9.144 000*E−01
yd^2	square metre (m^2)	8.361 274 E−01
yd^3	cubic metre (m^3)	7.645 549 E−01
yd^3/min	cubic metre per second (m^3/s)	1.274 258 E−02
year (calendar)	second (s)	3.153 600 E+07
year (sidereal)	second (s)	3.155 815 E+07
year (tropical)	second (s)	3.155 693 E+07

Table C-2. Temperature conversion formulae

To convert from	*to*	*Use formula*
Celsius temperature ($t_{°C}$)	Kelvin temperature (t_K)	$t_K = t_{°C} + 273.15$
Fahrenheit temperature ($t_{°F}$)	Celsius temperature ($t_{°C}$)	$t_{°C} = (t_{°F} - 32)/1.8$
Fahrenheit temperature ($t_{°F}$)	Kelvin temperature (t_K)	$t_K = (t_{°F} + 459.67)/1.8$
Kelvin temperature (t_K)	Celsius temperature ($t_{°C}$)	$t_{°C} = t_K - 273.15$
Rankine temperature ($t_{°R}$)	Kelvin temperature (t_K)	$t_K = t_{°R}/1.8$

ATTACHMENT D. CO-ORDINATED UNIVERSAL TIME

1. Co-ordinated Universal Time (UTC) has now replaced Greenwich Mean Time (GMT) as the accepted international standard for clock time. It is the basis for civil time in many States and is also the time used in the world-wide time signal broadcasts used in aviation. The use of UTC is recommended by such bodies as the General Conference on Weights and Measures (CGPM), the International Radio Consultative Committee (CCIR) and the World Administration Radio Conference (WARC).

2. The basis for all clock time is the time of apparent rotation of the sun. This is, however, a variable quantity which depends, among other things, on where it is measured on earth. A mean value of this time, based upon measurements in a number of places on the earth, is known as Universal Time. A different time scale, based upon the definition of the second, is known as International Atomic Time (TAI). A combination of these two scales results in Co-ordinated Universal Time. This consists of TAI adjusted as necessary by the use of leap seconds to obtain a close approximation (always within 0.5 seconds) of Universal Time.

ATTACHMENT E. PRESENTATION OF DATE AND TIME IN ALL-NUMERIC FORM

1. Introduction

The International Organization for Standardization (ISO) Standards 2014 and 3307 specify the procedures for writing the date and time in all-numeric form and ICAO will be using these procedures in its documents where appropriate in the future.

2. Presentation of Date

Where dates are presented in all-numeric form, ISO 2014 specifies that the sequence year-month-day should be used. The elements of the date should be:

— four digits to represent the year, except that the century digits may be omitted where no possible confusion could arise from such an omission. There is value in using the century digits during the period of familiarization with the new format to make it clear that the new order of elements is being used;

— two digits to represent the month;

— two digits to represent the day.

Where it is desired to separate the elements for easier visual understanding, only a space or a hyphen should be used as a separator. As an example, 25 August 1983 may be written as:

19830825 or 830825

or 1983-08-25 or 83-08-25

or 1983 08 25 or 83 08 25.

It should be emphasized that the ISO sequence should only be used where it is intended to use an all-numeric presentation. Presentations using a combination of figures and words may still be used if required (e.g. 25 August 1983).

3. Presentation of Time

3.1 Where the time of day is to be written in all-numeric form, ISO 3307 specifies that the sequence hours-minutes-seconds should be used.

3.2 Hours should be represented by two digits from 00 to 23 in the 24-hour timekeeping system and may be followed either by decimal fractions of an hour or by minutes and seconds. Where decimal fractions of an hour are used, the normal decimal separator should be used followed by the number of digits necessary to provide the required accuracy.

3.3 Minutes should likewise be represented by two digits from 00 to 59 followed by either decimal fractions of a minute or by seconds.

3.4 Seconds should also be represented by two digits from 00 to 59 and followed by decimal fractions of a second if required.

3.5 Where it is necessary to facilitate visual understanding a colon should be used to separate hours and minutes and minutes and seconds. For example, 20 minutes and 18 seconds past 3 o'clock in the afternoon may be written as:

152018 or 15:20:18 in hours, minutes and seconds

or 1520.3 or 15:20.3 in hours, minutes and decimal fractions of a minute

or 15.338 in hours and decimal fractions of an hour.

4. Combination Date and Time Groups

This presentation lends itself to a uniform method of writing date and time together where necessary. In such cases, the sequence of elements year-month-day-hour-minute-second should be used. It may be noted that not all the elements need be used in every case — in a typical application, for example, only the elements day-hour-minute might be used.

— END —

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

OPERATION OF AIRCRAFT

ANNEX 6

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

PART I
INTERNATIONAL COMMERCIAL AIR TRANSPORT — AEROPLANES

SIXTH EDITION OF PART I — JULY 1995

This edition incorporates all amendments adopted by the Council prior to 9 March 1995 and supersedes, on 9 November 1995, all previous editions of Part I of Annex 6.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-21	Incorporated in this Edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

ABBREVIATIONS AND SYMBOLS

(used in this Annex)

Abbreviations

A/H	Altitude/height
AFCS	Automatic flight control system
AGA	Aerodromes, air routes and ground aids
AIG	Accident investigation and prevention
AOC	Air operator certificate
ASDA	Accelerate stop distance available
ATC	Air traffic control
ATS	Air traffic services
CAS	Calibrated airspeed
cm	Centimetre
CVR	Cockpit voice recorder
DA/H	Decision altitude/height
DA	Decision altitude
DH	Decision height
DME	Distance measuring equipment
ECAM	Electronic centralized aircraft monitor
EFIS	Electronic flight instrument system
EGT	Exhaust gas temperature
EICAS	Engine indication and crew alerting system
EPR	Engine pressure ratio
FDR	Flight data recorder
ft	Foot
ft/min	Feet per minute
g	Normal acceleration
GPWS	Ground proximity warning system
hPa	Hectopascal
IFR	Instrument flight rules
IMC	Instrument meteorological conditions
INS	Inertial navigation system
ISA	International standard atmosphere
kg	Kilogram
km	Kilometre
km/h	Kilometre per hour
kt	Knot
lb	Pound
LDA	Landing distance available
m	Metre
MDA/H	Minimum descent altitude/height
MEL	Minimum equipment list
MHz	Megahertz
MMEL	Master minimum equipment list
MNPS	Minimum navigation performance specifications
m/s	Metres per second
MSL	Mean sea level
NAV	Navigation
N1	High pressure turbine speed
NM	Nautical mile
OCA/H	Obstacle clearance altitude/height
OCA	Obstacle clearance altitude
OCH	Obstacle clearance height
RVR	Runway visual range
SST	Supersonic transport
STOL	Short take-off and landing
TAS	True airspeed
TODA	Take-off distance available
TORA	Take-off run available
UTC	Universal co-ordinated time
VFR	Visual flight rules
VHF	Very high frequency
V_D	Design diving speed
VMC	Visual meteorological conditions
VMC	Minimum control speed with the critical engine inoperative
V_{S_0}	Stalling speed or the minimum steady flight speed in the landing configuration
V_{S_1}	Stalling speed or the minimum steady flight speed in a specified configuration
VTOL	Vertical take-off and landing
WXR	Weather

Symbols

°C	Degrees Celsius

PUBLICATIONS
(referred to in this Annex)

Convention on International Civil Aviation (Doc 7300)

Nationality and Registration of Aircraft Operated by International Operating Agencies (Doc 8722)

International Regulations for Preventing Collisions at Sea

Final Report of the ICAO Standing Committee on Performance (Doc 7401)

Annexes to the Convention on International Civil Aviation

Annex 1 — Personnel Licensing

Annex 2 — Rules of the Air

Annex 3 — Meteorological Service for International Air Navigation

Annex 4 — Aeronautical Charts

Annex 5 — Units of Measurement to be Used in Air and Ground Operations

Annex 6 — Operation of Aircraft
Part II — *International General Aviation — Aeroplanes*
Part III — *International Operations — Helicopters*

Annex 8 — Airworthiness of Aircraft

Annex 9 — Facilitation

Annex 10 — Aeronautical Telecommunications
Volume I (Part I — *Equipment and Systems;*
Part II — *Radio Frequencies*)
Volume II *(Communication Procedures including those with PANS status)*

Annex 12 — Search and Rescue

Annex 13 — Aircraft Accident Investigation

Annex 14 — Aerodromes
Volume I — *Aerodrome Design and Operations*

Annex 15 — Aeronautical Information Services

Annex 16 — Environmental Protection
Volume I — *Aircraft Noise*
Volume II — *Aircraft Engine Emissions*

Annex 18 — The Safe Transport of Dangerous Goods by Air

Procedures for Air Navigation Services

OPS — Aircraft Operations (Doc 8168)
Volume I — *Flight Procedures*

Volume II — *Construction of Visual and Instrument Flight Procedures*

RAC — Rules of the Air and Air Traffic Services (Doc 4444)

Regional Supplementary Procedures (Doc 7030)

Manuals

Accident/Incident Reporting Manual (ADREP Manual) (Doc 9156)

Accident Prevention Manual (Doc 9422)

Airport Services Manual (Doc 9137)
Part 1 — *Rescue and Fire Fighting*
Part 8 — *Airport Operational Services*

Airworthiness Technical Manual (Doc 9051)

Continuing Airworthiness Manual (Doc 9642)

Manual of All-Weather Operations (Doc 9365)

Manual of Criteria for the Qualification of Flight Simulators (Doc 9625)

Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL290 and FL410 Inclusive (Doc 9574)

Manual on Required Navigation Performance (RNP) (Doc 9613)

Preparation of an Operations Manual (Doc 9376)

Circulars

Flight Crew Fatigue and Flight Time Limitations (Circ. 52)

Guidance Material on SST Aircraft Operations (Circ. 126)

9/11/95

ANNEX 6 — PART I
INTERNATIONAL COMMERCIAL AIR TRANSPORT — AEROPLANES

FOREWORD

Historical background

Standards and Recommended Practices for the Operation of Aircraft — International Commercial Air Transport were first adopted by the Council on 10 December 1948 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago, 1944) and designated as Annex 6 to the Convention. They became effective on 15 July 1949. The Standards and Recommended Practices were based on recommendations of the Operations Division at its first session in April 1946, which were further developed at the second session of the Division in February 1947.

Amendments to the Annex, which included additional Standards and Recommended Practices as well as modifications to existing Standards, and which were based on recommendations of the Operations Division at its third and fourth sessions in February-March 1949 and March-April 1951, were adopted by the Council on 5 December 1950 (Amendments 1-127), 4 December 1951 (Amendments 128-131), 28 November 1952 (Amendments 132 and 133), 2 December 1952 (Amendment 134), 20 October 1953 (Amendment 135), 23 February 1956 (Amendment 136), 8 May 1956 (Amendment 137) and 15 May 1956 (Amendment 138), and became effective on 1 June 1951, 1 May 1952, 1 April 1953, 1 May 1953, 1 March 1954, 1 July 1956, 1 September 1956 and 15 September 1956 respectively.

The Third Air Navigation Conference (Montreal, September-October 1956) made, among other things, a complete review of Chapter 5 of the Annex. As a result of those recommendations, their submission to all Contracting States, and their review by the Air Navigation Commission, a complete new text of Chapter 5 was adopted by the Council as Amendment 139 on 13 June 1957 and became effective on 1 October 1957.

Additionally, the Council adopted Amendment 140 on 13 June 1957, containing amendments to Chapter 6 covering the marking of break-in points on aircraft and the characteristics of navigation lights, to Chapter 8 respecting the qualification of persons to certify aircraft as airworthy, to Chapter 9 respecting the route and aerodrome qualification of pilots and to Chapter 10 respecting requirements for licensing of flight operations officers, which became effective on 1 October 1957. Subsequent to the issuance of the fifth edition, Amendment 141 (4.1.1 and 4.1.2) was adopted by the Council on 12 May 1958 and became applicable on 1 December 1958. On 8 December 1959 the Council adopted Amendment 142 relating to the provisions in Chapter 6 for the carriage of portable emergency radio transmitters. The Amendment became effective on 1 May 1960 and applicable on 1 August 1960. On 2 December 1960 the Council adopted Amendment 143 relating to the provisions in Chapter 4 for co-ordination of operational instructions involving a change in the air traffic control flight plan. The Amendment became effective on 1 April 1961 and applicable on 1 July 1961. On 24 March 1961 the Council adopted Amendment 144 relating to the establishment of limitations upon flight duty periods and provision of rest periods for flight crew members, and the Attachment to the Annex of guidance material on the establishment of flight time and flight duty period limitations and rest periods. The Amendment became effective on 1 August 1961 and applicable on 1 October 1961. The Council on 24 March 1961 approved Amendment 145 containing the Note under 6.2.2 a). On 13 December 1961 the Council adopted Amendments 146, 147 and approved Amendment 148. These relate respectively to the modernizing of the specifications concerning the provision and use of oxygen supply systems, the installation of high intensity anti-collision lights on aeroplanes and to purely editorial changes respecting references to other documents. The Amendments became effective on 1 April 1962 and applicable on 1 July 1962. On 8 April 1963 the Council adopted Amendment 149. This Amendment related to the specification of the circumstances under which emergency and survival equipment shall be carried on long range over water flights. The Amendment became effective on 1 August 1963 and applicable on 1 November 1963.

As a result of the adoption of Amendment 150, a sixth edition of the Annex was published. This was necessitated by the extensive nature of the Amendment which followed recommendations of the Fourth Air Navigation Conference (Montreal, November-December 1965) for extensive revision of the Annex, chiefly with the aim of bringing it up to date to meet the operational needs of high performance turbo-jet aeroplanes. Furthermore, on the recommendation of the Conference, the applicability of the Annex is now limited to "aeroplanes" engaged in scheduled and non-scheduled international air transport operations. Previously this limitation applied only to non-scheduled international air transport operations. Amendment 150 was adopted by the Council on 14 December 1966, became effective on 14 April 1967 and applicable on 24 August 1967.

The Council, on 8 November 1967, adopted Amendment 151 which redefined "Aircraft" as a result of adoption by

Council of Amendment 2 to Annex 7 to the Convention and amended 5.2.7.2.2 to cater for three-engined aeroplanes. The Amendment became effective on 8 March 1968 and applicable on 22 August 1968.

Amendment 152 was adopted by the Council on 23 January 1969. Besides revising certain paragraphs in Chapters 4, 7 and 8 to give them more precision, the Amendment also adds a provision in Chapter 4 which prohibits, when passengers are being carried, the in-flight simulation of emergency situations affecting the flight characteristics of the aeroplane. The opportunity presented by this Amendment was also taken to introduce changes to the Annex as a consequence of the adoption by the Council of a companion document — International Standards and Recommended Practices — *Operation of Aircraft — Annex 6: Part II. — International General Aviation.* These changes consisted of designating this document, previously known as Annex 6, "Annex 6, Part I, First Edition". Amendment 152 became effective on 23 May 1969 and applicable on 18 September 1969.

Consequent to the adoption of Annex 6, Part III, *International Operations* — Helicopters, an amendment to the title was introduced to indicate that Annex 6, Part I was applicable only to aeroplanes.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

The present edition of Annex 6, Part I, contains Standards and Recommended Practices adopted by the International Civil Aviation Organization as the minimum Standards applicable to the operation of aeroplanes by operators authorized to conduct international commercial air transport operations. These international commercial air transport operations include scheduled international air services and non-scheduled international air transport operations for remuneration or hire.

In conjunction, these two types of operations include all international air transport operations conducted for remuneration or hire by aeroplanes. The distinction between them lies in the fact that scheduled international air services are especially provided for in the Convention in contradistinction to international air transport operations in general, of which non-scheduled international air transport operations for remuneration or hire were considered most urgently to require the establishment of International Standards and Recommended Practices. It is no longer considered necessary to differentiate in the Standards and Recommended Practices between scheduled international air services and non-scheduled international air transport operations.

The purpose of Annex 6, Part I, is to contribute to the safety of international air navigation by providing criteria of safe operating practice and to contribute to the efficiency and regularity of international air navigation by encouraging States to facilitate the passage over their territories of aeroplanes in international commercial air transport belonging to other States that operate in conformity with such Standards.

Chapter 5

An element of the safety of an operation is the intrinsic safety of the aircraft, that is, its level of airworthiness. The level of airworthiness of an aircraft is, however, not fully defined by the application of the airworthiness Standards of Annex 8, but also requires the application of those Standards in the present Annex that are complementary to them.

As originally adopted and also as amended by Amendments 1 to 138, the Annex contained a chapter "Aeroplane Operating Limitations" which included general provisions applicable to the operation of all aeroplanes within the scope of the Annex, a section or sections applicable to aeroplanes certificated in ICAO categories according to the then existent Annex 8, and a section applicable to aeroplanes not so certificated.

At its fourth session, the Operations Division, collaborating with the Airworthiness Division, made, in addition to the proposals that resulted in Amendments 128 to 133, recommendations concerning the use of a performance code as an alternative to the one prescribed for ICAO Category A aeroplanes in which some essential climb values had the status of Recommended Practices. Further, the Airworthiness Division made recommendations concerning certain aspects of the certification in ICAO categories. As a result of those recommendations, the Council, on 2 December 1952, adopted Amendment 134 (which became effective 1 May 1953), and approved the incorporation of the alternative performance code as Attachment A, but stated its belief that since agreement had not yet been reached upon Standards covering performance, there existed no basis for certification in ICAO Category A. It urged the Contracting States to refrain from such certification pending the becoming effective of Standards on performance or until such time as the Council decides on the basic policy on airworthiness.

The Assembly at its seventh session (June 1953) endorsed the action already taken by the Council and the Air Navigation Commission to initiate a fundamental study of ICAO policy on international airworthiness and directed the Council to complete the study as rapidly as practicable.

In pursuing such study the Air Navigation Commission was helped by an international body of experts designated as the "Airworthiness Panel", which contributed to the preparation of the work of the Third Air Navigation Conference.

As a result of these studies a revised policy on international airworthiness was developed and it was approved by the Council in 1956. According to this policy the principle of certification in an ICAO Category was abandoned. Instead, Annex 8 included broad Standards which defined, for application by the competent national authorities, the complete minimum international basis for the recognition by States of certificates of airworthiness for the purpose of the flight of aircraft of other States into or over their territories, thereby achieving, among other purposes, protection of other aircraft, third persons and property. It was considered that this met the obligation of the Organization under Article 37 of the Convention to adopt international Standards of airworthiness.

It was recognized that the ICAO Standards of airworthiness would not replace national regulations and that national codes of airworthiness containing the full scope and extent of detail considered necessary by individual States would be necessary as the basis for the certification of individual aircraft. Each State would establish its own comprehensive and detailed code of airworthiness, or would select a comprehensive and detailed code established by another Contracting State. The level of airworthiness defined by this code would be indicated by the Standards, supplemented, if necessary, by Acceptable Means of Compliance.

A revised text consistent with the above principles was prepared for Chapter 5 of Annex 6. It included: a) broad Standards that were complementary to the Standards related to aeroplane performance in Annex 8; and b) two Acceptable Means of Compliance which illustrated by examples the level of performance intended by the broad Standards. To adopt a code giving an appreciably lower level of performance than that illustrated by these Acceptable Means of Compliance was considered to be a violation of the Standards in Chapter 5 of this Annex.

Present Policy on International Airworthiness. There had been some concern about the slow progress that had been made over the years with respect to developing supplementary airworthiness specifications in the form of Acceptable Means of Compliance. It was noted that the majority of the Acceptable Means of Compliance in Annexes 6 and 8 had been developed in 1957 and were therefore applicable to only those aeroplane types operating at that time. No effort had been made to update the specifications in these Acceptable Means of Compliance nor had there been any recommendations from the Airworthiness Committee for upgrading of any of the Provisional Acceptable Means of Compliance, which had been developed as potential material for full-fledged Acceptable Means of Compliance. The Air Navigation Commission therefore requested the Airworthiness Committee to review the progress made by it since its inception with a view to determining whether or not desired results had been achieved and to recommend any changes to improve the development of detailed airworthiness specifications.

The Airworthiness Committee at its Ninth Meeting (Montreal, November/December 1970) made a detailed study of the problems and recommended that the concept of developing airworthiness specifications in the form of Acceptable Means of Compliance and Provisional Acceptable Means of Compliance should be abandoned and a provision should be made for an Airworthiness Technical Manual to be prepared and published by ICAO to include guidance material intended to facilitate the development and uniformity of national airworthiness codes by Contracting States.

The Air Navigation Commission reviewed the recommendations of the Airworthiness Committee in the light of the history of the development of the airworthiness policy approved by the Council in 1956. It came to the conclusion that the basic objectives and principles on which the ICAO airworthiness policy had been based were sound and did not require any significant change. It was also concluded that the main reason for the slow progress in the development of airworthiness specifications in the form of Acceptable Means of Compliance and Provisional Acceptable Means of Compliance was the degree of mandatory status to the former implied by the following statement included in the Forewords of Annexes 6 and 8:

> "To adopt a code giving an appreciably lower level of airworthiness that that given in an Acceptable Means of Compliance would be a violation of the Standard supplement by that Acceptable Means of Compliance."

Several approaches were examined by the Air Navigation Commission to eliminate this difficulty. Finally it came to the conclusion that the idea of developing airworthiness specifications in the form of Acceptacle Means of Compliance and Provisional Acceptable Means of Compliance should be abandoned and ICAO should declare that the States' obligations, for the purpose of Article 33 of the Convention, shall be met by their compliance with the broad Standards in Annex 8 supplemented, as necessary, by airworthiness technical guidance material, devoid of all mandatory implications or obligations. Also the requirement that each Contracting State should either establish its own comprehensive and detailed code of airworthiness or select a comprehensive and detailed code established by another Contracting State, should be retained.

The Council on 15 March 1972 approved the above approach to form the basis for the present policy of ICAO in the field of airworthiness.

It also approved the issuance of the airworthiness guidance material under the title of "Airworthiness Technical Manual". It was understood that the guidance material would have no formal status and its main purpose would be to provide guidance to Contracting States in developing the detailed national airworthiness code mentioned in 2.2 of Part II of Annex 8.

With respect to Annex 6, Part I, it was agreed that the guidance material in the Acceptable Means of Compliance for Aeroplane Performance Operating Limitations should be edited suitably and retained in the Annex but in the form of an Attachment (green pages).

Performance Standards of Annex 8. Chapter 2, Part III, of Annex 8 contains aeroplane performance Standards that are complementary to the Standards in Chapter 5 of this Annex. Both state broad objectives. The Council has urged Contracting States not to impose on visiting aeroplanes, not exempted by Article 41, operational requirements other than those established by the State of Registry, provided that those requirements assure the level of performance equivalent to that intended by the Standards of Chapter 5 of this Annex and the complementary Standards of Chapter 2, Part III, of Annex 8.

In respect of aircraft exempted by Article 41, Chapter 5 of this Annex contains a Recommended Practice to the effect that the State of Registry should ensure that the level of performance specified in 5.2 applicable to aeroplanes not exempted should be met as far as practicable by those aeroplanes. The Council has urged Contracting States not to impose on visiting aircraft exempted by Article 41 requirements other than those established by the State of Registry provided that in establishing those requirements the State of Registry complied with the Recommended Practice. These recommendations complement one made by the Council in respect of aircraft exempted by Article 41, to the effect that Contracting States apply as far as practicable to aeroplanes over 5 700 kg mass intended for the carriage of passengers or cargo or mail in international air navigation, the Standards of Part III of Annex 8.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each Amendment to this Annex.

Attention of States is also drawn to the provision of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.—*Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Coui. il under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

It is to be noted that some Standards in this Annex incorporate, by reference, other specifications having the status of Recommended Practices. In such cases, the text of the Recommended Practice becomes part of the Standard.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 6

Amendment	*Source(s)*	*Subject(s)*	*Adopted* *Effective* *Applicable*
1st Edition	Derived from Sixth Edition of Annex 6, including Amendment 152		23 January 1969 23 May 1969 18 September 1969
1 (2nd Edition)	Sixth Air Navigation Conference	a) A shift in emphasis of the responsibility for the establishment of minimum en-route flight altitudes from the operator to the State flown over; b) the requirement for additional instruments in aeroplanes operated as controlled VFR flights in the en-route phase; and, of special importance; c) the permitting of aeroplanes, when unable to navigate by visual references to landmarks, to be navigated by equipment other than radio navigation equipment, e.g. solely by self-contained navigation means, provided that certain equipment capabilities are met, thus eliminating any requirement for the carriage of radio navigation equipment.	25 May 1970 25 September 1970 4 February 1971
2	Special Meeting on Aircraft Noise in the Vicinity of Aerodromes (1969) and the Second Meeting of the Supersonic Transport Panel	a) The weight of an aeroplane at the start of take-off or at the expected time of landing not to exceed, except in prescribed circumstances, the relative maximum weights at which compliance has been demonstrated with the applicable Noise Certification Standards; b) the carriage on board an aeroplane of a document attesting noise certification; c) all aeroplanes intended to be operated above 15 000 m (49 000 ft) to carry equipment to measure and indicate continuously the total cosmic radiation being received.	2 April 1971 2 August 1971 6 January 1972
3	Council action in pursuance of Assembly Resolution A17-10	Inclusion in the Annex of a Recommended Practice to the effect that, in all passenger-carrying aeroplanes, the flight crew compartment door should be capable of being locked from within the compartment.	10 December 1971 10 April 1972 7 December 1972
4 (3rd Edition)	Air Navigation Commission Review of the Annex	a) Deletion from Chapter 2 of the provision which allowed, in prescribed circumstances, certain specifications classed as Standards to have the status of Recommended Practices; b) introduction of the term "Aerodrome operating minima" in lieu of "Aerodrome meteorological minima"; c) introduction of the terms "Decision height", "Instrument meteorological conditions", "Runway visual range" and "Visual meteorological conditions"; d) Introduction of provisions to require the operator to provide a copy of its Operations Manual to the State of Registry and to incorporate in the Manual certain mandatory material; e) the inclusion of an updated list of the supplies, etc., to be carried aboard aircraft in first-aid kits; f) a change in the equivalent of 5 700 kg from 12 500 lb to 12 566 lb; g) the introduction of a reference to the need for certain types of aeroplanes to be equipped with a Mach number indicator; h) the introduction of a provision for cabin attendants to be seated and secured during certain prescribed flight phases.	27 June 1972 27 October 1972 1 March 1973

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
5	Seventh Air Navigation Conference	Inclusion in the Annex of definitions of "Flight recorder" and "Maximum weight" (of aircraft) and revision of the specifications for the carriage, recording parameters and operation of flight recorders.	29 May 1973 1 October 1973 23 May 1974
6	In pursuance of new policy on international airworthiness and action in pursuance of Assembly Resolution A18-16	Replacement of the Acceptable Means of Compliance on Aeroplane Performance Operating Limitations by guidance material on the subject in the form of an Attachment, and incorporation of provisions for emergency power supply to operate attitude indicating instruments on the total failure of the main electrical generating system. The opportunity presented by this Amendment was also taken to revise the Introductory Note to Chapter 3 of the Annex. The revision points to a practical method for States to discharge their functions in the cases of lease, charter, and interchange of aircraft in international operations.	30 October 1973 28 February 1974 23 May 1974
7	Council action in pursuance of Assembly Resolutions A17-10 and A18-10	Introduced provisions relating to practices to be followed in the event that an aircraft is being subjected to unlawful interference.	7 December 1973 7 April 1974 23 May 1974
8	Pursuant to an Air Navigation Commission study concerning the interception of civil aircraft	Introduced provisions designed to reduce the risk for intercepted aircraft.	4 February 1975 4 June 1975 9 October 1975
9	Accident Investigation and Prevention Divisional Meeting (1974). Fifth Meeting of the Supersonic Transport Panel. Consequent to amendments to Annexes 3 and 14	Introduced requirements for the safeguarding and preservation of flight recorder records of aeroplanes involved in accidents and incidents, provision and use of flight crew restraining devices, procedures to be followed in the event of excessive cosmic radiation exposure during flight, and the maintenance of records for crew members on total cosmic radiation dosages. The Amendment also provided amplification of the specifications for the type of timepiece required for operations in accordance with Instrument Flight Rules and controlled VFR flights and provided a cross-reference to guidance material on SST fuel supplies. The opportunity presented by this Amendment was also taken to introduce changes to the Annex as a result of the adoption by the Council of amendments to companion documents — Annex 3 and Annex 14. These changes consist of the elimination of reference to PANS-MET and the revision of the definitions of Aerodrome, Runway Visual Range, Take-off Run Available and Landing Distance Available.	7 April 1976 7 August 1976 30 December 1976
10	ASIA/PAC Regional Air Navigation Meeting (1973)	The requirement for the carriage of survival radio equipment over those areas in which search and rescue would be especially difficult to be determined by States rather than regional air navigation agreement.	16 June 1976 16 October 1976 6 October 1977
11	Seventh Air Navigation Conference and Air Navigation Commission Study	Required the operator to establish operational procedures designed to ensure that an aeroplane conducting precision approaches crosses the threshold by a safe margin.	23 June 1977 23 October 1977 23 February 1978
12	Air Navigation Commission Study	Required the fitting of ground proximity warning systems to certain aeroplanes.	15 December 1977 15 April 1978 10 August 1978
13	Air Navigation Commission Study	Required the fitting of seats with safety harness and their use by cabin attendants assigned emergency evacuation duties.	13 December 1978 13 April 1979 29 November 1979
14	Air Navigation Commission Study	New definition of "operational control" and introduction of requirements for navigation equipment to meet minimum navigational performance specifications (MNPS)	2 April 1980 2 August 1980 27 November 1980
15	Air Navigation Commission Study	Revision of the provisions relating to exterior lights to align with new provisions in Annexes 2 and 8, and requirements to include a check-list of emergency and safety equipment, including instructions for its use, in the Operations Manual.	22 March 1982 22 July 1982 25 November 1982

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
16 (4th Edition)	Third and Fourth meetings of the Operations Panel, AGA Divisional Meeting (1981), amendments consequent to adoption of Annex 18 and an Air Navigation Study	Introduced provisions related to aircraft operating procedures for noise abatement, development and use of instrument flight procedures, authority and competence to taxi aeroplanes and refuelling with passengers on board. Changes to the Annex were introduced as a result of adoption by the Council of Annex 18 in respect to the carriage of dangerous goods and requirements for crew training programmes in their carriage in commercial aeroplanes. The provisions in respect of aerodromes operating minima were revised to clarify the requirements and to include a requirement for RVR information. Units of measurement were brought in line with the provisions of Annex 5, and the Note in Chapter 3 concerning lease, charter and interchange was updated.	29 March 1983 29 July 1983 24 November 1983
17	Accident Prevention and Investigation Divisional Meeting, AIG (1979)	Revision of the provisions relating to flight recorders. Introduction of related guidance material in an attachment.	6 March 1985 29 July 1985 21 November 1985
18	Seventh meeting of the Obstacle Clearance Panel, Air Navigation Commission studies and a proposal by a State	Provision of climb performance data with all engines operating; extended range operations by aeroplanes with two power-units; the provision of obstacle data; take-off alignment distance accountability.	25 March 1986 27 July 1986 20 November 1986
19 (5th Edition)	Air Navigation Commission review of the Annex, Stage I. Third meeting of the Visual Flight Rules Operations Panel. Air Navigation Commission Study	a) Introduction of new definitions for commercial air transport operations, air operator certificate, master minimum equipment list and minimum equipment list. Introduction of revised definitions of aerial work and general aviation to Annex 6, Part I. Revision of the definition of alternate aerodrome to introduce take-off, en-route and destination alternate aerodromes; b) elimination of the differences between the specifications for scheduled and non-scheduled operations; c) introduction of the concept of the applicability of Annex 6, Part I to the operation of aeroplanes by operators authorized to conduct international commercial air transport operations; d) requirements for the issue of an air operator certificate and the introduction of guidance material; e) requirements for the development of minimum equipment lists and the introduction of guidance material; f) requirements for the specification of alternate aerodromes; g) requirement for the provision of an aircraft operating manual; h) requirement for the operator to establish an accident prevention and flight safety programme and specifications related to carry-on baggage; i) differentiation in Annex 6, Part I between operational and ATS flight plans; j) requirements for the pilot-in-command to demonstrate knowledge of long-range navigation procedures where appropriate; k) elimination of the term "controlled VFR flight" and recognition that a VFR flight may be a controlled flight; l) amendment to Chapter 13 — Security to make the recommendation on the provision of a lockable flight crew compartment door applicable to all aeroplanes rather than only passenger-carrying aeroplanes, to require guidance material to support the aeroplane search procedure checklist, and to require the operator to establish a training programme for employees in preventative measures and techniques in relation to acts of sabotage or unlawful interference; m) introduction of guidance material concerning flight data recording of important operational information in aeroplanes with electronic displays; n) revision of the requirements for the contents of the operations manual;	19 March 1990 30 July 1990 15 November 1990

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
		o) requirements concerning carry-on baggage; p) change of the expression "flight check system" to "checklist";	
20	Fifth meeting of the Operations Panel, Seventh and Eighth meetings of the Review of the General Concept of Separation Panel, Accident Investigation Divisional meeting (AIG/1992), Third meeting of the Continuing Airworthiness Panel, Air Navigation Commission studies	a) Revision of definitions of aerodrome operating minima, decision altitude/height, minimum descent altitude/height and obstacle clearance altitude/height; b) introduction of new definitions for emergency locator transmitters (ELTs), required navigation performance (RNP) and RNP type; c) introduction of the definition for the classification of instrument approach and landing operations; d) introduction of a reference to the *Continuing Airworthiness Manual;* e) revision of the requirements concerning the use of engraving metal foil flight data recorders; f) introduction of carriage requirements for emergency locator transmitters (ELTs) to replace provisions regarding survival radio equipment and emergency location beacon — ELBA; g) introduction of a requirement that the navigation equipment carried shall enable the aircraft to proceed in accordance with RNP types prescribed for the intended route(s) or areas(s), provisions to permit the uniform implementation of 300 m (1 000 ft) VSM above FL 290 and reference to the requirements relating to operations in RNP airspace in the operations manual; h) revision of the requirements concerning maintenance inspection, modifications and repairs and continuing airworthiness information.	21 March 1994 25 July 1994 10 November 1994
21 (6th Edition)	Air Navigation Commission studies, Fourteenth meeting of the Dangerous Goods Panel, editorial amendment, text alignment with Annex 6, Part II and/or Part III, consequential amendment	a) Introduction of new and revised definitions for cabin attendant, flight manual, large aeroplane, operations manual and small aeroplane; b) revision of the provisions concerning operating facilities, flight preparation, flight time, flight duty periods and rest periods for crew members, oxygen supply and extended range operations (ETOPS); c) new requirements for determining the length of the runway available; d) revised and new provisions concerning ground proximity warning systems (GPWS), medical supplies, oxygen equipment for aeroplanes on high altitude flights; e) revision of the provisions concerning aeroplanes operated in accordance with instrument flight rules (IFR); f) inclusion of references to the ICAO *Manual of Criteria for the Qualification of Flight Simulators* (Doc 9625) and new requirements for the flight crew training programme concerning knowledge and skills related to human performance and limitations; g) revision of the denomination of flight operations officer to align with Annex 1; h) revision of the contents of the operations manual and new provisions concerning aerodrome operating minima, oxygen supply, flight and duty time limitations, departure contingency procedures, instructions for mass and balance control and instructions and training requirements for the avoidance of controlled flight into terrain (CFIT) and policy for the use of ground proximity warning systems (GPWS); i) new provisions on flight time, flight duty periods and rest periods for cabin attendants and revision of the provisions concerning training; and j) revised and new requirements related to the incorporation of security into aircraft design.	8 March 1995 24 July 1995 9 November 1995

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

When the following terms are used in the Standards and Recommended Practices for operation of aircraft in international commercial air transport, they have the following meanings:

Aerial work. An aircraft operation in which an aircraft is used for specialized services such as agriculture, construction, photography, surveying, observation and patrol, search and rescue, aerial advertisement, etc.

Aerodrome. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome operating minima. The limits of usability of an aerodrome for:

a) take-off, expressed in terms of runway visual range and/or visibility and, if necessary, cloud conditions;

b) landing in precision approach and landing operations, expressed in terms of visibility and/or runway visual range and decision altitude/height (DA/H) as appropriate to the category of the operation; and

c) landing in non-precision approach and landing operations, expressed in terms of visibility and/or runway visual range, minimum descent altitude/height (MDA/H) and, if necessary, cloud conditions.

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Air operator certificate (AOC). A certificate authorizing an operator to carry out specified commercial air transport operations.

Alternate aerodrome. An aerodrome to which an aircraft may proceed when it becomes either impossible or inadvisable to proceed to or to land at the aerodrome of intended landing. Alternate aerodromes include the following:

Take-off alternate. An alternate aerodrome at which an aircraft can land should this become necessary shortly after take-off and it is not possible to use the aerodrome of departure.

En-route alternate. An aerodrome at which an aircraft would be able to land after experiencing an abnormal or emergency condition while en route.

Destination alternate. An alternate aerodrome to which an aircraft may proceed should it become either impossible or inadvisable to land at the aerodrome of intended landing.

Note.— The aerodrome from which a flight departs may also be an en-route or a destination alternate aerodrome for that flight.

Cabin attendant. A crew member who performs, in the interest of safety of passengers, duties assigned by the operator or the pilot-in-command of the aircraft, but who shall not act as a flight crew member.

Commercial air transport operation. An aircraft operation involving the transport of passengers, cargo or mail for remuneration or hire.

Crew member. A person assigned by an operator to duty on an aircraft during flight time.

Cruising level. A level maintained during a significant portion of a flight.

Dangerous goods. Articles or substances which are capable of posing significant risk to health, safety or property when transported by air.

Note.— Dangerous goods are classified in Annex 18, Chapter 3.

Decision altitude (DA) or decision height (DH). A specified altitude or height in the precision approach at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Note 1.— Decision altitude (DA) is referenced to mean sea level and decision height (DH) is referenced to the threshold elevation.

Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In Category III operations with a decision height the required visual reference is that specified for the particular procedure and operation.

Note 3.— For convenience where both expressions are used they may be written in the form "decision altitude/ height" and abbreviated "DA/H".

Emergency locator transmitter (ELT). A generic term describing equipment which broadcast distinctive signals on designated frequencies and, depending on application, may either sense a crash and operate automatically or be manually activated. An ELT may be any of the following:

Automatic fixed ELT (ELT(AF)). An ELT which is permanently attached to an aircraft.

Automatic portable ELT (ELT(AP)). An ELT which is rigidly attached to an aircraft but readily removable from the aircraft after a crash.

Automatically deployable ELT (ELT(AD)). An ELT which is rigidly attached to an aircraft and deployed automatically in response to a crash. Manual deployment is also provided.

Survival ELT (ELT(S)). An ELT which is removable from an aircraft, stowed so as to facilitate its ready use in an emergency and activated by survivors. Automatic activation may apply.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aircraft during flight time.

Flight duty period. The total time from the moment a flight crew member commences duty, immediately subsequent to a rest period and prior to making a flight or a series of flights, to the moment the flight crew member is relieved of all duties having completed such flight or series of flights.

Flight manual. A manual, associated with the certificate of airworthiness, containing limitations within which the aircraft is to be considered airworthy, and instructions and information necessary to the flight crew members for the safe operation of the aircraft.

Flight plan. Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Flight recorder. Any type of recorder installed in the aircraft for the purpose of complementing accident/incident investigation.

Flight time. The total time from the moment an aircraft first moves under its own power for the purpose of taking off until the moment it comes to rest at the end of the flight.

Note.— Flight time as here defined is synonymous with the term "block to block" time or "chock to chock" time in general usage which is measured from the time an aircraft moves from the loading point until it stops at the unloading point.

General aviation operation. An aircraft operation other than a commercial air transport operation or an aerial work operation.

Instrument approach and landing operations. Instrument approach and landing operations using instrument approach procedures are classified as follows:

Non-precision approach and landing operations. An instrument approach and landing which does not utilize electronic glide path guidance.

Precision approach and landing operations. An instrument approach and landing using precision azimuth and glide path guidance with minima as determined by the category of operation.

Categories of precision approach and landing operations:

Category I (CAT I) operation. A precision instrument approach and landing with a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or a runway visual range not less than 550 m.

Category II (CAT II) operation. A precision instrument approach and landing with a decision height lower than 60 m (200 ft), but not lower than 30 m (100 ft), and a runway visual range not less than 350 m.

Category IIIA (CAT IIIA) operation. A precision instrument approach and landing with:

a) a decision height lower than 30 m (100 ft) or no decision height; and

b) a runway visual range not less than 200 m.

Category IIIB (CAT IIIB) operation. A precision instrument approach and landing with:

a) a decision height lower than 15 m (50 ft) or no decision height; and

b) a runway visual range less than 200 m but not less than 50 m.

Category IIIC (CAT IIIC) operation. A precision instrument approach and landing with no decision height and no runway visual range limitations.

Note.— Where decision height (DH) and runway visual range (RVR) fall into different categories of operation, the instrument approach and landing operation would be conducted in accordance with the requirements of the most demanding category (e.g. an operation with a DH in the range of CAT IIIA but with an RVR in the range of CAT IIIB would be considered a CAT IIIB operation or an operation with a DH in the range of CAT II but with an RVR in the range of CAT I would be considered a CAT II operation.

Instrument meteorological conditions (IMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling*, less than the minima specified for visual meteorological conditions.

Note.— The specified minima for visual meteorological conditions are contained in Chapter 4 of Annex 2.

Large aeroplane. An aeroplane of a maximum certificated take-off mass of over 5 700 kg.

Master minimum equipment list (MMEL). A list established for a particular aircraft type by the manufacturer with the approval of the State of Manufacture containing items, one or more of which is permitted to be unserviceable at the commencement of a flight. The MMEL may be associated with special operating conditions, limitations or procedures.

Maximum mass. Maximum certificated take-off mass.

Minimum descent altitude (MDA) or minimum descent height (MDH). A specified altitude or height in a non-precision approach or circling approach below which descent must not be made without the required visual reference.

Note 1.— Minimum descent altitude (MDA) is referenced to mean sea level and minimum descent height (MDH) is referenced to the aerodrome elevation or to the threshold elevation if that is more than 2 m (7 ft) below the aerodrome elevation. A minimum descent height for a circling approach is referenced to the aerodrome elevation.

Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In the case of a circling approach the required visual reference is the runway environment.

Note 3.— For convenience when both expressions are used they may be written in the form "minimum descent altitude/height" and abbreviated "MDA/H".

Minimum equipment list (MEL). A list which provides for the operation of aircraft, subject to specified conditions, with particular equipment inoperative, prepared by an operator in conformity with, or more restrictive than, the MMEL established for the aircraft type.

Night. The hours between the end of evening civil twilight and the beginning of morning civil twilight or such other period between sunset and sunrise, as may be prescribed by the appropriate authority.

Note.— Civil twilight ends in the evening when the centre of the sun's disc is 6 degrees below the horizon and begins in the morning when the centre of the sun's disc is 6 degrees below the horizon.

Obstacle clearance altitude (OCA) or obstacle clearance height (OCH). The lowest altitude, or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria.

Note 1.— Obstacle clearance altitude is referenced to mean sea level and obstacle clearance height is referenced to the threshold elevation or in the case of non-precision approaches to the aerodrome elevation or the threshold elevation if that is more than 2 m (7 ft) below the aerodrome elevation. An obstacle clearance height for a circling approach is referenced to the aerodrome elevation.

Note 2.— For convenience when both expressions are used they may be written in the form "obstacle clearance altitude/height" and abbreviated "OCA/H".

Operational control. The exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of the safety of the aircraft and the regularity and efficiency of the flight.

Operational flight plan. The operator's plan for the safe conduct of the flight based on considerations of aeroplane performance, other operating limitations and relevant expected conditions on the route to be followed and at the aerodromes concerned.

Operations manual. A manual containing procedures, instructions and guidance for use by operational personnel in the execution of their duties.

Operator. A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

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* As defined in Annex 2.

Pressure-altitude. An atmospheric pressure expressed in terms of altitude which corresponds to that pressure in the Standard Atmosphere**.

Required navigation performance (RNP). A statement of the navigation performance accuracy necessary for operation within a defined airspace.

Rest period. Any period of time on the ground during which a flight crew member is relieved of all duties by the operator.

RNP type. A containment value expressed as a distance in nautical miles from the intended position within which flights would be for at least 95 per cent of the total flying time.

Example. — RNP 4 represents a navigation accuracy of plus or minus 7.4 km (4 NM) on a 95 per cent containment basis.

Runway visual range. The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

Small aeroplane. An aeroplane of a maximum certificated take-off mass of 5 700 kg or less.

State of Registry. The State on whose register the aircraft is entered.

Note.— In the case of the registration of aircraft of an international operating agency on other than a national basis, the States constituting the agency are jointly and severally bound to assume the obligations which, under the Chicago Convention, attach to a State of Registry. See, in this regard, the Council Resolution of 14 December 1967 on Nationality and Registration of Aircraft Operated by International Operating Agencies *(Doc 8722).*

State of the Operator. The State in which the operator's principal place of business is located or, if there is no such place of business, the operator's permanent residence.

Synthetic flight trainer. Any one of the following three types of apparatus in which flight conditions are simulated on the ground:

A flight simulator, which provides an accurate representation of the flight deck of a particular aircraft type to the extent that the mechanical, electrical, electronic, etc., aircraft systems control functions, the normal environment of flight crew members, and the performance and flight characteristics of that type of aircraft are realistically simulated;

A flight procedures trainer, which provides a realistic flight deck environment, and which simulates instrument responses, simple control functions of mechanical, electrical, electronic, etc., aircraft systems, and the performance and flight characteristics of aircraft of a particular class;

A basic instrument flight trainer, which is equipped with appropriate instruments, and which simulates the flight deck environment of an aircraft in flight in instrument flight conditions.

Visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling,* equal to or better than specified minima.

Note.— The specified minima are contained in Chapter 4 of Annex 2.

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* As defined in Annex 2.
** As defined in Annex 8.

CHAPTER 2. APPLICABILITY

The Standards and Recommended Practices contained in Annex 6, Part I, shall be applicable to the operation of aeroplanes by operators authorized to conduct international commercial air transport operations.

Note 1.— Standards and Recommended Practices applicable to international general aviation operations with aeroplanes are to be found in Annex 6, Part II.

Note 2.— Standards and Recommended Practices applicable to international commercial air transport operations or international general aviation operations with helicopters are to be found in Annex 6, Part III.

CHAPTER 3. GENERAL

Note 1.— Although the Convention on International Civil Aviation allocates to the State of Registry certain functions which that State is entitled to discharge, or obligated to discharge, as the case may be, the Assembly recognized, in Resolution A23-13 that the State of Registry may be unable to fulfil its responsibilities adequately in instances where aircraft are leased, chartered or interchanged — in particular without crew — by an operator of another State and that the Convention may not adequately specify the rights and obligations of the State of an operator in such instances until such time as Article 83 bis *of the Convention enters into force. Accordingly, the Council urged that if, in the abovementioned instances, the State of Registry finds itself unable to discharge adequately the functions allocated to it by the Convention, it delegate to the State of the Operator, subject to acceptance by the latter State, those functions of the State of Registry that can more adequately be discharged by the State of the Operator. It is understood that pending entry into force of Article 83* bis *of the Convention the foregoing action will only be a matter of practical convenience and will not affect either the provisions of the Chicago Convention prescribing the duties of the State of Registry or any third State.*

Note 2.— In the case of international operations effected jointly with aeroplanes not all of which are registered in the same Contracting State, nothing in this Part prevents the States concerned entering into an agreement for the joint exercise of the functions placed upon the State of Registry by the provisions of this Part.

3.1 An operator shall ensure that all employees when abroad know that they must comply with the laws, regulations and procedures of those States in which operations are conducted.

3.2 An operator shall ensure that all pilots are familiar with the laws, regulations and procedures, pertinent to the performance of their duties, prescribed for the areas to be traversed, the aerodromes to be used and the air navigation facilities relating thereto. The operator shall ensure that other members of the flight crew are familiar with such of these laws, regulations and procedures as are pertinent to the performance of their respective duties in the operation of the aeroplane.

3.3 An operator or a designated representative shall have responsibility for operational control.

Note.— The rights and obligations of a State in respect to the operation of aeroplanes registered in that State are not affected by this provision.

3.4 If an emergency situation which endangers the safety of the aeroplane or persons necessitates the taking of action which involves a violation of local regulations or procedures, the pilot-in-command shall notify the appropriate local authority without delay. If required by the State in which the incident occurs, the pilot-in-command shall submit a report on any such violation to the appropriate authority of such State; in that event, the pilot-in-command shall also submit a copy of it to the State of the Operator. Such reports shall be submitted as soon as possible and normally within ten days.

3.5 Operators shall ensure that pilots-in-command have available on board the aeroplane all the essential information concerning the search and rescue services in the area over which the aeroplane will be flown.

Note.— This information may be made available to the pilot by means of the operations manual or such other means as is considered appropriate.

3.6 An operator shall establish and maintain an accident prevention and flight safety programme.

Note.— Guidance on accident prevention is contained in the Accident Prevention Manual *(Doc 9422) and in the manual* Preparation of an Operations Manual *(Doc 9376).*

3.7 Dangerous goods.

Note 1.— Provisions for carriage of dangerous goods are contained in Annex 18.

Note 2 — Article 35 of the Convention refers to certain classes of cargo restrictions.

CHAPTER 4. FLIGHT OPERATIONS

4.1 Operating facilities

4.1.1 An operator shall ensure that a flight will not be commenced unless it has been ascertained by every reasonable means available that the ground and/or water facilities available and directly required on such flight, for the safe operation of the aeroplane and the protection of the passen-gers, are adequate for the type of operation under which the flight is to be conducted and are adequately operated for this purpose.

Note.— "Reasonable means" in this Standard is intended to denote the use, at the point of departure, of information available to the operator either through official information published by the aeronautical information services or readily obtainable from other sources.

4.1.2 An operator shall ensure that any inadequacy of facilities observed in the course of operations is reported to the authority responsible for them, without undue delay.

4.1.3 Subject to their published conditions of use, aerodromes and their facilities shall be kept continuously available for flight operations during their published hours of operations, irrespective of weather conditions.

4.2 Operational certification and supervision

4.2.1 The air operator certificate

4.2.1.1 An operator shall not engage in commercial air transport operations unless in possession of a valid air operator certificate or equivalent document issued by the State of the Operator.

4.2.1.2 The air operator certificate or equivalent document shall authorize the operator to conduct commercial air transport operations in accordance with such conditions and limitations as may be specified.

4.2.1.3 The issue of an air operator certificate or equivalent document by the State of the Operator shall be dependent upon the operator demonstrating an adequate organ-ization, method of control and supervision of flight operations, training programme and maintenance arrangements consistent with the nature and extent of the operations specified.

Note.— Attachment F contains guidance on the issue of an air operator certificate.

4.2.1.4 The continued validity of an air operator certificate or equivalent document shall depend upon the operator maintaining the requirements of 4.2.1.3 under the supervision of the State of the Operator..

4.2.1.5 The air operator certificate or equivalent document shall contain at least the following:

a) operator's identification (name, location);

b) date of issue and period of validity;

c) description of the types of operations authorized;

d) the type(s) of aircraft authorized for use; and

e) authorized areas of operation or routes.

4.2.2 Operations manual

4.2.2.1 An operator shall provide, for the use and guidance of operations personnel concerned, an operations manual in accordance with 11.1. The operations manual shall be amended or revised as is necessary to ensure that the information contained therein is kept up to date. All such amendments or revisions shall be issued to all personnel that are required to use this manual.

4.2.2.2 An operator shall provide the State of the Operator with a copy of the operations manual together with all amendments and/or revisions to it and shall incorporate in it such mandatory material as the State of the Operator may require.

4.2.3 Operating instructions — general

4.2.3.1 An operator shall ensure that all operations personnel are properly instructed in their particular duties and responsibilities and the relationship of such duties to the operation as a whole.

4.2.3.2 An aeroplane shall not be taxied on the movement area of an aerodrome unless the person at the controls:

a) has been duly authorized by the operator or a designated agent;

b) is fully competent to taxi the aeroplane;

c) is qualified to use the radio telephone; and

d) has received instruction from a competent person in respect of aerodrome layout, routes, signs, marking, lights, air traffic control (ATC) signals and instructions, phraseology and procedures, and is able to conform to the operational standards required for safe aeroplane movement at the aerodrome.

4.2.3.3 **Recommendation.—** *The operator should issue operating instructions and provide information on aeroplane climb performance with all engines operating to enable the pilot-in-command to determine the climb gradient that can be achieved during the departure phase for the existing take-off conditions and intended take-off technique. This information should be included in the operations manual.*

4.2.4 In-flight simulation of emergency situations

An operator shall ensure that when passengers or cargo are being carried, no emergency or abnormal situations shall be simulated.

4.2.5 Checklists

The checklists provided in accordance with 6.1.3 shall be used by flight crews prior to, during and after all phases of operations, and in emergency, to ensure compliance with the operating procedures contained in the aircraft operating manual and the flight manual or other documents associated with the certificate of airworthiness and otherwise in the operations manual.

4.2.6 Minimum flight altitudes

4.2.6.1 An operator shall be permitted to establish minimum flight altitudes for those routes flown for which minimum flight altitudes have been established by the State flown over or the responsible State, provided that they shall not be less than those established by that State.

4.2.6.2 An operator shall specify the method by which it is intended to determine minimum flight altitudes for operations conducted over routes for which minimum flight altitudes have not been established by the State flown over or the responsible State, and shall include this method in the operations manual. The minimum flight altitudes determined in accordance with the above method shall not be lower than specified in Annex 2.

4.2.6.3 **Recommendation.—** *The method for establishing the minimum flight altitudes should be approved by the State of the Operator.*

4.2.6.4 **Recommendation.—** *The State of the Operator should approve such method only after careful consideration of the probable effects of the following factors on the safety of the operation in question:*

a) the accuracy and reliability with which the position of the aeroplane can be determined;

b) the inaccuracies in the indications of the altimeters used;

c) the characteristics of the terrain (e.g. sudden changes in the elevation);

d) the probability of encountering unfavourable meteorological conditions (e.g. severe turbulence and descending air currents);

e) possible inaccuracies in aeronautical charts; and

f) airspace restrictions.

4.2.7 Aerodrome operating minima

4.2.7.1 The State of the Operator shall require that the operator establish aerodrome operating minima for each aerodrome to be used in operations, and shall approve the method of determination of such minima. Such minima shall not be lower than any that may be established for such aerodromes by the State in which the aerodrome is located, except when specifically approved by that State.

Note.— This Standard does not require the State in which the aerodrome is located to establish aerodrome operating minima.

4.2.7.2 The State of the Operator shall require that in establishing the aerodrome operating minima which will apply to any particular operation, full account shall be taken of:

a) the type, performance and handling characteristics of the aeroplane;

b) the composition of the flight crew, their competence and experience;

c) the dimensions and characteristics of the runways which may be selected for use;

d) the adequacy and performance of the available visual and non-visual ground aids;

e) the equipment available on the aeroplane for the purpose of navigation and/or control of the flight path during the approach to landing and the missed approach;

f) the obstacles in the approach and missed approach areas and the obstacle clearance altitude/height for the instrument approach procedures;

g) the means used to determine and report meteorological conditions; and

h) the obstacles in the climb-out areas and necessary clearance margins.

Note.— Guidance on the establishment of aerodrome operating minima is contained in the Manual of All-Weather Operations *(Doc 9365).*

4.2.7.3 **Recommendation.—** *For aeroplane landing operations, aerodrome operating minima below 800 m visibility should not be authorized unless RVR information is provided.*

4.2.8 Threshold crossing height for precision approaches

An operator shall establish operational procedures designed to ensure that an aeroplane being used to conduct precision approaches crosses the threshold by a safe margin, with the aeroplane in the landing configuration and attitude.

4.2.9 Fuel and oil records

4.2.9.1 An operator shall maintain fuel and oil records to enable the State of the Operator to ascertain that, for each flight, the requirements of 4.3.6 have been complied with.

4.2.9.2 Fuel and oil records shall be retained by the operator for a period of three months.

4.2.10 Crew

4.2.10.1 *Pilot-in-command.* For each flight, the operator shall designate one pilot to act as pilot-in-command.

4.2.10.2 *Flight time, flight duty periods and rest periods.* An operator shall formulate rules to limit flight time and flight duty periods and for the provision of adequate rest periods for all its crew members. These rules shall be in accordance with the regulations established by the State of the Operator, or approved by that State, and included in the operations manual.

4.2.10.3 An operator shall maintain current records of the flight time, flight duty periods and rest periods of all its crew members.

Note.— Guidance on the establishment of limitations is given in Attachment A.

4.2.10.4 For each flight of an aeroplane above 15 000 m (49 000 ft), the operator shall maintain records so that the total cosmic radiation dose received by each crew member over a period of 12 consecutive months can be determined.

Note.— Guidance on the maintenance of cumulative radiation records is given in Circular 126 — Guidance Material on SST Aircraft Operations.

4.2.11 Passengers

4.2.11.1 An operator shall ensure that passengers are made familiar with the location and use of:

a) seat belts;

b) emergency exits;

c) life jackets, if the carriage of life jackets is prescribed;

d) oxygen dispensing equipment, if the provision of oxygen for the use of passengers is prescribed; and

e) other emergency equipment provided for individual use, including passenger emergency briefing cards.

4.2.11.2 The operator shall inform the passengers of the location and general manner of use of the principal emergency equipment carried for collective use.

4.2.11.3 In an emergency during flight, passengers shall be instructed in such emergency action as may be appropriate to the circumstances.

4.2.11.4 The operator shall ensure that during take-off and landing and whenever, by reason of turbulence or any emergency occurring during flight, the precaution is considered necessary, all passengers on board an aeroplane shall be secured in their seats by means of the seat belts or harnesses provided.

4.3 Flight preparation

4.3.1 A flight shall not be commenced until flight preparation forms have been completed certifying that the pilot-in-command is satisfied that:

a) the aeroplane is airworthy;

b) the instruments and equipment prescribed in Chapter 6, for the particular type of operation to be undertaken, are installed and are sufficient for the flight;

c) a maintenance release as prescribed in 8.7 has been issued in respect of the aeroplane;

d) the mass of the aeroplane and centre of gravity location are such that the flight can be conducted safely, taking into account the flight conditions expected;

e) any load carried is properly distributed and safely secured;

f) a check has been completed indicating that the operating limitations of Chapter 5 can be complied with for the flight to be undertaken; and

g) the Standards of 4.3.3 relating to operational flight planning have been complied with.

4.3.2 Completed flight preparation forms shall be kept by an operator for a period of three months.

4.3.3 Operational flight planning

4.3.3.1 An operational flight plan shall be completed for every intended flight. The operational flight plan shall be approved and signed by the pilot-in-command and, where applicable, signed by the flight operations officer/flight dispatcher, and a copy shall be filed with the operator or a designated agent, or, if these procedures are not possible, it shall be left with the aerodrome authority or on record in a suitable place at the point of departure.

Note.— The duties of a flight operations officer/flight dispatcher are contained in 4.6.

4.3.3.2 The operations manual must describe the content and use of the operational flight plan.

4.3.4 Alternate aerodromes

4.3.4.1 *Take-off alternate aerodrome*

4.3.4.1.1 A take-off alternate aerodrome shall be selected and specified in the operational flight plan if the weather conditions at the aerodrome of departure are at or below the applicable aerodrome operating minima or it would not be possible to return to the aerodrome of departure for other reasons.

4.3.4.1.2 The take-off alternate aerodrome shall be located within the following distance from the aerodrome of departure:

a) aeroplanes having two power-units. Not more than a distance equivalent to a flight time of one hour at the single-engine cruise speed; and

b) aeroplanes having three or more power-units. Not more than a distance equivalent to a flight time of two hours at the one-engine inoperative cruise speed.

4.3.4.1.3 For an aerodrome to be selected as a take-off alternate the available information shall indicate that, at the estimated time of use, the conditions will be at or above the aerodrome operating minima for that operation.

4.3.4.2 *En-route alternate aerodromes*

En-route alternate aerodromes, required by 4.7 for extended range operations by aeroplanes with two turbine power-units, shall be selected and specified in the operational and air traffic services (ATS) flight plans.

4.3.4.3 *Destination alternate aerodromes*

For a flight to be conducted in accordance with the instrument flight rules, at least one destination alternate aerodrome shall be selected and specified in the operational and ATS flight plans, unless:

a) the duration of the flight and the meteorological conditions prevailing are such that there is reasonable certainty that, at the estimated time of arrival at the aerodrome of intended landing, and for a reasonable period before and after such time, the approach and landing may be made under visual meteorological conditions; or

b) the aerodrome of intended landing is isolated and there is no suitable destination alternate aerodrome.

4.3.5 Weather conditions

4.3.5.1 A flight to be conducted in accordance with the visual flight rules shall not be commenced unless current meteorological reports or a combination of current reports and forecasts indicate that the meteorological conditions along the route or that part of the route to be flown under the visual flight rules will, at the appropriate time, be such as to render compliance with these rules possible.

4.3.5.2 A flight to be conducted in accordance with instrument flight rules shall not be commenced unless information is available which indicates that conditions at the aerodrome of intended landing or, where a destination alternate is required, at least one destination alternate aerodrome will, at the estimated time of arrival, be at or above the aerodrome operating minima.

Note.— It is the practice in some States to declare, for flight planning purposes, higher minima for an aerodrome when nominated as a destination alternate than for the same aerodrome when planned as that of intended landing.

4.3.5.3 A flight to be operated in known or expected icing conditions shall not be commenced unless the aeroplane is certificated and equipped to cope with such conditions.

4.3.6 Fuel and oil supply

Note.— Fuel and oil reserves for supersonic aeroplanes will require special consideration to account for the particular operating characteristics of this type of aeroplane. Guidance on fuel supplies for supersonic aeroplanes is given in Circular 126 — Guidance Material on SST Aircraft Operations.

4.3.6.1 *All aeroplanes.* A flight shall not be commenced unless, taking into account both the meteorological conditions and any delays that are expected in flight, the aeroplane carries sufficient fuel and oil to ensure that it can safely complete the flight. In addition, a reserve shall be carried to provide for contingencies.

4.3.6.2 *Propeller-driven aeroplanes.* The fuel and oil carried in order to comply with 4.3.6.1 shall, in the case of propeller-driven aeroplanes, be at least the amount sufficient to allow the aeroplane:

4.3.6.2.1 When a destination alternate aerodrome is required, either:

a) to fly to the aerodrome to which the flight is planned thence to the most critical (in terms of fuel consumption) alternate aerodrome specified in the operational and ATS flight plans and thereafter for a period of 45 minutes; or

b) to fly to the alternate aerodrome via any predetermined point and thereafter for 45 minutes, provided that this shall not be less than the amount required to fly to the aerodrome to which the flight is planned and thereafter for:

1) 45 minutes plus 15 per cent of the flight time planned to be spent at the cruising level(s), or

2) two hours,

whichever is less.

4.3.6.2.2 When a destination alternate aerodrome is not required:

a) in terms of 4.3.4.3 a), to fly to the aerodrome to which the flight is planned and thereafter for a period of 45 minutes; or

b) in terms of 4.3.4.3 b), to fly to the aerodrome to which the flight is planned and thereafter for:

1) 45 minutes plus 15 per cent of the flight time planned to be spent at the cruising level(s), or

2) two hours,

whichever is less.

4.3.6.3 *Aeroplanes equipped with turbo-jet engines.* The fuel and oil carried in order to comply with 4.3.6.1 shall, in the case of turbo-jet aeroplanes, be at least the amount sufficient to allow the aeroplane:

4.3.6.3.1 When a destination alternate aerodrome is required, either:

a) to fly to and execute an approach, and a missed approach, at the aerodrome to which the flight is planned, and thereafter:

1) to fly to the alternate aerodrome specified in the operational and ATS flight plans; and then

2) to fly for 30 minutes at holding speed at 450 m (1 500 ft) above the alternate aerodrome under standard temperature conditions, and approach and land; and

3) to have an additional amount of fuel sufficient to provide for the increased consumption on the occurrence of any of the potential contingencies specified by the operator to the satisfaction of the State of the Operator; or

b) to fly to the alternate aerodrome via any predetermined point and thereafter for 30 minutes at 450 m (1 500 ft) above the alternate aerodrome, due provision having been made for an additional amount of fuel sufficient to provide for the increased consumption on the occurrence of any of the potential contingencies specified by the operator to the satisfaction of the State of the Operator; provided that fuel shall not be less than the amount of fuel required to fly to the aerodrome to which the flight is planned and thereafter for two hours at normal cruise consumption.

4.3.6.3.2 When a destination alternate aerodrome is not required:

a) in terms of 4.3.4.3 a), to fly to the aerodrome to which the flight is planned and additionally:

1) to fly 30 minutes at holding speed at 450 m (1 500 ft) above the aerodrome to which the flight is planned under standard temperature conditions; and

2) to have an additional amount of fuel, sufficient to provide for the increased consumption on the occurrence of any of the potential contingencies specified by the operator to the satisfaction of the State of the Operator; and

b) in terms of 4.3.4.3 b), to fly to the aerodrome to which the flight is planned and thereafter for a period of two hours at normal cruise consumption.

4.3.6.4 In computing the fuel and oil required in 4.3.6.1 at least the following shall be considered:

a) meteorological conditions forecast;

b) expected air traffic control routings and traffic delays;

c) for IFR flight, one instrument approach at the destination aerodrome, including a missed approach;

d) the procedures prescribed in the operations manual for loss of pressurization, where applicable, or failure of one power unit while en route; and

e) any other conditions that may delay the landing of the aeroplane or increase fuel and/or oil consumption.

Note.— Nothing in 4.3.6 precludes amendment of a flight plan in flight in order to re-plan the flight to another aerodrome, provided that the requirements of 4.3.6 can be complied with from the point where the flight has been replanned.

4.3.7 Refuelling with passengers on board

4.3.7.1 An aeroplane shall not be refuelled when passengers are embarking, on board or disembarking unless it is properly attended by qualified personnel ready to initiate and direct an evacuation of the aeroplane by the most practical and expeditious means available.

4.3.7.2 When refuelling with passengers embarking, on board or disembarking, two-way communication shall be maintained by the aeroplane's inter-communication system or other suitable means between the ground crew supervising the refuelling and the qualified personnel on board the aeroplane.

Note 1.— The provisions of 4.3.7.1 do not necessarily require the deployment of integral aeroplane stairs or the opening of emergency exits as a prerequisite to refuelling.

Note 2.— Provisions concerning aircraft refuelling are contained in Annex 14 and guidance on safe refuelling practices is contained in the Airport Services Manual, *(Doc 9137), Parts 1 and 8.*

Note 3.— Additional precautions are required when refuelling with fuels other than aviation kerosene or when refuelling results in a mixture of aviation kerosene with other aviation turbine fuels, or when an open line is used.

4.3.8 Oxygen supply

Note.— Approximate altitudes in the Standard Atmosphere corresponding to the values of absolute pressure used in the text are as follows:

Absolute pressure	Metres	Feet
700 hPa	*3 000*	*10 000*
620 hPa	*4 000*	*13 000*
376 hPa	*7 600*	*25 000*

4.3.8.1 A flight to be operated at flight altitudes at which the atmospheric pressure in personnel compartments will be less than 700 hPa shall not be commenced unless sufficient stored breathing oxygen is carried to supply:

a) all crew members and 10 per cent of the passengers for any period in excess of 30 minutes that the pressure in compartments occupied by them will be between 700 hPa and 620 hPa; and

b) the crew and passengers for any period that the atmospheric pressure in compartments occupied by them will be less than 620 hPa.

4.3.8.2 A flight to be operated with a pressurized aeroplane shall not be commenced unless a sufficient quantity of stored breathing oxygen is carried to supply all the crew members and passengers, as is appropriate to the circumstances of the flight being undertaken, in the event of loss of pressurization, for any period that the atmospheric pressure in any compartment occupied by them would be less than 700 hPa. In addition, when an aeroplane is operated at flight altitudes at which the atmospheric pressure is less than 376 hPa, or which, if operated at flight altitudes at which the atmospheric pressure is more than 376 hPa and cannot descend safely within four minutes to a flight altitude at which the atmospheric pressure is equal to 620 hPa, there shall be no less than a 10-minute supply for the occupants of the passenger compartment.

4.4 In-flight procedures

4.4.1 Aerodrome operating minima

4.4.1.1 A flight shall not be continued towards the aerodrome of intended landing, unless the latest available information indicates that at the expected time of arrival, a landing can be effected at that aerodrome or at least one destination alternate aerodrome, in compliance with the operating minima established in accordance with 4.2.7.1.

4.4.1.2 Except in case of emergency, an aeroplane shall not continue its approach-to-land at any aerodrome beyond a point at which the limits of the operating minima specified for that aerodrome would be infringed.

4.4.2 Meteorological observations

Note.— The procedures for making meteorological observations on board aircraft in flight and for recording and reporting them are contained in Annex 3, the PANS-RAC (Doc 4444) and the appropriate Regional Supplementary Procedures *(Doc 7030).*

4.4.3 Hazardous flight conditions

Hazardous flight conditions encountered, other than those associated with meteorological conditions, shall be reported to the appropriate aeronautical station as soon as possible. The reports so rendered shall give such details as may be pertinent to the safety of other aircraft.

4.4.4 Flight crew members at duty stations

4.4.4.1 *Take-off and landing.* All flight crew members required to be on flight deck duty shall be at their stations.

4.4.4.2 *En route.* All flight crew members required to be on flight deck duty shall remain at their stations except when their absence is necessary for the performance of duties in connexion with the operation of the aeroplane or for physiological needs.

4.4.4.3 *Seat belts.* All flight crew members shall keep their seat belts fastened when at their stations.

4.4.4.4 *Safety harness.* Any flight crew member occupying a pilot's seat shall keep the safety harness fastened during the take-off and landing phases; all other flight crew members shall keep their safety harnesses fastened during the take-off and landing phases unless the shoulder straps interfere with the performance of their duties, in which case the shoulder straps may be unfastened but the seat belt must remain fastened.

Note.— Safety harness includes shoulder straps and a seat belt which may be used independently.

4.4.5 Use of oxygen

4.4.5.1 All flight crew members, when engaged in performing duties essential to the safe operation of an aeroplane in flight, shall use breathing oxygen continuously whenever the circumstances prevail for which its supply has been required in 4.3.8.1 or 4.3.8.2.

4.4.5.2 All flight crew members of pressurized aeroplanes operating above an altitude where the atmospheric pressure is less than 376 hPa shall have available at the flight duty station a quick-donning type of oxygen mask which will readily supply oxygen upon demand.

4.4.6 Safeguarding of cabin attendants and passengers in pressurized aeroplanes in the event of loss of pressurization

Recommendation.— *Cabin attendants should be safeguarded so as to ensure reasonable probability of their retaining consciousness during any emergency descent which may be necessary in the event of loss of pressurization and, in addition, they should have such means of protection as will enable them to administer first aid to passengers during stabilized flight following the emergency. Passengers should be safeguarded by such devices or operational procedures as will ensure reasonable probability of their surviving the effects of hypoxia in the event of loss of pressurization.*

Note.— It is not envisaged that cabin attendants will always be able to provide assistance to passengers during emergency descent procedures which may be required in the event of loss of pressurization.

4.4.7 In-flight operational instructions

Operational instructions involving a change in the ATS flight plan shall, when practicable, be co-ordinated with the appropriate ATS unit before transmission to the aeroplane.

Note.— When the above co-ordination has not been possible, operational instructions do not relieve a pilot of the responsibility for obtaining an appropriate clearance from an ATS unit, if applicable, before making a change in flight plan.

4.4.8 Instrument flight procedures

4.4.8.1 One or more instrument approach procedures designed in accordance with the classification of instrument approach and landing operations shall be approved and promulgated by the State in which the aerodrome is located to serve each instrument runway or aerodrome utilized for instrument flight operations.

4.4.8.2 All aeroplanes operated in accordance with instrument flight rules shall comply with the instrument flight procedures approved by the State in which the aerodrome is located.

Note 1.— Definitions for the classification of instrument approach and landing operations are in Chapter 1.

Note 2.— Operational procedures recommended for the guidance of operations personnel involved in instrument flight operations are described in PANS-OPS (Doc 8168), Volume I.

Note 3.— Criteria for the construction of instrument flight procedures for the guidance of procedure specialists are provided in PANS-OPS (Doc 8168), Volume II.

4.4.9 Aeroplane operating procedures for noise abatement

4.4.9.1 **Recommendation.—** *Aeroplane operating procedures for noise abatement should comply with the provisions of PANS-OPS (Doc 8168), Volume I, Part V.*

4.4.9.2 **Recommendation.—** *Noise abatement procedures specified by an operator for any one aeroplane type should be the same for all aerodromes.*

4.5 Duties of pilot-in-command

4.5.1 The pilot-in-command shall be responsible for the operation and safety of the aeroplane and for the safety of all persons on board, during flight time.

4.5.2 The pilot-in-command shall ensure that the checklists specified in 4.2.5 are complied with in detail.

4.5.3 The pilot-in-command shall be responsible for notifying the nearest appropriate authority by the quickest available means of any accident involving the aeroplane, resulting in serious injury or death of any person or substantial damage to the aeroplane or property.

Note.— A definition of the term "serious injury" is contained in Annex 13 and an explanation of the term "substantial damage" is given in the Accident/Incident Reporting Manual (ADREP Manual) *(Doc 9156).*

4.5.4 The pilot-in-command shall be responsible for reporting all known or suspected defects in the aeroplane, to the operator, at the termination of the flight.

4.5.5 The pilot-in-command shall be responsible for the journey log book or the general declaration containing the information listed in 11.5.1.

Note.— By virtue of Resolution A10-36 of the Tenth Session of the Assembly (Caracas, June-July 1956) "the General Declaration, [described in Annex 9] when prepared so as to contain all the information required by Article 34 [of the Convention on International Civil Aviation] with respect to the journey log book, may be considered by Contracting States to be an acceptable form of journey log book".

4.6 Duties of flight operations officer/ flight dispatcher

4.6.1 A flight operations officer/flight dispatcher when employed in conjunction with a method of flight supervision in accordance with 4.2.1 shall:

a) assist the pilot-in-command in flight preparation and provide the relevant information required;

b) assist the pilot-in-command in preparing the operational and ATS flight plans, sign when applicable and file the ATS flight plan with the appropriate ATS unit;

c) furnish the pilot-in-command while in flight, by appropriate means, with information which may be necessary for the safe conduct of the flight; and

d) in the event of an emergency, initiate such procedures as may be outlined in the operations manual.

4.6.2 A flight operations officer/flight dispatcher shall avoid taking any action that would conflict with the procedures established by:

a) air traffic control;

b) the meteorological service; or

c) the communications service.

4.7 Additional requirements for extended range operations by aeroplanes with two turbine power-units

4.7.1 Unless the operation has been specifically approved by the State of the Operator, an aeroplane with two turbine power-units shall not, except as provided in 4.7.4, be operated on a route where the flight time at single engine cruise speed to an adequate en-route alternate aerodrome exceeds a threshold time established for such operations by that State.

Note 1.— Guidance on the value of the threshold time is contained in Attachment E.

Note 2.— In the context of the approval of operations at which the requirements of 5.2.11 can be met, guidance material on adequate and suitable alternate aerodromes is contained in Attachment E.

4.7.2 In approving the operation, the State of the Operator shall ensure that:

a) the airworthiness certification of the aeroplane type;

b) the reliability of the propulsion system; and

c) the operator's maintenance procedures, operating practices, flight dispatch procedures and crew training programmes;

provide the over-all level of safety intended by the provisions of Annexes 6 and 8. In making this assessment, account shall be taken of the route to be flown, the anticipated operating conditions and the location of adequate en-route alternate aerodromes.

Note 1.— Guidance on compliance with the requirements of this provision is contained in Attachment E.

Note 2.— The Airworthiness Technical Manual *(Doc 9051) contains guidance on the level of performance and reliability of aeroplane systems intended by 4.7.2.*

Note 3.— The Continuing Airworthiness Manual (Doc 9642) *contains guidance on continuing airworthiness aspects of the requirements of 4.7.2.*

4.7.3 A flight to be conducted in accordance with 4.7.1 shall not be commenced unless, during the possible period of arrival, the required en-route alternate aerodrome(s) will be available and the available information indicates that conditions at those aerodromes will be at or above the aerodrome operating minima approved for the operation.

4.7.4 **Recommendation.—** *The State of the Operator of an aeroplane type with two turbine power-units which, prior to 25 March 1986 was authorized and operating on a route where the flight time at single engine cruise speed to an adequate en-route alternate aerodrome exceeded the threshold time established for such operations in accordance with 4.7.1 should give consideration to permitting such an operation to continue on that route after that date.*

4.8 Carry-on baggage

The operator shall ensure that all baggage carried onto an aeroplane and taken into the passenger cabin is adequately and securely stowed.

CHAPTER 5. AEROPLANE PERFORMANCE OPERATING LIMITATIONS

5.1 General

5.1.1 Aeroplanes shall be operated in accordance with a comprehensive and detailed code of performance established by the State of Registry in compliance with the applicable Standards of this chapter.

5.1.2 Single engine aeroplanes shall only be operated in conditions of weather and light, and over such routes and diversions therefrom, that permit a safe forced landing to be executed in the event of engine failure.

5.1.3 **Recommendation.**— *For aeroplanes for which Part III of Annex 8 is not applicable because of the exemption provided for in Article 41 of the Convention, the State of Registry should ensure that the level of performance specified in 5.2 should be met as far as practicable.*

5.2 Applicable to aeroplanes certificated in accordance with Part III of Annex 8

5.2.1 The Standards contained in 5.2.2 to 5.2.11 inclusive are applicable to the aeroplanes to which Part III of Annex 8 is applicable.

Note.— The following Standards do not include quantitative specifications comparable to those found in national airworthiness codes. In accordance with 5.1.1, they are to be supplemented by national requirements prepared by Contracting States.

5.2.2 The level of performance defined by the appropriate parts of the comprehensive and detailed national code referred to in 5.1.1 for the aeroplanes designated in 5.2.1 shall be at least substantially equivalent to the over-all level embodied in the Standards of this chapter.

Note.— Attachment C contains guidance material which indicates by examples the level of performance intended by the Standards and Recommended Practices of this chapter.

5.2.3 An aeroplane shall be operated in compliance with the terms of its certificate of airworthiness and within the approved operating limitations contained in its flight manual.

5.2.4 The State of Registry shall take such precautions as are reasonably possible to ensure that the general level of safety contemplated by these provisions is maintained under all expected operating conditions, including those not covered specifically by the provisions of this chapter.

5.2.5 A flight shall not be commenced unless the performance information provided in the flight manual indicates that the Standards of 5.2.6 to 5.2.11 can be complied with for the flight to be undertaken.

5.2.6 In applying the Standards of this chapter, account shall be taken of all factors that significantly affect the performance of the aeroplane (such as: mass, elevation, or the pressure-altitude appropriate to the elevation of the aerodrome, temperature, wind, runway gradient and condition of runway, i.e. presence of slush, water and/or ice, for landplanes, water surface condition for seaplanes). Such factors shall be taken into account directly as operational parameters or indirectly by means of allowances or margins, which may be provided in the scheduling of performance data or in the comprehensive and detailed code of performance in accordance with which the aeroplane is being operated.

5.2.7 Mass limitations

a) The mass of the aeroplane at the start of take-off shall not exceed the mass at which 5.2.8 is complied with, nor the mass at which 5.2.9, 5.2.10 and 5.2.11 are complied with, allowing for expected reductions in mass as the flight proceeds, and for such fuel jettisoning as is envisaged in applying 5.2.9 and 5.2.10 and, in respect of alternate aerodromes, 5.2.7 c) and 5.2.11.

b) In no case shall the mass at the start of take-off exceed the maximum take-off mass specified in the flight manual for the elevation or the pressure-altitude appropriate to the elevation of the aerodrome, and, if used as a parameter to determine the maximum take-off mass, any other local atmospheric condition.

c) In no case shall the estimated mass for the expected time of landing at the aerodrome of intended landing and at any destination alternate aerodrome, exceed the maximum landing mass specified in the flight manual for the elevation or the pressure-altitude appropriate to the elevation of those aerodromes, and if used as a parameter to determine the maximum landing mass, any other local atmospheric condition.

d) In no case shall the mass at the start of take-off, or at the expected time of landing at the aerodrome of intended landing and at any destination alternate aerodrome, exceed the relevant maximum masses at which compliance has been demonstrated with the applicable noise certification Standards in Annex 16, Volume I, unless otherwise authorized in exceptional circumstances for a certain aerodrome or a runway where there is no noise disturbance problem, by the competent authority of the State in which the aerodrome is situated.

5.2.8 *Take-off.* The aeroplane shall be able, in the event of a critical power-unit failing at any point in the take-off, either to discontinue the take-off and stop within the accelerate-stop distance available, or to continue the take-off and clear all obstacles along the flight path by an adequate margin until the aeroplane is in a position to comply with 5.2.9.

Note.— "An adequate margin" referred to in this provision is illustrated by the appropriate examples included in Attachment C.

5.2.8.1 In determining the length of the runway available, account shall be taken of the loss, if any, of runway length due to alignment of the aeroplane prior to take-off.

5.2.9 *En route — one power-unit inoperative.* The aeroplane shall be able, in the event of the critical power-unit becoming inoperative at any point along the route or planned diversions therefrom, to continue the flight to an aerodrome at which the Standard of 5.2.11 can be met, without flying below the minimum flight altitude at any point.

5.2.10 *En route — two power-units inoperative.* In the case of aeroplanes having three or more power-units, on any part of a route where the location of en-route alternate aerodromes and the total duration of the flight are such that the probability of a second power-unit becoming inoperative must be allowed for if the general level of safety implied by the Standards of this chapter is to be maintained, the aeroplane shall be able, in the event of any two power-units becoming inoperative, to continue the flight to an en-route alternate aerodrome and land.

5.2.11 *Landing.* The aeroplane shall, at the aerodrome of intended landing and at any alternate aerodrome, after clearing all obstacles in the approach path by a safe margin, be able to land, with assurance that it can come to a stop or, for a seaplane, to a satisfactorily low speed, within the landing distance available. Allowance shall be made for expected variations in the approach and landing techniques, if such allowance has not been made in the scheduling of performance data.

5.3 Obstacle data

5.3.1 Obstacle data shall be provided to enable the operator to develop procedures to comply with 5.2.8.

Note.— See Annex 4 and Annex 15 for methods of presentation of certain obstacle data.

5.3.2 The operator shall take account of charting accuracy when assessing compliance with 5.2.8.

CHAPTER 6. AEROPLANE INSTRUMENTS, EQUIPMENT, AND FLIGHT DOCUMENTS

Note.— Specifications for the provision of aeroplane communication and navigation equipment are contained in Chapter 7.

6.1 General

6.1.1 In addition to the minimum equipment necessary for the issuance of a certificate of airworthiness, the instruments, equipment and flight documents prescribed in the following paragraphs shall be installed or carried, as appropriate, in aeroplanes according to the aeroplane used and to the circumstances under which the flight is to be conducted.

6.1.2 The operator shall include in the operations manual a minimum equipment list (MEL), approved by the State of the Operator which will enable the pilot-in-command to determine whether a flight may be commenced or continued from any intermediate stop should any instrument, equipment or systems become inoperative.

Note.— Attachment G contains guidance on the minimum equipment list.

6.1.3 The operator shall provide operations staff and flight crew with an aircraft operating manual, for each aircraft type operated, containing the normal, abnormal and emergency procedures relating to the operation of the aircraft. The manual shall include details of the aircraft systems and of the checklists to be used.

6.2 All aeroplanes on all flights

6.2.1 An aeroplane shall be equipped with instruments which will enable the flight crew to control the flight path of the aeroplane, carry out any required procedural manoeuvres and observe the operating limitations of the aeroplane in the expected operating conditions.

6.2.2 An aeroplane shall be equipped with:

a) accessible and adequate medical supplies appropriate to the number of passengers the aeroplane is authorized to carry;

Recommendation.— *Medical supplies should comprise:*

1) one or more first-aid kits; and

2) a medical kit, for the use of medical doctors or other qualified persons in treating in-flight medical emergencies for aeroplanes authorized to carry more than 250 passengers.

Note.— Guidance on the types, number, location and contents of the medical supplies is given in Attachment B.

b) portable fire extinguishers of a type which, when discharged, will not cause dangerous contamination of the air within the aeroplane. At least one shall be located in:

1) the pilot's compartment; and

2) each passenger compartment that is separate from the pilot's compartment and that is not readily accessible to the flight crew;

Note.— Any portable fire extinguisher so fitted in accordance with the certificate of airworthiness of the aeroplane may count as one prescribed.

c) 1) a seat or berth for each person over an age to be determined by the State of the Operator;

2) a seat belt for each seat and restraining belts for each berth; and

3) a safety harness for each flight crew seat. The safety harness for each pilot seat shall incorporate a device which will automatically restrain the occupant's torso in the event of rapid deceleration;

Recommendation.— *The safety harness for each pilot seat should incorporate a device to prevent a suddenly incapacitated pilot from interfering with the flight controls.*

Note.— Safety harness includes shoulder straps and a seat belt which may be used independently.

d) means of ensuring that the following information and instructions are conveyed to passengers:

1) when seat belts are to be fastened;

2) when and how oxygen equipment is to be used if the carriage of oxygen is required;

3) restrictions on smoking;

4) location and use of life jackets or equivalent individual floatation devices where their carriage is required; and

5) location and method of opening emergency exits; and

e) spare electrical fuses of appropriate ratings for replacement of those accessible in flight.

6.2.3 An aeroplane shall carry:

a) the operations manual prescribed in 4.2.2, or those parts of it that pertain to flight operations;

b) the flight manual for the aeroplane, or other documents containing performance data required for the application of Chapter 5 and any other information necessary for the operation of the aeroplane within the terms of its certificate of airworthiness, unless these data are available in the operations manual; and

c) current and suitable charts to cover the route of the proposed flight and any route along which it is reasonable to expect that the flight may be diverted.

6.2.4 Marking of break-in points

6.2.4.1 If areas of the fuselage suitable for break-in by rescue crews in emergency are marked on an aeroplane such areas shall be marked as shown below (see figure following). The colour of the markings shall be red or yellow, and if necessary they shall be outlined in white to contrast with the background.

6.2.4.2 If the corner markings are more than 2 m apart, intermediate lines 9 cm x 3 cm shall be inserted so that there is no more than 2 m between adjacent markings.

Note.— This Standard does not require any aeroplane to have break-in areas.

6.3 Flight recorders

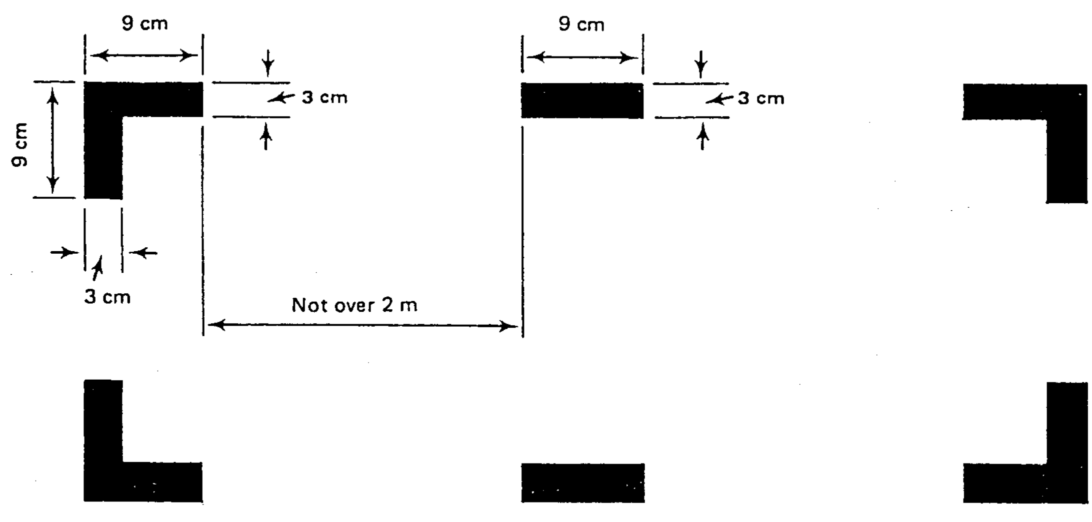
Note 1.— Flight recorders comprise two systems, a flight data recorder and a cockpit voice recorder.

Note 2.— Detailed guidance on flight recorders is contained in Attachment D.

6.3.1 Flight data recorders — types

6.3.1.1 A Type I flight data recorder shall record the parameters required to determine accurately the aeroplane flight path, speed, attitude, engine power, configuration and operation.

6.3.1.2 Types II and IIA flight data recorders shall record the parameters required to determine accurately the aeroplane flight path, speed, attitude, engine power and configuration of lift and drag devices.



MARKING OF BREAK-IN POINTS (see 6.2.4)

6.3.1.3 The use of engraving metal foil flight data recorders shall be discontinued by 1 January 1995.

6.3.2 Flight data recorders — duration

All flight data recorders shall be capable of retaining the information recorded during at least the last 25 hours of their operation, except for the Type IIA flight data recorder which shall be capable of retaining the information recorded during at least the last 30 minutes of its operation.

6.3.3 Flight data recorders — aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 1989

6.3.3.1 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg shall be equipped with a Type I flight data recorder.

6.3.3.2 All aeroplanes of a maximum certificated take-off mass of over 5 700 kg, up to and including 27 000 kg, shall be equipped with a Type II flight data recorder.

6.3.3.3 **Recommendation.—** *All multi-engine turbine powered aeroplanes of a maximum certificated take-off mass of 5 700 kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 1990 should be equipped with a Type IIA flight data recorder.*

6.3.4 Flight data recorders — aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 1987 but before 1 January 1989

6.3.4.1 All turbine engine aeroplanes of a maximum certificated take-off mass of over 5 700 kg, except those in 6.3.4.3, shall be equipped with a flight data recorder which shall record time, altitude, airspeed, normal acceleration and heading.

6.3.4.2 **Recommendation.—** *All turbine engine aeroplanes of a maximum certificated take-off mass of over 5 700 kg, except those in 6.3.4.3, should be equipped with a flight data recorder which shall record time, altitude, airspeed, normal acceleration, heading and such additional parameters as are necessary to determine pitch attitude, roll attitude, radio transmission keying and power on each engine.*

6.3.4.3 All turbine engine aeroplanes of a maximum certificated take-off mass of over 27 000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 shall be equipped with a Type II flight data recorder.

6.3.5 Flight data recorders — aeroplanes for which the individual certificate of airworthiness is first issued before 1 January 1987

6.3.5.1 All turbine engine aeroplanes of a maximum certificated take-off mass of over 5 700 kg shall be equipped with a flight data recorder which shall record time, altitude, airspeed, normal acceleration and heading.

6.3.5.2 **Recommendation.—** *All turbine engine aeroplanes of a maximum certificated take-off mass of over 27 000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 should be equipped with a flight data recorder which should record, in addition to time, altitude, airspeed, normal acceleration and heading, such additional parameters as are necessary to meet the objectives of determining:*

a) the attitude of the aeroplane in achieving its flight path; and

b) the basic forces acting upon the aeroplane resulting in the achieved flight path and the origin of such basic forces.

6.3.6 Cockpit voice recorders — aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 1987

6.3.6.1 All aeroplanes of a maximum certificated take-off mass of over 5 700 kg shall be equipped with a cockpit voice recorder, the objective of which is the recording of the aural environment on the flight deck during flight time.

6.3.6.2 **Recommendation.—** *All multi-engine turbine powered aeroplanes of a maximum certificated take-off mass of 5 700 kg or less for which the individual certificate of airworthiness is first issued on or after 1 January 1990 should be equipped with a cockpit voice recorder, the objective of which is the recording of the aural environment on the flight deck during flight time.*

6.3.7 Cockpit voice recorders — aeroplanes for which the individual certificate of airworthiness is first issued before 1 January 1987

6.3.7.1 All turbine engine aeroplanes of a maximum certificated take-off mass of over 27 000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 shall be equipped with a cockpit voice recorder, the objective of which is the recording of the aural environment on the flight deck during flight time.

6.3.7.2 **Recommendation.—** *All turbine engine aeroplanes of a maximum certificated take-off mass of over*

5 700 kg up to and including 27 000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 should be equipped with a cockpit voice recorder, the objective of which is the recording of the aural environment on the flight deck during flight time.

6.3.8 Cockpit voice recorders — duration

6.3.8.1 A cockpit voice recorder shall be capable of retaining the information recorded during at least the last 30 minutes of its operation.

6.3.8.2 **Recommendation.—** *A cockpit voice recorder, installed in aeroplanes of a maximum certificated take-off mass of over 5 700 kg for which the individual certificate of airworthiness is first issued on or after 1 January 1990, should be capable of retaining the information recorded during at least the last two hours of its operation.*

6.3.9 Flight recorders — construction and installation

Flight recorders shall be constructed, located and installed so as to provide maximum practical protection for the recordings in order that the recorded information may be preserved, recovered and transcribed.

6.3.10 Flight recorders — operation

6.3.10.1 Flight recorders shall not be switched off during flight time.

6.3.10.2 **Recommendation.—** *To preserve flight recorder records, flight recorders should be de-activated upon completion of flight time following an accident or incident, and not re-activated prior to removal of these records.*

6.4 All aeroplanes operated as VFR flights

6.4.1 All aeroplanes when operated as VFR flights shall be equipped with:

a) a magnetic compass;

b) an accurate timepiece indicating the time in hours, minutes and seconds;

c) a sensitive pressure altimeter;

d) an airspeed indicator; and

e) such additional instruments or equipment as may be prescribed by the appropriate authority.

6.4.2 VFR flights which are operated as controlled flights shall be equipped in accordance with 6.9.

6.5 All aeroplanes on flights over water

6.5.1 Seaplanes

All seaplanes for all flights shall be equipped with:

a) one life jacket, or equivalent individual floatation device, for each person on board, stowed in a position easily accessible from the seat or berth of the person for whose use it is provided;

b) equipment for making the sound signals prescribed in the International Regulations for Preventing Collisions at Sea, where applicable; and

c) one sea anchor (drogue).

Note.— "Seaplanes" includes amphibians operated as seaplanes.

6.5.2 Landplanes

6.5.2.1 Landplanes shall carry the equipment prescribed in 6.5.2.2:

a) when flying over water and at a distance of more than 93 km (50 NM) away from the shore, in the case of landplanes operated in accordance with 5.2.9 or 5.2.10;

b) when flying en route over water beyond gliding distance from the shore, in the case of all other landplanes; and

c) when taking off or landing at an aerodrome where, in the opinion of the State of the Operator, the take-off or approach path is so disposed over water that in the event of a mishap there would be a likelihood of a ditching.

6.5.2.2 The equipment referred to in 6.5.2.1 shall comprise one life jacket or equivalent individual floatation device for each person on board, stowed in a position easily accessible from the seat or berth of the person for whose use it is provided.

Note.— "Landplanes" includes amphibians operated as landplanes.

6.5.3 All aeroplanes on long range over water flights

6.5.3.1 In addition to the equipment prescribed in 6.5.1 or 6.5.2 whichever is applicable, the following equipment shall be installed in all aeroplanes when used over routes on which the aeroplane may be over water and at more than a distance corresponding to 120 minutes at cruising speed or 740 km (400 NM), whichever is the lesser, away from land suitable for making an emergency landing in the case of aircraft operated in accordance with 5.2.9 or 5.2.10, and 30 minutes or 185 km (100 NM), whichever is the lesser, for all other aeroplanes:

a) life-saving rafts in sufficient numbers to carry all persons on board, stowed so as to facilitate their ready use in emergency, provided with such life-saving equipment including means of sustaining life as is appropriate to the flight to be undertaken; and

b) equipment for making the pyrotechnical distress signals described in Annex 2.

6.5.3.2 Each life jacket and equivalent individual floatation device, when carried in accordance with 6.5.1 a), 6.5.2.1 and 6.5.2.2, shall be equipped with a means of electric illumination for the purpose of facilitating the location of persons, except where the requirement of 6.5.2.1 c) is met by the provision of individual floatation devices other than life jackets.

6.6 All aeroplanes on flights over designated land areas

Aeroplanes, when operated across land areas which have been designated by the State concerned as areas in which search and rescue would be especially difficult, shall be equipped with such signalling devices and life-saving equipment (including means of sustaining life) as may be appropriate to the area overflown.

6.7 All aeroplanes on high altitude flights

Note.— Approximate altitude in the Standard Atmosphere corresponding to the value of absolute pressure used in this text is as follows:

Absolute pressure	Metres	Feet
700 hPa	*3 000*	*10 000*
620 hPa	*4 000*	*13 000*
376 hPa	*7 600*	*25 000*

6.7.1 An aeroplane intended to be operated at flight altitudes at which the atmospheric pressure is less than 700 hPa in personnel compartments shall be equipped with oxygen storage and dispensing apparatus capable of storing and dispensing the oxygen supplies required in 4.3.8.1.

6.7.2 An aeroplane intended to be operated at flight altitudes at which the atmospheric pressure is less than 700 hPa but which is provided with means of maintaining pressures greater than 700 hPa in personnel compartments shall be provided with oxygen storage and dispensing apparatus capable of storing and dispensing the oxygen supplies required in 4.3.8.2.

6.7.3 Pressurized aeroplanes newly introduced into service on or after 1 July 1962 and intended to be operated at flight altitudes at which the atmospheric pressure is less than 376 hPa shall be equipped with a device to provide positive warning to the pilot of any dangerous loss of pressurization.

6.7.4 **Recommendation.—** *Pressurized aeroplanes introduced into service before 1 July 1962 and intended to be operated at flight altitudes at which the atmospheric pressure is less than 376 hPa should be equipped with a device to provide positive warning to the pilot of any dangerous loss of pressurization.*

6.7.5 An aeroplane intended to be operated at flight altitudes at which the atmospheric pressure is less than 376 hPa, or which, if operated at flight altitudes at which the atmospheric pressure is more than 376 hPa, cannot descend safely within four minutes to a flight altitude at which the atmospheric pressure is equal to 620 hPa and for which the individual certificate of airworthiness was issued on or after 9 November 1998, shall be provided with automatically deployable oxygen equipment to satisfy the requirements of 4.3.8.2. The total number of oxygen dispensing units shall exceed the number of passenger and cabin attendant seats by at least 10 per cent.

6.7.6 **Recommendation.—** *An aeroplane intended to be operated at flight altitudes at which the atmospheric pressure is less than 376 hPa, or which, if operated at flight altitudes at which the atmospheric pressure is more than 376 hPa cannot descend safely within four minutes to a flight altitude at which the atmospheric pressure is equal to 620 hPa, and for which the individual certificate of airworthiness is issued before 9 November 1998, should be provided with automatically deployable oxygen equipment to satisfy the requirements of 4.3.8.2. The total number of oxygen dispensing units should exceed the number of passenger and cabin attendant seats by at least 10 per cent.*

6.8 All aeroplanes in icing conditions

All aeroplanes shall be equipped with suitable anti-icing and/or de-icing devices when operated in circumstances in which icing conditions are reported to exist or are expected to be encountered.

6.9 All aeroplanes operated in accordance with instrument flight rules

6.9.1 All aeroplanes when operated in accordance with the instrument flight rules, or when the aeroplane cannot be maintained in a desired attitude without reference to one or more flight instruments, shall be equipped with:

a) a magnetic compass;

b) an accurate timepiece indicating the time in hours, minutes and seconds;

c) two sensitive pressure altimeters;

Note.— A sensitive altimeter of any type fitted in accordance with the airworthiness standards may be included in the two here prescribed. Due to the long history of misreadings, the use of drum-pointer altimeters is not recommended.

d) an airspeed indicating system with means of preventing malfunctioning due to either condensation or icing;

e) a turn and slip indicator;

f) an attitude indicator (artificial horizon);

g) a heading indicator (directional gyroscope);

Note.— The requirements of e), f) and g) above may be met by combinations of instruments or by integrated flight director systems provided that the safeguards against total failure, inherent in the three separate instruments, are retained.

h) a means of indicating whether the power supply to the gyroscopic instrument is adequate;

i) a means of indicating in the flight crew compartment the outside air temperature;

j) a rate-of-climb and descent indicator; and

k) such additional instruments or equipment as may be prescribed by the appropriate authority.

6.9.2 All aeroplanes over 5 700 kg — Emergency power supply for electrically operated attitude indicating instruments

6.9.2.1 All aeroplanes of a maximum certificated take-off mass of over 5 700 kg newly introduced into service after 1 January 1975 shall be fitted with an emergency power supply, independent of the main electrical generating system, for the purpose of operating and illuminating, for a minimum period of 30 minutes, an attitude indicating instrument (artificial horizon), clearly visible to the pilot-in-command. The emergency power supply shall be automatically operative after the total failure of the main electrical generating system and clear indication shall be given on the instrument panel that the attitude indicator(s) is being operated by emergency power.

6.9.2.2 Those instruments that are used by any one pilot shall be so arranged as to permit the pilot to see their indications readily from his or her station, with the minimum practicable deviation from the position and line of vision normally assumed when looking forward along the flight path.

6.10 All aeroplanes when operated at night

All aeroplanes, when operated at night shall be equipped with:

a) all equipment specified in 6.9;

b) the lights required by Annex 2 for aircraft in flight or operating on the movement area of an aerodrome;

Note.— Specifications for lights meeting the requirements of Annex 2 for navigation lights are contained in the Appendix. The general characteristics of lights are specified in Annex 8. Detailed specifications for lights meeting the requirements of Annex 2 for aircraft in flight or operating on the movement area of an aerodrome are contained in the Airworthiness Technical Manual *(Doc 9051).*

c) two landing lights;

Note.— Aeroplanes not certificated in accordance with Annex 8 which are equipped with a single landing light having two separately energized filaments will be considered to have complied with 6.10 c).

d) illumination for all instruments and equipment that are essential for the safe operation of the aeroplane that are used by the flight crew;

e) lights in all passenger compartments; and

f) an electric torch for each crew member station.

6.11 Pressurized aeroplanes when carrying passengers — weather radar

Recommendation.— *Pressurized aeroplanes when carrying passengers should be equipped with operative weather radar whenever such aeroplanes are being operated in areas where thunderstorms or other potentially hazardous weather conditions, regarded as detectable with airborne weather radar, may be expected to exist along the route either at night or under instrument meteorological conditions.*

6.12 All aeroplanes operated above 15 000 m (49 000 ft) — radiation indicator

All aeroplanes intended to be operated above 15 000 m (49 000 ft) shall carry equipment to measure and indicate continuously the dose rate of total cosmic radiation being received (i.e. the total of ionizing and neutron radiation of galactic and solar origin) and the cumulative dose on each flight. The display unit of the equipment shall be readily visible to a flight crew member.

Note.— The equipment is calibrated on the basis of assumptions acceptable to the appropriate national authorities.

6.13 All aeroplanes complying with the noise certification Standards in Annex 16, Volume I

An aeroplane shall carry a document attesting noise certification.

Note.— The attestation may be contained in any document, carried on board, approved by the State of Registry.

6.14 Mach number indicator

All aeroplanes with speed limitations expressed in terms of Mach number, shall be equipped with a Mach number indicator.

Note.— This does not preclude the use of the airspeed indicator to derive Mach number for ATS purposes.

6.15 Turbine engine aeroplanes — ground proximity warning system (GPWS)

6.15.1 All turbine engine aeroplanes of a maximum certificated take-off mass in excess of 15 000 kg or authorized to carry more than 30 passengers, for which the individual certificate of airworthiness was first issued on or after 1 July 1979, shall be equipped with a ground proximity warning system.

6.15.2 **Recommendation.—** *All turbine engine aeroplanes of a maximum certificated take-off mass in excess of 15 000 kg or authorized to carry more than 30 passengers, for which the individual certificate of airworthiness was first issued before 1 July 1979, should be equipped with a ground proximity warning system.*

6.15.3 All turbine engine aeroplanes of a maximum certificated take-off mass in excess of 5 700 kg or authorized to carry more than nine passengers shall be equipped with a ground proximity warning system on or after 1 January 1999.

6.15.4 A ground proximity warning system shall provide automatically a timely and distinctive warning to the flight crew when the aeroplane is in potentially hazardous proximity to the earth's surface.

6.15.5 On or after 1 January 1999, a ground proximity warning system shall provide, as a minimum, warnings of the following circumstances:

1) excessive descent rate;

2) excessive terrain closure rate;

3) excessive altitude loss after take-off or go-around;

4) unsafe terrain clearance while not in landing configuration;

   a) gear not locked down;

   b) flaps not in a landing position; and

5) excessive descent below the instrument glide path.

6.16 Aeroplanes carrying passengers — cabin attendants' seats

6.16.1 Aeroplanes for which the individual certificate of airworthiness was first issued on or after 1 January 1981

All aeroplanes shall be equipped with a forward or rearward facing (within 15 degrees of the longitudinal axis of the aeroplane) seat, fitted with a safety harness for the use of each cabin attendant required to satisfy the intent of 12.1 in respect of emergency evacuation.

6.16.2 Aeroplanes for which the individual certificate of airworthiness was first issued before 1 January 1981

Recommendation.— *All aeroplanes should be equipped with a forward or rearward facing (within 15 degrees of the longitudinal axis of the aeroplane) seat, fitted with a safety harness for the use of each cabin attendant required to satisfy the intent of 12.1 in respect of emergency evacuation.*

Note 1.— Guidance material on emergency evacuation provisions is contained in the Airworthiness Technical Manual, *Part III, Section 4, Chapter 1.*

Note 2.— Safety harness includes shoulder straps and a seat belt which may be used independently.

6.16.3 Cabin attendants' seats provided in accordance with 6.16.1 and 6.16.2 shall be located near floor level and other emergency exits as required by the State of Registry for emergency evacuation.

6.17 Emergency locator transmitter (ELT)

6.17.1 All aeroplanes operated on long range over water flights as described in 6.5.3 shall be equipped with at least two ELT(S).

6.17.2 Aeroplanes on flights over designated land areas as described in 6.6 shall be equipped with at least one ELT(S).

6.17.3 **Recommendation.—** *All aeroplanes should carry an automatically activated ELT.*

6.17.4 ELT equipment carried to satisfy the requirements of 6.17.1, 6.17.2 and 6.17.3 shall operate in accordance with the relevant provisions of Annex 10, Volume I.

CHAPTER 7. AEROPLANE COMMUNICATION AND NAVIGATION EQUIPMENT

7.1 Communication equipment

7.1.1 An aeroplane shall be provided with radio communication equipment capable of:

a) conducting two-way communication for aerodrome control purposes;

b) receiving meteorological information at any time during flight; and

c) conducting two-way communication at any time during flight with at least one aeronautical station and with such other aeronautical stations and on such frequencies as may be prescribed by the appropriate authority.

Note.— The requirements of 7.1.1 are considered fulfilled if the ability to conduct the communications specified therein is established during radio propagation conditions which are normal for the route.

7.1.2 The radio communication equipment required in accordance with 7.1.1 shall provide for communications on the aeronautical emergency frequency 121.5 MHz.

7.2 Navigation equipment

7.2.1 An aeroplane shall be provided with navigation equipment which will enable it to proceed:

a) in accordance with its operational flight plan;

b) in accordance with prescribed RNP types; and

c) in accordance with the requirements of air traffic services;

except when, if not so precluded by the appropriate authority, navigation for flights under the visual flight rules is accomplished by visual reference to landmarks.

Note.— Information on RNP and associated procedures is contained in the Manual on Required Navigation Performance (RNP) *(Doc 9613).*

7.2.2 For flights in defined portions of airspace where, based on Regional Air Navigation Agreement, minimum navigation performance specifications (MNPS) are prescribed, an aeroplane shall be provided with navigation equipment which:

a) continuously provides indications to the flight crew of adherence to or departure from track to the required degree of accuracy at any point along that track; and

b) has been authorized by the State of the Operator for MNPS operations concerned.

Note.— The prescribed minimum navigation performance specifications and the procedures governing their application are published in Regional Supplementary Procedures *(Doc 7030).*

7.2.3 For flights in defined portions of airspace where, based on Regional Air Navigation Agreement, a vertical separation minimum (VSM) of 300 m (1 000 ft) is applied above FL 290, an aeroplane:

a) shall be provided with equipment which is capable of:

1) indicating to the flight crew the flight level being flown;

2) automatically maintaining a selected flight level;

3) providing an alert to the flight crew when a deviation occurs from the selected flight level. The threshold for the alert shall not exceed ± 90 m (300 ft); and

4) automatically reporting pressure-altitude; and

b) shall be authorized by the State of the operator for operation in the airspace concerned.

7.2.4 The aeroplane shall be sufficiently provided with navigation equipment to ensure that, in the event of the failure of one item of equipment at any stage of the flight, the remaining equipment will enable the aeroplane to navigate in accordance with 7.2.1 and where applicable 7.2.2 and 7.2.3.

Note.— Guidance material relating to aircraft equipment necessary for flight in airspace where a 300 m (1 000 ft) VSM is applied above FL 290 is contained in the Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive (Doc 9574).

7.2.5 On flights in which it is intended to land in instrument meteorological conditions an aeroplane shall be provided with radio equipment capable of receiving signals providing guidance to a point from which a visual landing can be effected. This equipment shall be capable of providing such guidance at each aerodrome at which it is intended to land in instrument meteorological conditions and at any designated alternate aerodromes.

7.3 Installation

The equipment installation shall be such that the failure of any single unit required for either communications or navigation purposes or both will not result in the failure of another unit required for communications or navigation purposes.

CHAPTER 8. AEROPLANE MAINTENANCE

Note on the application of this chapter.— For the purpose of this chapter "aeroplane" includes: powerplants, propellers, components, accessories, instruments, equipment and apparatus including emergency equipment.

8.1 General

8.1.1 An operator shall ensure that there is provided an organization, including trained staff, workshops and other equipment and facilities, to maintain all aeroplanes in an airworthy condition when in use.

8.1.2 When the performance of the maintenance required in 8.1 is assigned, either partially or wholly, to a maintenance organization approved by the State of Registry of the aeroplane concerned, the operator's responsibility for compliance with Standards 8.2, 8.3 and 8.4, which follow, shall be modified according to the extent to which maintenance is assigned.

8.2 Maintenance manual

8.2.1 An operator shall ensure that there is provided, for the use and guidance of maintenance organizations and personnel, a maintenance manual containing the information specified in 11.3.

8.2.2 An operator shall ensure that the maintenance manual is amended or revised as is necessary to keep the information contained therein up to date.

8.2.3 Copies of all revisions and amendments of a maintenance manual shall be furnished promptly to all organizations or persons to whom the manual has been issued.

8.3 Training

An operator shall ensure that all maintenance personnel are instructed regarding the maintenance methods to be employed, in particular when new or unfamiliar equipment is introduced into service.

8.4 Inspection

An operator shall ensure that there is provided a system of inspection to ensure that all maintenance, overhaul, modifications and repairs which affect airworthiness, are effected as prescribed in the maintenance manual or otherwise as made mandatory by the State of Registry.

8.5 Qualification to certify as airworthy

Each person charged with the responsibility of certifying as to the airworthiness of an aeroplane shall be qualified in accordance with Annex 1.

8.6 Modifications and repairs

All modifications and repairs shall comply with airworthiness requirements acceptable to the State of Registry. Procedures shall be established to ensure that the substantiating data supporting compliance with the airworthiness requirements are retained.

8.7 Maintenance release

A maintenance release shall be completed and signed by a person or persons qualified in accordance with Annex 1 to certify that the maintenance work has been completed satisfactorily and in accordance with the methods prescribed in the maintenance manual.

8.8 Records

8.8.1 An operator shall ensure that the following records are kept:

a) the total time in service (hours, calendar time and cycles, as appropriate) of the aeroplane and all life limited components;

b) the current status of compliance with all mandatory continuing airworthiness information;

c) appropriate details of modifications and repairs to the aeroplane and its major components;

d) the time in service (hours, calendar time and cycles, as appropriate) since last overhaul of the aeroplane or its components subject to a mandatory overhaul life;

e) the current aeroplane inspection status such that compliance with the maintenance manual can be established; and

f) the detailed maintenance records to show that all requirements in the maintenance manual for issuance of a maintenance release have been met.

8.8.2 The records in 8.8.1 a) to e) shall be kept for a period of 90 days after the end of the operating life of the unit to which they refer, and the records in 8.8.1 f) for a period of one year after the issuance of the maintenance release.

8.8.3 The records shall be transferred to the new operator in the event of any change of operator.

8.9 Continuing airworthiness information

8.9.1 The operator of an aeroplane over 5 700 kg maximum certificated take-off mass shall monitor and assess maintenance and operational experience with respect to airworthiness and provide the information as prescribed by the State of Registry and report through the system specified in Annex 8, Part II, 4.2.5 and 4.2.8.

8.9.2 The operator of an aeroplane over 5 700 kg maximum certificated take-off mass shall obtain and assess airworthiness information and recommendations available from the organization responsible for the type design and shall implement resulting actions considered necessary in accordance with a procedure acceptable to the State of Registry.

Note.— Guidance on interpretation of "the organization responsible for the type design" is contained in Part II, Section 1, Chapter 2 of the Airworthiness Technical Manual *(Doc 9051).*

CHAPTER 9. AEROPLANE FLIGHT CREW

9.1 Composition of the flight crew

9.1.1 The number and composition of the flight crew shall not be less than that specified in the operations manual. The flight crews shall include flight crew members in addition to the minimum numbers specified in the flight manual or other documents associated with the certificate of airworthiness, when necessitated by considerations related to the type of aeroplane used, the type of operation involved and the duration of flight between points where flight crews are changed.

9.1.2 Radio operator

The flight crew shall include at least one member who holds a valid licence, issued or rendered valid by the State of Registry, authorizing operation of the type of radio transmitting equipment to be used.

9.1.3 Flight engineer

When a separate flight engineer's station is incorporated in the design of an aeroplane, the flight crew shall include at least one flight engineer especially assigned to that station, unless the duties associated with that station can be satisfactorily performed by another flight crew member, holding a flight engineer licence, without interference with regular duties.

9.1.4 Flight navigator

The flight crew shall include at least one member who holds a flight navigator licence in all operations where, as determined by the State of the Operator, navigation necessary for the safe conduct of the flight cannot be adequately accomplished by the pilots from the pilot station.

9.2 Flight crew member emergency duties

An operator shall, for each type of aeroplane, assign to all flight crew members the necessary functions they are to perform in an emergency or in a situation requiring emergency evacuation. Annual training in accomplishing these functions shall be contained in the operator's training programme and shall include instruction in the use of all emergency and life-saving equipment required to be carried, and drills in the emergency evacuation of the aeroplane.

9.3 Flight crew member training programmes

9.3.1 An operator shall establish and maintain a ground and flight training programme, approved by the State of the Operator, which ensures that all flight crew members are adequately trained to perform their assigned duties. Ground and flight training facilities and properly qualified instructors as determined by the State of the Operator shall be provided. The training programme shall consist of ground and flight training in the type(s) of aeroplane on which the flight crew member serves, and shall include proper flight crew co-ordination and training in all types of emergency or abnormal situations or procedures caused by powerplant, airframe or systems malfunctions, fire or other abnormalities. The training programme shall also include training in knowledge and skills related to human performance and limitations and in the transport of dangerous goods. The training for each flight crew member, particularly that relating to abnormal or emergency pro-cedures, shall ensure that all flight crew members know the functions for which they are responsible and the relation of these functions to the functions of other crew members. The training programme shall be given on a recurrent basis, as determined by the State of the Operator and shall include an examination to determine competence.

Note 1.— Paragraph 4.2.4 prohibits the in-flight simulation of emergency or abnormal situations when passengers or cargo are being carried.

Note 2.— Flight training may, to the extent deemed appropriate by the State of the Operator, be given in aeroplane synthetic flight trainers approved by the State for that purpose.

Note 3.— The scope of the recurrent training required by 9.2 and 9.3 may be varied and need not be as extensive as the initial training given in a particular type of aeroplane.

Note 4.— The use of correspondence courses and written examinations as well as other means may, to the extent deemed feasible by the State of the Operator, be utilized in meeting the requirements for periodic ground training.

Note 5.— Provisions for training in the transport of dangerous goods are contained in Annex 18.

9.3.2 The requirement for recurrent flight training in a particular type of aeroplane shall be considered fulfilled by:

a) the use, to the extent deemed feasible by the State of the Operator, of aeroplane synthetic flight trainers approved by that State for that purpose; or

b) the completion within the appropriate period of the proficiency check required by 9.4.4 in that type of aeroplane.

9.4 Qualifications

9.4.1 Recent experience — pilot-in-command

An operator shall not assign a pilot to act as pilot-in-command of an aeroplane unless, on the same type of aeroplane within the preceding 90 days, that pilot has made at least three take-offs and landings.

9.4.2 Recent experience — co-pilot

An operator shall not assign a co-pilot to serve at the flight controls during take-off and landing unless, on the same type of aeroplane within the preceding 90 days, that co-pilot has served as pilot-in-command or co-pilot at the flight controls or has otherwise demonstrated competence to act as co-pilot.

9.4.3 Pilot-in-command route and airport qualification

9.4.3.1 An operator shall not utilize a pilot as pilot-in-command of an aeroplane on a route or route segment for which that pilot is not currently qualified until such pilot has complied with 9.4.3.2 and 9.4.3.3.

9.4.3.2 Each such pilot shall demonstrate to the operator an adequate knowledge of:

a) the route to be flown, and the aerodromes which are to be used. This shall include knowledge of:

1) the terrain and minimum safe altitudes;

2) the seasonal meteorological conditions;

3) the meteorological, communication and air traffic facilities, services and procedures;

4) the search and rescue procedures; and

5) the navigational facilities and procedures, including any long-range navigation procedures, associated with the route along which the flight is to take place; and

b) procedures applicable to flight paths over heavily populated areas and areas of high air traffic density, obstructions, physical layout, lighting, approach aids and arrival, departure, holding and instrument approach procedures, and applicable operating minima.

Note.— That portion of the demonstration relating to arrival, departure, holding and instrument approach procedures may be accomplished in an appropriate training device which is adequate for this purpose.

9.4.3.3 A pilot-in-command shall have made an actual approach into each aerodrome of landing on the route, accompanied by a pilot who is qualified for the aerodrome, as a member of the flight crew or as an observer on the flight deck, unless:

a) the approach to the aerodrome is not over difficult terrain and the instrument approach procedures and aids available are similar to those with which the pilot is familiar, and a margin to be approved by the State of the Operator is added to the normal operating minima, or there is reasonable certainty that approach and landing can be made in visual meteorological conditions; or

b) the descent from the initial approach altitude can be made by day in visual meteorological conditions; or

c) the operator qualifies the pilot-in-command to land at the aerodrome concerned by means of an adequate pictorial presentation; or

d) the aerodrome concerned is adjacent to another aerodrome at which the pilot-in-command is currently qualified to land.

9.4.3.4 The operator shall maintain a record, sufficient to satisfy the State of the Operator of the qualification of the pilot and of the manner in which such qualification has been achieved.

9.4.3.5 An operator shall not continue to utilize a pilot as a pilot-in-command on a route unless, within the preceding 12 months, the pilot has made at least one trip between the terminal points of that route as a pilot member of the flight crew, or as a check pilot, or as an observer on the flight deck. In the event that more than 12 months elapse in which a pilot has not made such a trip on a route in close proximity and over similar terrain, prior to again serving as a pilot-in-command on that route, that pilot must requalify in accordance with 9.4.3.2 and 9.4.3.3.

9.4.4 Pilot proficiency checks

An operator shall ensure that piloting technique and the ability to execute emergency procedures is checked in such a way as to demonstrate the pilot's competence. Where the operation may be conducted under instrument flight rules, an operator shall ensure that the pilot's competence to comply with such rules is demonstrated to either a check pilot of the operator or to a representative of the State of the Operator. Such checks shall be performed twice within any period of one year. Any two such checks which are similar and which occur within a period of four consecutive months shall not alone satisfy this requirement.

Note 1.— Flight simulators approved by the State of the Operator may be used for those parts of the checks for which they are specifically approved.

Note 2.— See ICAO Manual of Criteria for the Qualification of Flight Simulators *(Doc 9625).*

9.5 Flight crew equipment

A flight crew member assessed as fit to exercise the privileges of a licence subject to the use of suitable correcting lenses, shall have a spare set of the correcting lenses readily available when exercising those privileges.

9.6 Flight time, flight duty periods and rest periods

The State of the Operator shall establish regulations specifying the limitations applicable to the flight time and flight duty periods for flight crew members. These regulations shall also make provision for adequate rest periods and shall be such as to ensure that fatigue occurring either in a flight or successive flights or accumulated over a period of time due to these and other tasks, does not endanger the safety of a flight.

Note.— Guidance on the establishment of limitations is given in Attachment A.

CHAPTER 10. FLIGHT OPERATIONS OFFICER/FLIGHT DISPATCHER

10.1 A flight operations officer/flight dispatcher, when employed in conjunction with an approved method of flight supervision requiring the services of licensed flight operations officers/flight dispatchers, shall be licensed in accordance with the provisions of Annex 1.

Note.— The above provisions do not necessarily require a flight operations officer/flight dispatcher to hold the licence specified in Annex 1. In accordance with 4.2.1 the method of flight supervision is subject to approval by the State of the Operator which may accept proof of qualifications other than the holding of the licence.

10.2 **Recommendation.—** *A flight operations officer/ flight dispatcher should not be assigned to duty unless that officer has:*

a) made within the preceding 12 months, at least a one-way qualification flight on the flight deck of an aeroplane over any area in which that individual is authorized to exercise flight supervision. The flight should include landings at as many aerodromes as practicable;

b) demonstrated to the operator a knowledge of:

1) the contents of the operations manual described in 11.1;

2) the radio equipment in the aeroplanes used; and

3) the navigation equipment in the aeroplanes used;

c) demonstrated to the operator a knowledge of the following details concerning operations for which the officer is responsible and areas in which that individual is authorized to exercise flight supervision:

1) the seasonal meteorological conditions and the sources of meteorological information;

2) the effects of meteorological conditions on radio reception in the aeroplanes used;

3) the peculiarities and limitations of each navigation system which is used by the operation; and

4) the aeroplane loading instructions; and

d) demonstrated to the operator the ability to perform the duties specified in 4.6.

10.3 **Recommendation.—** *A flight operations officer/ flight dispatcher assigned to duty should maintain complete familiarization with all features of the operation which are pertinent to such duties.*

10.4 **Recommendation.—** *A flight operations officer/ flight dispatcher should not be assigned to duty after 12 consecutive months of absence from such duty, unless the provisions of 10.2 are met.*

CHAPTER 11. MANUALS, LOGS AND RECORDS

11.1 Operations manual

An operations manual, which may be issued in separate parts corresponding to specific aspects of operations, provided in accordance with 4.2.2 shall contain at least the following:

1) instructions outlining the responsibilities of operations personnel pertaining to the conduct of flight operations;

2) the flight crew for each type of operation including the designation of the succession of command;

3) rules limiting the flight time and flight duty periods and providing for adequate rest periods for flight crew members and cabin attendants;

4) the in-flight and the emergency duties assigned to each crew member;

5) checklist of emergency and safety equipment and instructions for its use;

6) minimum flight altitudes:

   a) the method for determining minimum flight altitudes; and

   b) the minimum flight altitudes for each route to be flown;

7) aerodrome operating minima:

   a) the methods for determining aerodrome operating minima;

   b) operating minima for each of the aerodromes that are likely to be used as aerodromes of intended landing or as alternate aerodromes and the increase of aerodrome operating minima in accordance with subparagraph 7 a) above, in case of degradation of approach or aerodrome facilities; and;

   c) conditions required to commence or to continue an instrument approach;

8) the circumstances in which a radio listening watch is to be maintained;

9) a list of the navigational equipment to be carried including any requirements relating to operations in RNP airspace;

10) specific instructions for the computation of the quantities of fuel and oil to be carried, having regard to all circumstances of the operation including the possibility of the failure of one or more powerplants while en route;

11) the minimum equipment list for the aeroplane types operated and specific operations authorized, including any requirements relating to operations in RNP airspace;

12) a route guide to ensure that the flight crew will have, for each flight, information relating to communication facilities, navigation aids, aerodromes, and such other information as the operator may deem necessary for the proper conduct of flight operations;

13) the conditions under which oxygen shall be used and the amount of oxygen determined in accordance with 4.3.8.2;

14) procedures, as prescribed in Annex 12, for pilots-in-command observing an accident;

15) the ground-air visual signal code for use by survivors, as contained in Annex 12;

16) information and instructions relating to the interception of civil aircraft including:

   a) procedures, as prescribed in Annex 2, for pilots-in-command of intercepted aircraft; and

   b) visual signals for use by intercepting and intercepted aircraft, as contained in Annex 2;

17) for aeroplanes intended to be operated above 15 000 m (49 000 ft):

   a) information which will enable the pilot to determine the best course of action to take in the event of exposure to solar cosmic radiation; and

   b) procedures in the event that a decision to descend is taken, covering:

      i) the necessity of giving the appropriate ATS unit prior warning of the situation and of obtaining a provisional descent clearance; and

ii) the action to be taken in the event that communication with the ATS unit cannot be established or is interrupted.

Note.— Guidance material on the information to be provided is contained in Circular 126 — Guidance Material on SST Aircraft Operations.

18) information and instructions on the carriage of dangerous goods, including action to be taken in the event of an emergency;

19) emergency evacuation procedures;

20) safety precautions during refuelling with passengers on board;

21) operating instructions and information on climb performance with all engines operating, if provided in accordance with 4.2.3.3;

22) the normal, abnormal and emergency procedures to be used by the flight crew, the checklists relating thereto and aircraft systems information as required by 6.1.3;

23) where relevant to the operations, the long-range navigation procedures to be used;

24) the specifications for the operational flight plan;

25) details of the flight crew training programme and requirements;

26) details of the cabin attendant duties training programme as required by 12.4;

27) security instructions and guidance;

28) details of the accident prevention and flight safety programme provided in accordance with 3.6;

29) departure contingency procedures;

30) instructions for mass and balance control; and

31) instructions and training requirements for the avoidance of controlled flight into terrain and policy for the use of the ground proximity warning system (GPWS).

11.2 Flight manual

Note.— The flight manual contains the information specified in Annex 8.

The flight manual shall be updated by implementing changes made mandatory by the State of Registry.

11.3 Maintenance manual

A maintenance manual provided in accordance with 8.2 shall contain the following information in respect of the aeroplanes operated:

a) procedures for servicing and maintenance;

b) an aeroplane maintenance programme, approved by the State of Registry, containing maintenance tasks and intervals at which these tasks are to be performed;

c) the responsibilities of the various classes of skilled maintenance personnel;

d) the servicing and maintenance methods which may be prescribed by, or which require the prior approval of, the State of Registry; and

e) the procedure for preparing the maintenance release, the circumstances under which this release is to be issued and the personnel required to sign it.

11.4 Maintenance release

A maintenance release shall contain a certification as to the satisfactory completion of maintenance work carried out in accordance with the methods prescribed in the maintenance manual.

11.5 Journey log book

11.5.1 **Recommendation.—** *The aeroplane journey log book should contain the following items and the corresponding roman numerals:*

I — *Aeroplane nationality and registration.*

II — *Date.*

III — *Names of crew members.*

IV — *Duty assignments of crew members.*

V — *Place of departure.*

VI — *Place of arrival.*

VII — *Time of departure.*

VIII — *Time of arrival.*

IX — *Hours of flight.*

X — *Nature of flight (private, aerial work, scheduled or non-scheduled).*

XI — *Incidents, observations, if any.*

XII — *Signature of person in charge.*

11.5.2 **Recommendation.**— *Entries in the journey log book should be made currently and in ink or indelible pencil.*

11.5.3 **Recommendation.**— *Completed journey log book should be retained to provide a continuous record of the last six months' operations.*

11.6 Records of emergency and survival equipment carried

Operators shall at all times have available for immediate communication to rescue co-ordination centres, lists containing information on the emergency and survival equipment carried on board any of their aeroplanes engaged in international air navigation. The information shall include, as applicable, the number, colour and type of life rafts and pyrotechnics, details of emergency medical supplies, water supplies and the type and frequencies of the emergency portable radio equipment.

Note.— The following additional manuals and records are associated with this Annex but are not included in this chapter:

Fuel and oil records — see 4.2.9

Maintenance records — see 8.8

Flight time records — see 4.2.10.2

Flight preparation forms — see 4.3

Operational flight plan — see 4.3.3.1 and 4.3.3.2

Pilot route and aerodrome qualification records — see 9.4.3.4

11.7 Flight recorder records

11.7.1 An operator shall ensure, to the extent possible, in the event an aircraft becomes involved in an accident, the preservation of all related flight recorder records, and if necessary the associated flight recorders, and their retention in safe custody pending their disposition as determined in accordance with Annex 13.

11.7.2 **Recommendation.**— *An operator should ensure, to the extent possible, in the event an aircraft becomes involved in an incident, the preservation of all related flight recorder records, and if necessary the associated flight recorders, and their retention in safe custody pending their disposition as determined in accordance with Annex 13.*

CHAPTER 12. CABIN ATTENDANTS

12.1 Assignment of emergency duties

An operator shall establish, to the satisfaction of the State of the Operator, the minimum number of cabin attendants required for each type of aeroplane, based on seating capacity or the number of passengers carried, in order to effect a safe and expeditious evacuation of the aeroplane, and the necessary functions to be performed in an emergency or a situation requiring emergency evacuation. The operator shall assign these functions for each type of aeroplane.

12.2 Cabin attendants at emergency evacuation stations

Each cabin attendant assigned to emergency evacuation duties shall occupy a seat provided in accordance with 6.16 during take-off and landing and whenever the pilot-in-command so directs.

12.3 Protection of cabin attendants during flight

Each cabin attendant shall be seated with seat belt or, when provided, safety harness fastened during take-off and landing and whenever the pilot-in-command so directs.

Note.— The foregoing does not preclude the pilot-in-command from directing the fastening of the seat belt only, at times other than during take-off and landing.

12.4 Training

An operator shall establish and maintain a training programme, approved by the State of the Operator, to be completed by all persons before being assigned as a cabin attendant. Cabin attendants shall complete a recurrent training programme annually. These training programmes shall ensure that each person is:

a) competent to execute those safety duties and functions which the cabin attendant is assigned to perform in the event of an emergency or in a situation requiring emergency evacuation;

b) drilled and capable in the use of emergency and life-saving equipment required to be carried, such as life jackets, life rafts, evacuation slides, emergency exits, portable fire extinguishers, oxygen equipment and first-aid kits;

c) when serving on aeroplanes operated above 3 000 m (10 000 ft), knowledgeable as regards the effect of lack of oxygen and, in the case of pressurized aeroplanes, as regards physiological phenomena accompanying a loss of pressurization;

d) aware of other crew members' assignments and functions in the event of an emergency so far as is necessary for the fulfillment of the cabin attendant's own duties; and

e) aware of the types of dangerous goods which may, and may not, be carried in a passenger cabin and has completed the dangerous goods training programme required by Annex 18.

12.5 Flight time, flight duty periods and rest periods

The State of the Operator shall establish regulations specifying the limits applicable to flight time, flight duty periods and rest periods for cabin attendants.

Note.— Guidance on the establishment of limitations is given in Attachment A.

CHAPTER 13. SECURITY*

13.1 Security of the flight crew compartment

In all aeroplanes which are equipped with a flight crew compartment door, this door shall be capable of being locked. It shall be lockable from within the compartment only.

13.2 Aeroplane search procedure checklist

An operator shall ensure that there is on board a checklist of the procedures to be followed in searching for a bomb in case of suspected sabotage. The checklist shall be supported by guidance on the course of action to be taken should a bomb or suspicious object be found and information on the least-risk bomb location specific to the aeroplane.

13.3 Training programmes

13.3.1 An operator shall establish and maintain a training programme which enables crew members to act in the most appropriate manner to minimize the consequences of acts of unlawful interference.

13.3.2 An operator shall also establish and maintain a training programme to acquaint appropriate employees with preventive measures and techniques in relation to passengers, baggage, cargo, mail, equipment, stores and supplies intended for carriage on an aeroplane so that they contribute to the prevention of acts of sabotage or other forms of unlawful interference.

13.4 Reporting acts of unlawful interference

Following an act of unlawful interference the pilot-in-command shall submit, without delay, a report of such an act to the designated local authority.

13.5 Miscellaneous

13.5.1 **Recommendation.—** *Specialized means of attenuating and directing the blast should be provided for use at the least-risk bomb location.*

13.5.2 **Recommendation.—** *Where an operator accepts the carriage of weapons removed from passengers, the aeroplane should have provision for stowing such weapons in a place so that they are inaccessible to any person during flight time.*

* In the context of this Chapter, the word "security" is used in the sense of prevention of illicit acts against civil aviation.

APPENDIX. LIGHTS TO BE DISPLAYED BY AEROPLANES

(Note.— See Chapter 6)

1. Terminology

When the following terms are used in this Appendix, they have the following meanings:

Angles of coverage.

a) Angle of coverage A is formed by two intersecting vertical planes making angles of 70 degrees to the right and 70 degrees to the left respectively, looking aft along the longitudinal axis to a vertical plane passing through the longitudinal axis.

b) Angle of coverage F is formed by two intersecting vertical planes making angles of 110 degrees to the right and 110 degrees to the left respectively, looking forward along the longitudinal axis to a vertical plane passing through the longitudinal axis.

c) Angle of coverage L is formed by two intersecting vertical planes, one parallel to the longitudinal axis of the aeroplane, and the other 110 degrees to the left of the first, when looking forward along the longitudinal axis.

d) Angle of coverage R is formed by two intersecting vertical planes, one parallel to the longitudinal axis of the aeroplane, and the other 110 degrees to the right of the first, when looking forward along the longitudinal axis.

Horizontal plane. The plane containing the longitudinal axis and perpendicular to the plane of symmetry of the aeroplane.

Longitudinal axis of the aeroplane. A selected axis parallel to the direction of flight at a normal cruising speed, and passing through the centre of gravity of the aeroplane.

Making way. An aeroplane on the surface of the water is "making way" when it is under way and has a velocity relative to the water.

Under command. An aeroplane on the surface of the water is "under command" when it is able to execute manoeuvres as required by the International Regulations for Preventing Collisions at Sea for the purpose of avoiding other vessels.

Under way. An aeroplane on the surface of the water is "under way" when it is not aground or moored to the ground or to any fixed object on the land or in the water.

Vertical planes. Planes perpendicular to the horizontal plane.

Visible. Visible on a dark night with a clear atmosphere.

2. Navigation lights to be displayed in the air

Note.— The lights specified herein are intended to meet the requirements of Annex 2 for navigation lights.

As illustrated in Figure 1, the following unobstructed navigation lights shall be displayed:

a) a red light projected above and below the horizontal plane through angle of coverage L;

b) a green light projected above and below the horizontal plane through angle of coverage R;

c) a white light projected above and below the horizontal plane rearward through angle of coverage A.

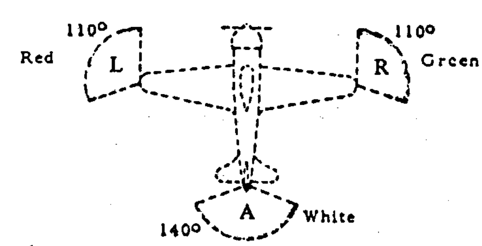


Figure 1

3. Lights to be displayed on the water

3.1 General

Note.— The lights specified herein are intended to meet the requirements of Annex 2 for lights to be displayed by aeroplanes on the water.

The International Regulations for Preventing Collisions at Sea require different lights to be displayed in each of the following circumstances:

a) when under way;

b) when towing another vessel or aeroplane;

c) when being towed;

d) when not under command and not making way;

e) when making way but not under command;

f) when at anchor;

g) when aground.

The lights required by aeroplanes in each case are described below.

3.2 When under way

As illustrated in Figure 2, the following appearing as steady unobstructed lights:

a) a red light projected above and below the horizontal through angle of coverage L;

b) a green light projected above and below the horizontal through angle of coverage R;

c) a white light projected above and below the horizontal through angle of coverage A; and

d) a white light projected through angle of coverage F.

The lights described in a), b) and c) should be visible at a distance of at least 3.7 km (2 NM). The light described in d) should be visible at a distance of 9.3 km (5 NM) when fitted to an aeroplane of 20 m or more in length or visible at a distance of 5.6 km (3 NM) when fitted to an aeroplane of less than 20 m in length.

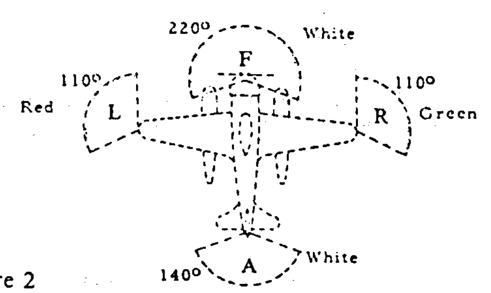


Figure 2

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3.3 When towing another vessel or aeroplane

As illustrated in Figure 3, the following appearing as steady, unobstructed lights:

a) the lights described in 3.2 above;

b) a second light having the same characteristics as the light described in 3.2 d) and mounted in a vertical line at least 2 m above or below it; and

c) a yellow light having otherwise the same characteristics as the light described in 3.2 c) and mounted in a vertical line at least 2 m above it.

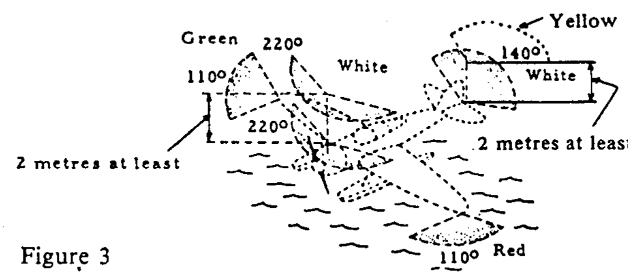


Figure 3

3.4 When being towed

The lights described in 3.2 a), b) and c) appearing as steady, unobstructed lights.

3.5 When not under command and not making way

As illustrated in Figure 4, two steady red lights placed where they can best be seen, one vertically over the other and not less than 1 m apart, and of such a character as to be visible all around the horizon at a distance of at least 3.7 km (2 NM).

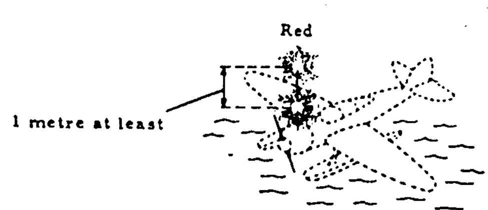


Figure 4

3.6 When making way but not under command

As illustrated in Figure 5, the lights described in 3.5 plus the lights described in 3.2 a), b) and c).

Note.— The display of lights prescribed in 3.5 and 3.6 above is to be taken by other aircraft as signals that the aeroplane showing them is not under command and cannot therefore get out of the way. They are not signals of aeroplanes in distress and requiring assistance.

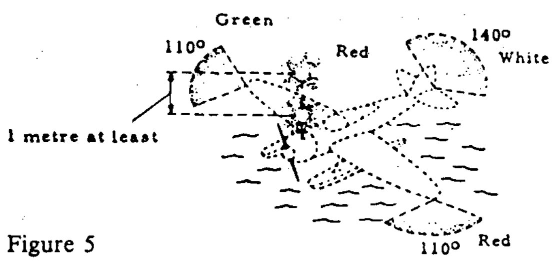


Figure 5

3.7 When at anchor

a) If less than 50 m in length, where it can best be seen, a steady white light (Figure 6), visible all around the horizon at a distance of at least 3.7 km (2 NM).

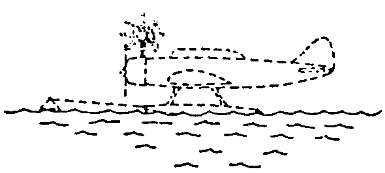


Figure 6

b) If 50 m or more in length, where they can best be seen, a steady white forward light and a steady white rear light (Figure 7) both visible all around the horizon at a distance of at least 5.6 km (3 NM).

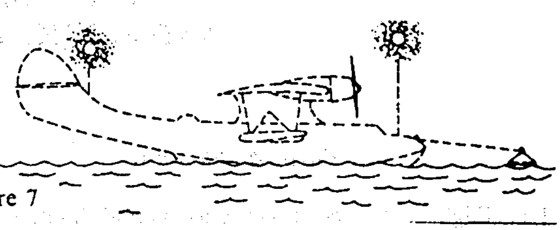
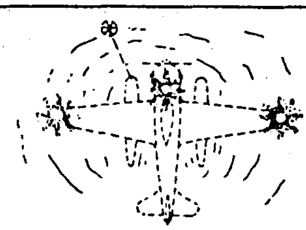


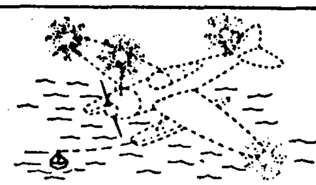
Figure 7

c) If 50 m or more in span a steady white light on each side (Figures 8 and 9) to indicate the maximum span and visible, so far as practicable, all around the horizon at a distance of at least 1.9 km (1 NM).



Less than 50 metres in length; 50 metres or more in span

Figure 8



50 metres or more in length; 50 metres or more in span

Figure 9

3.8 When aground

The lights prescribed in 3.7 and in addition two steady red lights in vertical line, at least 1 m apart so placed as to be visible all around the horizon.

ATTACHMENT A. FLIGHT TIME AND FLIGHT DUTY PERIOD LIMITATIONS

Supplementary to 4.2.10.3

1. Purpose and scope

1.1 Flight time and flight duty period limitations are established for the sole purpose of reducing the probability that fatigue of flight crew members may adversely affect the safety of flight.

1.2 In order to guard against this, two types of fatigue must be taken into account, namely, transient fatigue and cumulative fatigue. Transient fatigue may be described as fatigue which is normally experienced by a healthy individual following a period of work, exertion or excitement, and it is normally dispelled by a single sufficient period of sleep. On the other hand cumulative fatigue may occur after delayed or incomplete recovery from transient fatigue or as the after-effect of more than a normal amount of work, exertion or excitement without sufficient opportunity for recuperation.

1.3 Limitations based on the provisions of this Part will provide safeguards against both kinds of fatigue because they will recognize:

1.3.1 The necessity to limit flight time in such a way as to guard against both kinds of fatigue.

1.3.2 The necessity to limit time spent on duty on the ground immediately prior to a flight or at intermediate points during a series of flights in such a way as to guard particularly against transient fatigue.

1.3.3 The necessity to provide flight crew members with adequate opportunity to recover from fatigue.

1.3.4 The necessity of taking into account other related tasks the flight crew member may be required to perform in order to guard particularly against cumulative fatigue.

2. Definitions

2.1 Flight time

The definition of flight time is of necessity very general but in the context of limitations it is, of course, intended to apply to flight crew members in accordance with the relevant definition of a flight crew member. Pursuant to that latter definition, licensed crew personnel travelling as passengers cannot be considered flight crew members, although this should be taken into account in arranging rest periods.

2.2 Flight duty periods

2.2.1 The definition of flight duty period is intended to cover a continuous period of duty which always includes a flight or a series of flights. It is meant to include all duties a flight crew member may be required to carry out from the moment he reports at his place of employment on the day of a flight until he is relieved of duties, having completed the flight or series of flights. It is considered necessary that this period should be subject to limitations because a flight crew member's activities within the limits of such period would eventually induce fatigue — transient or cumulative — which could endanger the safety of a flight. There is on the other hand (from the point of view of flight safety) insufficient reason to establish limitations for any other time during which a flight crew member is performing a task assigned to him by the operator. Such task should, therefore, only be taken into account when making provisions for rest periods as one among many factors which could lead to fatigue.

2.2.2 The definition does not imply the inclusion of such periods as time taken for a flight crew member to travel from home to the place of employment.

2.2.3 An important safeguard may be established if States and operators recognize the right of a crew member to refuse further flight duty when suffering from fatigue of such a nature as to affect adversely the safety of flight.

2.3 Rest periods

The definition of rest period implies an absence of duty and is intended to be for the purpose of recovering from fatigue; the way in which this recovery is achieved is the responsibility of the individual.

3. Types of limitations

3.1 Limitations are broadly divided by time; for example, the majority of States reporting to ICAO prescribe daily, monthly and yearly flight time limitations, and a considerable number also prescribe quarterly flight time limitations. It will probably be sufficient to prescribe flight duty period limitations on a daily basis. It must be understood, however, that these limitations will vary considerably taking into account a variety of situations.

3.2 In formulating regulations or rules governing flight time limitations the size of the crew complement and the extent to which the various tasks to be performed can be divided among the crew members should be taken into account; and in the case where adequate facilities for relief are provided in the aircraft in such a way that a crew member may have horizontal rest and a degree of privacy, flight duty periods could be extended. Adequate rest facilities on the ground are required at places where relief periods are to be given. Also States or operators should give due weight to the following factors: traffic density; navigational and communication facilities; rhythm of work/sleep cycle; number of landings and take-offs; aircraft handling and performance characteristics and weather conditions.

Note.— Circular 52, Flight Crew Fatigue and Flight Time Limitations, *contains extracts of some States' regulations for implementation of 4.2.10.3 of this Part.*

ATTACHMENT B. FIRST-AID MEDICAL SUPPLIES

Supplementary to 6.2.2 a)

TYPES, NUMBER, LOCATION AND CONTENTS OF MEDICAL SUPPLIES

1. Types

Two types of medical supplies should be provided: first-aid kit(s) for carriage in all aeroplanes and a medical kit for carriage where the aeroplane is authorized to carry more than 250 passengers.

2. Number of first-aid kits

The number of first-aid kits should be appropriate to the number of passengers which the aeroplane is authorized to carry:

Passenger	*First-aid kits*
0 – 50	1
51 – 150	2
151 – 250	3
More than 250	4

3. Location

3.1 It is essential that the required first-aid kits be distributed as evenly as practicable throughout the passenger cabin. They should be readily accessible to cabin attendants, and, in view of the possible use of medical supplies outside the aeroplane in an emergency situation, they should be located near an exit.

3.2 The medical kit, when carried, should be stored in an appropriate secure location.

4. Contents

4.1 Different factors must be taken into consideration in deciding the contents of first-aid kits and medical kits. The following are typical contents of first-aid and medical kits for carriage aboard an aeroplane.

4.1.1 *First-aid kit:*

— a handbook on first aid
— "ground-air visual signal code for use by survivors" as contained in Annex 12
— materials for treating injuries
— ophthalmic ointment
— a decongestant nasal spray
— insect repellant
— emollient eye drops
— sunburn cream
— water-miscible antiseptic/skin cleanser
— materials for treatment of extensive burns
— oral drugs as follows: analgesic, antispasmodic, central nervous system stimulant, circulatory stimulant, coronary vasodilator, antidiarrhoeic and motion sickness medications
— an artificial plastic airway and splints.

4.1.2 *Medical kit:*

Equipment
— one pair of sterile surgical gloves
— sphygmomanometer
— stethoscope
— sterile scissors
— haemostatic forceps
— haemostatic bandages or tourniquet
— sterile equipment for suturing wounds
— disposable syringes and needles
— disposable scalpel handle and blade

Drugs
— coronary vasodilators
— analgesics
— diuretics
— anti-allergics
— steroids
— sedatives
— ergometrine
— where compatible with regulations of the appropriate authority, a narcotic drug in injectable form
— injectable broncho dilator.

Note.— The United Nations Conference for Adoption of a Single Convention on Narcotic Drugs in March 1961 adopted such a Convention, Article 32 of which contains special provisions concerning the carriage of drugs in medical kits of aircraft engaged in international flight.

ATTACHMENT C. AEROPLANE PERFORMANCE OPERATING LIMITATIONS

Example 1

Purpose and scope

The purpose of the following example is to illustrate the level of performance intended by the provisions of Chapter 5 as applicable to the types of aeroplanes described below.

The Standards and Recommended Practices in Annex 6 effective on 14 July 1949 contained specifications similar to those adopted by some Contracting States for inclusion in their national performance codes. A very substantial number of civil transport aeroplanes have been manufactured and are being operated in accordance with these codes. Those aeroplanes are powered with reciprocating engines including turbo-compound design. They embrace twin-engined and four-engined aeroplanes over a mass range from approximately 4 200 kg to 70 000 kg over a stalling speed range, V_{S_0} from approximately 100 to 175 km/h (55 to 95 kt) and over a wing loading range from approximately 120 to 360 kg/m^2. Cruising speeds range over 555 km/h (300 kt). Those aeroplanes have been used in a very wide range of altitude, air temperature and humidity conditions. At a later date, the code was applied with respect to the evaluation of certification of the so-called "first generation" of turboprop and turbo-jet aeroplanes.

Although only past experience can warrant the fact that this example illustrates the level of performance intended by the Standards and Recommended Practices of Chapter 5, it is considered to be applicable over a wide range of aeroplane characteristics and atmospheric conditions. Reservation should however be made concerning the application of this example with respect to conditions of high air temperatures. In certain extreme cases, it has been found desirable to apply additional temperature and/or humidity accountability, particularly for the obstacle limited take-off flight path.

This example is not intended for application to aeroplanes having short take-off and landing (STOL) or vertical take-off and landing (VTOL) capabilities.

No detailed study has been made of the applicability of this example to operations in all-weather conditions. The validity of this example has not therefore been established for operations which may involve low decision heights and be associated with low minima operating techniques and procedures.

1. Definitions

CAS (Calibrated airspeed). The calibrated airspeed is equal to the airspeed indicator reading corrected for position and instrument error. (As a result of the sea level adiabatic compressible flow correction to the airspeed instrument dial, CAS is equal to the true airspeed (TAS) in Standard Atmosphere at sea level.)

Declared distances.

a) *Take-off run available (TORA).* The length of runway declared available and suitable for the ground run of an aeroplane taking off.

b) *Take-off distance available (TODA).* The length of the take-off run available plus the length of the clearway, if provided.

c) *Accelerate-stop distance available (ASDA).* The length of the take-off run available plus the length of the stopway, if provided.

d) *Landing distance available (LDA).* The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Note.— The calculation of declared distances is described in Annex 14, Attachment A.

Height. The vertical distance of a level, a point, or an object considered as a point, measured from a specified datum.

Note.— For the purposes of this example, the point referred to above is the lowest part of the aeroplane and the specified datum is the take-off or landing surface, whichever is applicable.

Landing surface. That part of the surface of an aerodrome, which the aerodrome authority has declared available for the normal ground or water run of aircraft landing in a particular direction.

Take-off surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft taking off in a particular direction.

V_{S_0}. A stalling speed or minimum steady flight speed in the landing configuration. *(Note.— See 2.4.)*

V_{S_1}. A stalling speed or minimum steady flight speed. *(Note.— See 2.5.)*

Note.— See Chapter 1 and Annexes 8 and 14 for other definitions.

2. Stalling speed — minimum steady flight speed

2.1 For the purpose of this example, the stalling speed is the speed at which an angle of attack greater than that of maximum lift is reached, or, if greater, the speed at which a large amplitude pitching or rolling motion, not immediately controllable, is encountered, when the manoeuvre described in 2.3 is executed.

Note.— It should be noted that an uncontrollable pitching motion of small amplitude associated with pre-stall buffeting does not necessarily indicate that the stalling speed has been reached.

2.2 The minimum steady flight speed is that obtained while maintaining the elevator control in the most rearward possible position when the manoeuvre described in 2.3 is executed. This speed would not apply when the stalling speed defined in 2.1 occurs before the elevator control reaches its stops.

2.3 Determination of stalling speed — Minimum steady flight speed

2.3.1 The aeroplane is trimmed for a speed of approximately $1.4V_{S_1}$. From a value sufficiently above the stalling speed to ensure that a steady rate of decrease is obtainable, the speed is reduced in straight flight at a rate not exceeding 0.5 m/s^2 (1 kt/s) until the stalling speed or the minimum steady flight speed, defined in 2.1 and 2.2, is reached.

2.3.2 For the purpose of measuring stalling speed and minimum steady flight speed, the instrumentation is such that the probable error of measurement is known.

2.4 V_{S_0}

V_{S_0} denotes the stalling speed if obtained in flight tests conducted in accordance with 2.3, or the minimum steady flight speed, CAS, as defined in 2.2, with:

a) engines at not more than sufficient power for zero thrust at a speed not greater than 110 per cent of the stalling speed;

b) propeller pitch controls in the position recommended for normal use during take-off;

c) landing gear extended;

d) wing flaps in the landing position;

e) cowl flaps and radiator shutters closed or nearly closed;

f) centre of gravity in that position within the permissible landing range which gives the maximum value of stalling speed or of minimum steady flight speed;

g) aeroplane mass equal to the mass involved in the specification under consideration.

2.5 V_{S_1}

V_{S_1} denotes the stalling speed if obtained in flight tests conducted in accordance with 2.3, or the minimum steady flight speed, CAS, as defined in 2.2, with:

a) engines at not more than sufficient power for zero thrust at a speed not greater than 110 per cent of the stalling speed;

b) propeller pitch controls in the position recommended for normal use during take-off;

c) aeroplane in the configuration in all other respects and at the mass prescribed in the specification under consideration.

3. Take-off

3.1 Mass

The mass of the aeroplane at take-off is not to exceed the maximum take-off mass specified in the flight manual for the altitude at which the take-off is to be made.

3.2 Performance

The performance of the aeroplane as determined from the information contained in the flight manual is such that:

a) the accelerate-stop distance required does not exceed the accelerate-stop distance available;

b) the take-off distance required does not exceed the take-off distance available;

c) the take-off path provides a vertical clearance of not less than 15.2 m up to D = 500 m (50 ft up to D = 1 500 ft) and 15.2 + 0.01 [D – 500] m (50 + 0.01 [D – 1 500] ft) thereafter, above all obstacles lying within 60 m plus half the wing span of the aeroplane plus 0.125D on either side of the flight path, except that obstacles lying beyond 1 500 m on either side of the flight path need not be cleared.

The distance D is the horizontal distance that the aeroplane has travelled from the end of the take-off distance available.

Note.— This need not be carried beyond the point at which the aeroplane would be able, without further gaining in height, to commence a landing procedure at the aerodrome of take-off or, alternatively, has attained the minimum safe altitude for commencing flight to another aerodrome.

However, the lateral obstacle clearance is liable to be reduced (below the values stated above) when, and to the extent that, this is warranted by special provisions or conditions which assist the pilot to avoid inadvertent lateral deviations from the intended flight path. For example, particularly in poor weather conditions, a precise radio aid may assist the pilot to maintain the intended flight path. Also, when the take-off is made in sufficiently good visibility conditions, it may, in some cases, be possible to avoid obstacles which are clearly visible but may be within the lateral limits noted in c) above.

Note 1.— The procedures used in defining the accelerate-stop distance required, the take-off distance required and the take-off flight path are described in the Appendix to this example.

Note 2.— In some national codes similar to this example, the specification for "performance" at take-off is such that no credit can be taken for any increase in length of accelerate-stop distance available and take-off distance available beyond the length specified in Section 1 for take-off run available. Those codes specify a vertical clearance of not less than 15.2 m (50 ft) above all obstacles lying within 60 m on either side of the flight path while still within the confines of the aerodrome, and 90 m on either side of the flight path when outside those confines. It is to be observed that those codes are such that they do not provide for an alternative to the method of elements (see the Appendix to this example) in the determination of the take-off path. It is considered that those codes are compatible with the general intent of this example.

3.3 Conditions

For the purpose of 3.1 and 3.2, the performance is that corresponding to:

a) the mass of the aeroplane at the start of take-off;

b) an altitude equal to the elevation of the aerodrome;

and for the purpose of 3.2:

c) the ambient temperature at the time of take-off for 3.2 a) and b) only;

d) the runway slope in the direction of take-off (landplanes);

e) not more than 50 per cent of the reported wind component opposite to the direction of take-off, and not less than 150 per cent of the reported wind component in the direction of take-off. In certain cases of operation of seaplanes, it has been found necessary to take account of the reported wind component normal to the direction of take-off.

3.4 Critical point

In applying 3.2 the critical point chosen for establishing compliance with 3.2 a) is not nearer to the starting point than that used for establishing compliance with 3.2 b) and 3.2 c).

3.5 Turns

In case the flight path includes a turn with bank greater than 15 degrees, the clearances specified in 3.2 c) are increased by an adequate amount during the turn, and the distance D is measured along the intended track.

4. En route

4.1 One power-unit inoperative

4.1.1 At all points along the route or planned diversion therefrom, the aeroplane is capable, at the minimum flight altitudes en route, of a steady rate of climb with one power-unit inoperative, as determined from the flight manual, of at least

1) $K\left(\frac{V_{S_0}}{185.2}\right)^2$ m/s, V_{S_0} being expressed in km/h;

2) $K\left(\frac{V_{S_0}}{100}\right)^2$ m/s, V_{S_0} being expressed in kt;

3) $K\left(\frac{V_{S_0}}{100}\right)^2$ ft/min, V_{S_0} being expressed in kt;

and K having the following value:

$K = 4.04 - \frac{5.40}{N}$ in the case of 1) and 2); and

$K = 797 - \frac{1\ 060}{N}$ in the case of 3)

where N is the number of power units installed.

It should be noted that minimum flight altitudes are usually considered to be not less than 300 m (1 000 ft) above terrain along and adjacent to the flight path.

4.1.2 As an alternative to 4.1.1 the aeroplane is operated at an all power-unit operating altitude such that, in the event of a power-unit failure, it is possible to continue the flight to an aerodrome where a landing can be made in accordance with 5.3, the flight path clearing all terrain and obstructions along the route within 8 km (4.3 NM) on either side of the intended track by at least 600 m (2 000 ft). In addition, if such a procedure is utilized, the following provisions are complied with:

a) the rate of climb, as determined from the flight manual for the appropriate mass and altitude, used in calculating the flight path is diminished by an amount equal to

1) $K \left(\frac{V_{S_0}}{185.2}\right)^2$ m/s, V_{S_0} being expressed in km/h;

2) $K \left(\frac{V_{S_0}}{100}\right)^2$ m/s, V_{S_0} being expressed in kt;

3) $K \left(\frac{V_{S_0}}{100}\right)^2$ ft/min, V_{S_0} being expressed in kt;

and K having the following value:

$K = 4.04 - \frac{5.40}{N}$ in the case of 1) and 2); and

$K = 797 - \frac{1\ 060}{N}$ in the case of 3)

where N is the number of power units installed;

b) the aeroplane complies with 4.1.1 at 300 m (1 000 ft) above the aerodrome used as an alternate in this procedure;

c) after the power-unit failure considered, account is taken of the effect of winds and temperatures on the flight path;

d) it is assumed that the mass of the aeroplane as it proceeds along its intended track is progressively reduced by normal consumption of fuel and oil;

e) it is customary to assume such fuel jettisoning as is consistent with reaching the aerodrome in question.

4.2 Two power-units inoperative
(applicable only to aeroplanes with four power-units)

The possibility of two power-units becoming inoperative when the aeroplane is more than 90 minutes at all power-units operating cruising speed from an en-route alternate aerodrome is catered for. This is done by verifying that at whatever such point such a double failure may occur, the aeroplane in the configuration and with the engine power specified in the flight manual can thereafter reach the alternate aerodrome without coming below the minimum flight altitude. It is customary to assume such fuel jettisoning as is consistent with reaching the aerodrome in question.

5. Landing

5.1 Mass

The calculated mass for the expected time of landing at the aerodrome of intended landing or any destination alternate aerodrome is not to exceed the maximum specified in the flight manual for the elevation of that aerodrome.

5.2 Landing distance

5.2.1 *Aerodrome of intended landing*

The landing distance at the aerodrome of the intended landing, as determined from the flight manual, is not to exceed 60 per cent of the landing distance available on:

a) the most suitable landing surface for a landing in still air; and, if more severe,

b) any other landing surface that may be required for landing because of expected wind conditions at the time of arrival.

5.2.2 *Alternate aerodromes*

The landing distance at any alternate aerodrome, as determined from the flight manual, is not to exceed 70 per cent of the landing distance available on:

a) the most suitable landing surface for a landing in still air; and, if more severe,

b) any other landing surface that may be required for landing because of expected wind conditions at the time of arrival.

Note.— The procedure used in determining the landing distance is described in the Appendix to this example.

5.3 Conditions

For the purpose of 5.2, the landing distances are not to exceed those corresponding to:

a) the calculated mass of the aeroplane for the expected time of landing;

b) an altitude equal to the elevation of the aerodrome;

c) for the purpose of 5.2.1 a) and 5.2.2 a), still air;

d) for the purpose of 5.2.1 b) and 5.2.2 b), not more than 50 per cent of the expected wind component along the landing path and opposite to the direction of landing and not less than 150 per cent of the expected wind component in the direction of landing.

APPENDIX TO EXAMPLE 1 ON AEROPLANE PERFORMANCE OPERATING LIMITATIONS — PROCEDURES USED IN DETERMINING TAKE-OFF AND LANDING PERFORMANCE

1. General

1.1 Unless otherwise specified, Standard Atmosphere and still air conditions are applied.

1.2 Engine powers are based on a water vapour pressure corresponding to 80 per cent relative humidity in standard conditions. When performance is established for temperature above standard, the water vapour pressure for a given altitude is assumed to remain at the value stated above for standard atmospheric conditions.

1.3 Each set of performance data required for a particular flight condition is determined with the powerplant accessories absorbing the normal amount of power appropriate to that flight condition.

1.4 Various wing flap positions are selected. These positions are permitted to be made variable with mass, altitude and temperature in so far as this is considered consistent with acceptable operating practices.

1.5 The position of the centre of gravity is selected within the permissible range so that the performance achieved in the configuration and power indicated in the specification under consideration is a minimum.

1.6 The performance of the aeroplane is determined in such a manner that under all conditions the approved limitations for the powerplant are not exceeded.

1.7 The determined performance is so scheduled that it can serve directly in showing compliance with the aeroplane performance operating limitations.

2. Take-off

2.1 General

2.1.1 The take-off performance data are determined:

a) for the following conditions:

1) sea level;

2) aeroplane mass equal to the maximum take-off mass at sea level;

3) level, smooth, dry and hard take-off surfaces (landplanes);

4) smooth water of declared density (seaplanes);

b) over selected ranges of the following variables:

1) atmospheric conditions, namely: altitude and also pressure-altitude and temperature;

2) aeroplane mass;

3) steady wind velocity parallel to the direction of take-off;

4) steady wind velocity normal to the direction of take-off (seaplanes);

5) uniform take-off surface slope (landplanes);

6) type of take-off surface (landplanes);

7) water surface condition (seaplanes);

8) density of water (seaplanes);

9) strength of current (seaplanes).

2.1.2 The methods of correcting the performance data to obtain data for adverse atmospheric conditions include appropriate allowance for any increased airspeeds and cowl flap or radiator shutter openings necessary under such conditions to maintain engine temperatures within appropriate limits.

2.1.3 For seaplanes appropriate interpretations of the term landing gear, etc., are made to provide for the operation of retractable floats, if employed.

2.2 Take-off safety speed

2.2.1 The take-off safety speed is an airspeed (CAS) so selected that it is not less than:

a) $1.20V_{S_1}$, for aeroplanes with two power-units;

b) $1.15V_{S_1}$, for aeroplanes having more than two power-units;

c) 1.10 times the minimum control speed, V_{MC} established as prescribed in 2.3;

where V_{S_1} is appropriate to the configuration, as described in 2.3.1 b), c) and d).

2.3 Minimum control speed

2.3.1 The minimum control speed, V_{MC}, is determined not to exceed a speed equal to $1.2V_{S_1}$, where V_{S_1} corresponds with the maximum certificated take-off mass with:

a) maximum take-off power on all power-units;

b) landing gear retracted;

c) wing flaps in take-off position;

d) cowl flaps and radiator shutters in the position recommended for normal use during take-off;

e) aeroplane trimmed for take-off;

f) aeroplane airborne and ground effect negligible.

2.3.2 The minimum control speed is such that, when any one power-unit is made inoperative at that speed, it is possible to recover control of the aeroplane with the one power-unit still inoperative and to maintain the aeroplane in straight flight at that speed either with zero yaw or with a bank not in excess of 5 degrees.

2.3.3 From the time at which the power-unit is made inoperative to the time at which recovery is complete, exceptional skill, alertness, or strength on the part of the pilot is not required to prevent any loss of altitude other than that implicit in the loss of performance or any change of heading in excess of 20 degrees, nor does the aeroplane assume any dangerous attitude.

2.3.4 It is demonstrated that to maintain the aeroplane in steady straight flight at this speed after recovery and before retrimming does not require a rudder control force exceeding 800 N and does not make it necessary for the flight crew to reduce the power of the remaining power-units.

2.4 Critical point

2.4.1 The critical point is a selected point at which, for the purpose of determining the accelerate-stop distance and the take-off path, failure of the critical power-unit is assumed to occur. The pilot is provided with a ready and reliable means of determining when the critical point has been reached.

2.4.2 If the critical point is located so that the airspeed at that point is less than the take-off safety speed, it is demonstrated that, in the event of sudden failure of the critical power-unit at all speeds down to the lowest speed corresponding with the critical point, the aeroplane is controllable satisfactorily and that the take-off can be continued safely, using normal piloting skill, without reducing the thrust of the remaining power-units.

2.5 Accelerate-stop distance required

2.5.1 The accelerate-stop distance required is the distance required to reach the critical point from a standing start and, assuming the critical power-unit to fail suddenly at this point, to stop if a landplane, or to bring the aeroplane to a speed of approximately 6 km/h (3 kt) if a seaplane.

2.5.2 Use of braking means in addition to, or in lieu of, wheel brakes is permitted in determining this distance, provided that they are reliable and that the manner of their employment is such that consistent results can be expected under normal conditions of operation, and provided that exceptional skill is not required to control the aeroplane.

2.5.3 The landing gear remains extended throughout this distance.

2.6 Take-off path

2.6.1 *General*

2.6.1.1 The take-off path is determined either by the method of elements, 2.6.2, or by the continuous method, 2.6.3, or by any acceptable combination of the two.

2.6.1.2 Adjustment of the provisions of 2.6.2.1 c) 1) and 2.6.3.1 c) is permitted when the take-off path would be affected by the use of an automatic pitch changing device, provided that a level of performance safety exemplified by 2.6 is demonstrated.

2.6.2 *Method of elements*

2.6.2.1 In order to define the take-off path, the following elements are determined:

a) The distance required to accelerate the aeroplane from a standing start to the point at which the take-off safety speed is first attained, subject to the following provisions:

1) the critical power-unit is made inoperative at the critical point;

2) the aeroplane remains on or close to the ground;

3) the landing gear remains extended.

b) The horizontal distance traversed and the height attained by the aeroplane operating at the take-off safety speed during the time required to retract the landing gear, retraction being initiated at the end of a) with:

1) the critical power-unit inoperative, its propeller windmilling, and the propeller pitch control in the position recommended for normal use during take-off, except that, if the completion of the retraction of the landing gear occurs later than the completion of the stopping of the propeller initiated in accordance with c) 1), the propeller may be assumed to be stopped throughout the remainder of the time required to retract the landing gear;

2) the landing gear extended.

c) When the completion of the retraction of the landing gear occurs earlier than the completion of the stopping of the propeller, the horizontal distance traversed and the height attained by the aeroplane in the time elapsed from the end of b) until the rotation of the inoperative propeller has been stopped, when:

1) the operation of stopping the propeller is initiated not earlier than the instant the aeroplane has attained a total height of 15.2 m (50 ft) above the take-off surface;

2) the aeroplane speed is equal to the take-off safety speed;

3) the landing gear is retracted;

4) the inoperative propeller is windmilling with the propeller pitch control in the position recommended for normal use during take-off.

d) The horizontal distance traversed and the height attained by the aeroplane in the time elapsed from the end of c) until the time limit on the use of take-off power is reached, while operating at the take-off safety speed, with:

1) the inoperative propeller stopped;

2) the landing gear retracted.

The elapsed time from the start of the take-off need not extend beyond a total of 5 minutes.

e) The slope of the flight path with the aeroplane in the configuration prescribed in d) and with the remaining power-unit(s) operating within the maximum continuous power limitations, where the time limit on the use of take-off power is less than 5 minutes.

2.6.2.2 If satisfactory data are available, the variations in drag of the propeller during feathering and of the landing gear throughout the period of retraction are permitted to be taken into account in determining the appropriate portions of the elements.

2.6.2.3 During the take-off and subsequent climb represented by the elements, the wing flap control setting is not changed, except that changes made before the critical point has been reached, and not earlier than 1 minute after the critical point has been passed, are permitted: in this case, it is demonstrated that such changes can be accomplished without undue skill, concentration, or effort on the part of the pilot.

2.6.3 *Continuous method*

2.6.3.1 The take-off path is determined from an actual take-off during which:

a) the critical power-unit is made inoperative at the critical point;

b) the climb-away is not initiated until the take-off safety speed has been reached and the airspeed does not fall below this value in the subsequent climb;

c) retraction of the landing gear is not initiated before the aeroplane reaches the take-off safety speed;

d) the wing flap control setting is not changed, except that changes made before the critical point has been reached, and not earlier than 1 minute after the critical point has been passed, are permitted; in this case, it is demonstrated that such changes can be accomplished without undue skill, concentration, or effort on the part of the pilot;

e) the operation of stopping the propeller is not initiated until the aeroplane has cleared a point 15.2 m (50 ft) above the take-off surface.

2.6.3.2 Suitable methods are provided and employed to take into account, and to correct for, any vertical gradient of wind velocity which may exist during the take-off.

2.7 Take-off distance required

The take-off distance required is the horizontal distance along the take-off flight path from the start of the take-off to a point where the aeroplane attains a height of 15.2 m (50 ft) above the take-off surface.

2.8 Temperature accountability

Operating correction factors for take-off mass and take-off distance are determined to account for temperature above and below those of the Standard Atmosphere. These factors are obtained as follows:

a) For any specific aeroplane type the average full temperature accountability is computed for the range of mass and altitudes above sea level, and for ambient temperatures expected in operation. Account is taken of the temperature effect both on the aerodynamic characteristics of the aeroplane and on the engine power. The full temperature accountability is expressed per degree of temperature in terms of a mass correction, a take-off distance correction and a change, if any, in the position of the critical point.

b) Where 2.6.2 is used to determine the take-off path, the operating correction factors for the aeroplane mass and take-off distance are at least one half of the full accountability values. Where 2.6.3 is used to determine the take-off path, the operating correction factors for the aeroplane mass and take-off distance are equal to the full accountability values. With both methods, the position of the critical point is further corrected by the average amount necessary to assure that the aeroplane can stop within the runway length at the ambient temperature, except that the speed at the critical point is not less than a minimum at which the aeroplane can be controlled with the critical power-unit inoperative.

3. Landing

3.1 General

3.1.1 The landing performance is determined:

a) for the following conditions:

1) sea level;

2) aeroplane mass equal to the maximum landing mass at sea level;

3) level, smooth, dry and hard landing surfaces (landplanes);

4) smooth water of declared density (seaplanes);

b) over selected ranges of the following variables:

1) atmospheric conditions, namely: altitude and also pressure-altitude and temperature;

2) aeroplane mass;

3) steady wind velocity parallel to the direction of landing;

4) uniform landing-surface slope (landplanes);

5) type of landing surface (landplanes);

6) water surface condition (seaplanes);

7) density of water (seaplanes);

8) strength of current (seaplanes).

3.2 Landing distance

3.2.1 The landing distance is the horizontal distance between that point on the landing surface at which the aeroplane is brought to a complete stop or, for seaplanes, to a speed of approximately 6 km/h (3 kt) and that point on the landing surface which the aeroplane cleared by 15.2 m (50 ft).

3.3 Landing technique

3.3.1 In determining the landing distance:

a) immediately before reaching the 15.2 m (50 ft) height, a steady approach is maintained, landing gear fully extended, with an airspeed of not less than $1.3V_{S_0}$;

b) the nose of the aeroplane is not depressed in flight nor the forward thrust increased by application of engine power after reaching the 15.2 m (50 ft) height;

c) the wing flap control is set in the landing position, and remains constant during the final approach, flare out and touch down, and on the landing surface at air speeds above $0.9V_{S_0}$. When the aeroplane is on the landing surface and the airspeed has fallen to less than $0.9V_{S_0}$, change of the wing-flap-control setting is permitted;

d) the landing is made in a manner such that there is no excessive vertical acceleration, no excessive tendency to bounce, and no display of any uncontrollable or otherwise undesirable ground (water) handling characteristics, and such that its repetition does not require either an exceptional degree of skill on the part of the pilot, or exceptionally favourable conditions;

e) wheel brakes are not used in a manner such as to produce excessive wear of brakes or tires, and the operating pressures on the braking system are not in excess of those approved.

3.3.2 In addition to, or in lieu of, wheel brakes, other reliable braking means are permitted to be used in determining the landing distance, provided that the manner of their employment is such that consistent results can be expected under normal conditions of operation and that exceptional skill is not required to control the aeroplane.

3.3.3 The gradient of the steady approach and the details of the technique used in determining the landing distance, together with such variations in the technique as are recommended for landing with the critical power-units inoperative, and any appreciable variation in landing distance resulting therefrom, are entered in the flight manual.

Example 2

Purpose and scope

The purpose of the following example is to illustrate the level of performance intended by the provisions of Chapter 5 as applicable to the types of aeroplanes described below.

This material was contained in substance in Attachment A to the now superseded edition of Annex 6 which became effective on 1 May 1953. It is based on the type of requirements developed by the Standing Committee on Performance* with such detailed changes as are necessary to make it reflect as closely as possible a performance code that has been used nationally.

A substantial number of civil transport aeroplanes have been manufactured and are being operated in accordance with these codes. Those aeroplanes are powered with reciprocating engines, turbo-propellers and turbo-jets. They embrace twin-engined and four-engined aeroplanes over a mass range from approximately 5 500 kg to 70 000 kg over a stalling speed range, V_{S_0}, from approximately 110 to 170 km/h (60 to 90 kt) and over a wing loading range from approximately 120 to 350 kg/m^2. Cruising speeds range up to 740 km/h (400 kt). Those aeroplanes have been used in a very wide range of altitude, air temperature and humidity conditions.

Although only past experience can warrant the fact that this example illustrates the level of performance intended by the Standards and Recommended Practices of Chapter 5, it is considered to be applicable, except for some variations in detail as necessary to fit particular cases, over a much wider range of aeroplane characteristics. Reservation should, however, be made concerning one point. The landing distance specification of this example, not being derived from the same method as other specifications, is valid only for the range of conditions stated for Example 1 in this Attachment.

This example is not intended for application to aeroplanes having short take-off and landing (STOL) or vertical take-off and landing (VTOL) capabilities.

No detailed study has been made of the applicability of this example to operations in all-weather conditions. The validity of this example has not therefore been established for operations which may involve low decision heights and be associated with low weather minima operating techniques and procedures.

1. Definitions

Declared distances.

a) *Take-off run available (TORA).* The length of runway declared available and suitable for the ground run of an aeroplane taking off.

b) *Take-off distance available (TODA).* The length of the take-off run available plus the length of the clearway, if provided.

* The ICAO Standing Committee on Performance, established as a result of recommendations of the Airworthiness and Operations Divisions at their Fourth Sessions, in 1951, met four times between 1951 and 1953. Its Final Report is Doc 7401-AIR/OPS/612.

c) *Accelerate-stop distance available (ASDA).* The length of the take-off run available plus the length of the stopway, if provided.

d) *Landing distance available (LDA).* The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Note.— The calculation of declared distances is described in Annex 14, Attachment A.

Declared temperature. A temperature selected in such a way that when used for performance purposes, over a series of operations, the average level of safety is not less than would be obtained by using official forecast temperatures.

Expected. Used in relation to various aspects of performance (e.g. rate or gradient of climb) this term means the standard performance for the type, in the relevant conditions (e.g. mass, altitude and temperature).

Height. The vertical distance of a level, a point, or an object considered as a point, measured from a specified datum.

Note.— For the purposes of this example, the point referred to above is the lowest part of the aeroplane and the specified datum is the take-off or landing surface, whichever is applicable.

Landing surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft landing in a particular direction.

Net gradient. The net gradient of climb throughout these requirements is the expected gradient of climb diminished by the manoeuvre performance (i.e. that gradient of climb necessary to provide power to manoeuvre) and by the margin (i.e. that gradient of climb necessary to provide for those variations in performance which are not expected to be taken explicit account of operationally).

Reference humidity. The relationship between temperature and reference humidity is defined as follows:

— at temperatures at and below ISA, 80 per cent relative humidity,

— at temperatures at and above ISA + 28°C, 34 per cent relative humidity,

— at temperatures between ISA and ISA + 28°C, the relative humidity varies linearly between the humidity specified for those temperatures.

Take-off surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft taking off in a particular direction.

TAS (True airspeed). The speed of the aeroplane relative to undisturbed air.

Note.— See Chapter 1 and Annexes 8 and 14 for other definitions.

2. Take-off

2.1 Mass

The mass of the aeroplane at take-off is not to exceed the maximum take-off mass specified in the flight manual for the altitude and temperature at which the take-off is to be made.

2.2 Performance

The performance of the aeroplane, as determined from the information contained in the flight manual, is such that:

a) the accelerate-stop distance required does not exceed the accelerate-stop distance available;

b) the take-off run required does not exceed the take-off run available;

c) the take-off distance required does not exceed the take-off distance available;

d) the net take-off flight path starting at a point 10.7 m (35 ft) above the ground at the end of the take-off distance required provides a vertical clearance of not less than 6 m (20 ft) plus 0.005D above all obstacles lying within 60 m plus half the wing span of the aeroplane plus 0.125D on either side of the intended track until the relevant altitude laid down in the operations manual for an en-route flight has been attained; except that obstacles lying beyond 1 500 m on either side of the flight path need not be cleared.

The distance D is the horizontal distance that the aeroplane has travelled from the end of the take-off distance available.

Note.— This need not be carried beyond the point at which the aeroplane would be able, without further gaining in height, to commence a landing procedure at the aerodrome of take-off or, alternatively, has attained the minimum safe altitude for commencing flight to another aerodrome.

However, the lateral obstacle clearance is liable to be reduced (below the values stated above) when, and to the extent that, this is warranted by special provisions or conditions which assist the pilot to avoid inadvertent lateral deviations from the intended flight path. For example, particularly in poor weather conditions, a precise radio aid may assist the pilot to maintain the intended flight path. Also, when the take-off is made in sufficiently good visibility conditions, it may, in some cases, be possible to avoid obstacles which are clearly visible but may be within the lateral limits noted in d) above.

Note.— The procedures used in determining the accelerate-stop distance required, the take-off run required, the take-off distance required and the net take-off flight path are described in the Appendix to this example.

2.3 Conditions

For the purpose of 2.1 and 2.2, the performance is that corresponding to:

a) the mass of the aeroplane at the start of take-off;

b) an altitude equal to the elevation of the aerodrome;

c) either the ambient temperature at the time of take-off, or a declared temperature giving an equivalent average level of performance;

and for the purpose of 2.2:

d) the surface slope in the direction of take-off (land-planes);

e) not more than 50 per cent of the reported wind component opposite to the direction of take-off, and not less than 150 per cent of the reported wind component in the direction of take-off. In certain cases of operation of seaplanes, it has been found necessary to take account of the reported wind component normal to the direction of take-off.

2.4 Power failure point

In applying 2.2 the power failure point chosen for establishing compliance with 2.2 a) is not nearer to the starting point than that used for establishing compliance with 2.2 b) and 2.2 c).

2.5 Turns

The net take-off flight path may include turns, provided that:

a) the radius of steady turn assumed is not less than that scheduled for this purpose in the flight manual;

b) if the planned change of direction of the take-off flight path exceeds 15 degrees, the clearance of the net take-off flight path above obstacles is at least 30 m (100 ft) during and after the turn, and the appropriate allowance, as prescribed in the flight manual, is made for the reduction in assumed gradient of climb during the turn;

c) the distance D is measured along the intended track.

3. En route

3.1 All power-units operating

At each point along the route and planned diversion therefrom, the all power-units operating performance ceiling appropriate to the aeroplane mass at that point, taking into account the amount of fuel and oil expected to be consumed, is not less than the minimum altitude (see 4.2.6 of this Part) or, if greater, the planned altitude which it is intended to maintain with all power-units operating, in order to ensure compliance with 3.2 and 3.3.

3.2 One power-unit inoperative

From each point along the route and planned diversions therefrom, it is possible in the event of one power-unit becoming inoperative to continue the flight to an en-route alternate aerodrome where a landing can be made in accordance with 4.2 and, on arrival at the aerodrome, the net gradient of climb is not less than zero at a height of 450 m (1 500 ft) above the elevation of the aerodrome.

3.3 Two power-units inoperative
(applicable only to aeroplanes with four power-units)

For each point along the route or planned diversions therefrom, at which the aeroplane is more than 90 minutes' flying time at all power-units operating cruising speed from an en-route alternate aerodrome, the two power-units inoperative net flight path is such that a height of at least 300 m (1 000 ft) above terrain can be maintained until arrival at such an aerodrome.

Note.— The net flight path is that attainable from the expected gradient of climb or descent diminished by 0.2 per cent.

3.4 Conditions

The ability to comply with 3.1, 3.2 and 3.3 is assessed:

a) either on the basis of forecast temperatures, or on the basis of declared temperatures giving an equivalent average level of performance;

b) on the forecast data on wind velocity versus altitude and locality assumed for the flight plan as a whole;

c) in the case of 3.2 and 3.3, on the scheduled gradient of climb or gradient of descent after power failure appropriate to the mass and altitude at each point considered;

d) on the basis that, if the aeroplane is expected to gain altitude at some point in the flight after power failure has occurred, a satisfactory positive net gradient of climb is available;

e) in the case of 3.2 on the basis that the minimum altitude (see 4.2.6 of this Part), appropriate to each point between the place at which power failure is assumed to occur and the aerodrome at which it is intended to alight, is exceeded;

f) in the case of 3.2, making reasonable allowance for indecision and navigational error in the event of power-unit failure at any point.

4. Landing

4.1 Mass

The calculated mass for the expected time of landing at the aerodrome of intended landing or any destination alternate aerodrome is not to exceed the maximum specified in the flight manual for the altitude and temperature at which the landing is to be made.

4.2 Landing distance required

The landing distance required at the aerodrome of the intended landing or at any alternate aerodrome, as determined from the flight manual, is not to exceed the landing distance available on:

a) the most suitable landing surface for a landing in still air; and, if more severe,

b) any other landing surface that may be required for landing because of expected wind conditions at the time of arrival.

4.3 Conditions

For the purpose of 4.2, the landing distance required is that corresponding to:

a) the calculated mass of the aeroplane for the expected time of landing;

b) an altitude equal to the elevation of the aerodrome;

c) the expected temperature at which landing is to be made or a declared temperature giving an equivalent average level of performance;

d) the surface slope in the direction of landing;

e) for the purpose of 4.2 a), still air;

f) for the purpose of 4.2 b), not more than 50 per cent of the expected wind component along the landing path and opposite to the direction of landing and not less than 150 per cent of the expected wind component in the direction of landing.

APPENDIX TO EXAMPLE 2 ON AEROPLANE PERFORMANCE OPERATING LIMITATIONS — PROCEDURES USED IN DETERMINING TAKE-OFF AND LANDING PERFORMANCE

1. General

1.1 Unless otherwise stated, reference humidity and still air conditions are applied.

1.2 The performance of the aeroplane is determined in such a manner that the approved airworthiness limitations for the aeroplane and its systems are not exceeded.

1.3 The wing flap positions for showing compliance with the performance specifications are selected.

Note.— Alternative wing flap positions are made available, if so desired, in such a manner as to be consistent with acceptably simple operating techniques.

1.4 The position of the centre of gravity is selected within the permissible range so that the performance achieved in the configuration and power indicated in the specification under consideration is a minimum.

1.5 The performance of the aeroplane is determined in such a manner that under all conditions the approved limitations for the powerplant are not exceeded.

1.6 While certain configurations of cooling gills have been specified based upon maximum anticipated temperature, the use of other positions is acceptable provided that an equivalent level of safety is maintained.

1.7 The determined performance is so scheduled that it can serve directly in showing compliance with the aeroplane performance operating limitations.

2. Take-off

2.1 General

2.1.1 The following take-off data are determined for sea level pressure and temperature in the Standard Atmosphere, and reference humidity conditions, with the aeroplane at the corresponding maximum take-off mass for a level, smooth, dry and hard take-off surface (landplanes) and for smooth water of declared density (seaplanes):

a) take-off safety speed and any other relevant speed;

b) power failure point; } associated with items d), e), f)

c) power failure point criterion, e.g. airspeed indicator reading; } associated with items d), e), f)

d) accelerate-stop distance required;

e) take-off run required;

f) take-off distance required;

g) net take-off flight path;

h) radius of a steady Rate 1 (180 degrees per minute) turn made at the airspeed used in establishing the net take-off flight path, and the corresponding reduction in gradient of climb in accordance with the conditions of 2.9.

2.1.2 The determination is also made over selected ranges of the following variables:

a) aeroplane mass;

b) pressure-altitude at the take-off surface;

c) outside air temperature;

d) steady wind velocity parallel to the direction of take-off;

e) steady wind velocity normal to the direction of take-off (seaplanes);

f) take-off surface slope over the take-off distance required (landplanes);

g) water surface condition (seaplanes);

h) density of water (seaplanes);

i) strength of current (seaplanes);

j) power failure point (subject to provisions of 2.4.3).

2.1.3 For seaplanes appropriate interpretations of the term landing gear, etc., are made to provide for the operation of retractable floats, if employed.

2.2 Take-off safety speed

2.2.1 The take-off safety speed is an airspeed (CAS) so selected that it is not less than:

a) $1.20V_{S_1}$, for aeroplanes with two power-units;

b) $1.15V_{S_1}$, for aeroplanes having more than two power-units;

c) 1.10 times the minimum control speed, V_{MC}, established as prescribed in 2.3;

d) the minimum speed prescribed in 2.9.7.6;

where V_{S_1} is appropriate to the take-off configuration.

Note.— See Example 1 for definition of V_{S_1}.

2.3 Minimum control speed

2.3.1 The minimum control speed is such that, when any one power-unit is made inoperative at that speed, it is possible to recover control of the aeroplane with the one power-unit still inoperative and to maintain the aeroplane in straight flight at that speed either with zero yaw or with a bank not in excess of 5 degrees.

2.3.2 From the time at which the power-unit is made inoperative to the time at which recovery is complete, exceptional skill, alertness, or strength, on the part of the pilot is not required to prevent any loss of altitude other than that implicit in the loss of performance or any change of heading in excess of 20 degrees, nor does the aeroplane assume any dangerous attitude.

2.3.3 It is demonstrated that to maintain the aeroplane in steady straight flight at this speed after recovery and before retrimming does not require a rudder control force exceeding 800 N and does not make it necessary for the flight crew to reduce the power of the remaining power-units.

2.4 Power failure point

2.4.1 The power failure point is the point at which sudden complete loss of power from the power-unit, critical from the performance aspect in the case considered, is assumed to occur. If the airspeed corresponding to this point is less than the take-off safety speed, it is demonstrated that, in the event of sudden failure of the critical power-unit at all speeds down to the lowest speed corresponding with the power failure point, the aeroplane is controllable satisfactorily and that the take-off can be continued safely, using normal piloting skill, without:

a) reducing the thrust of the remaining power-units; and

b) encountering characteristics which would result in unsatisfactory controllability on wet runways.

2.4.2 If the critical power-unit varies with the configuration, and this variation has a substantial effect on performance, either the critical power-unit is considered separately for each element concerned, or it is shown that the established performance provides for each possibility of single power-unit failure.

2.4.3 The power failure point is selected for each take-off distance required and take-off run required, and for each accelerate-stop distance required. The pilot is provided with a ready and reliable means of determining when the applicable power failure point has been reached.

2.5 Accelerate-stop distance required

2.5.1 The accelerate-stop distance required is the distance required to reach the power failure point from a standing start and, assuming the critical power-unit to fail suddenly at this point, to stop if a landplane, or to bring the aeroplane to a speed of approximately 9 km/h (5 kt) if a seaplane.

2.5.2 Use of braking means in addition to, or in lieu of, wheel brakes is permitted in determining this distance, provided that they are reliable and that the manner of their employment is such that consistent results can be expected under normal conditions of operation, and provided that exceptional skill is not required to control the aeroplane.

2.6 Take-off run required

The take-off run required is the greater of the following:

1.15 times the distance required with all power-units operating to accelerate from a standing start to take-off safety speed;

1.0 times the distance required to accelerate from a standing start to take-off safety speed assuming the critical power-unit to fail at the power failure point.

2.7 Take-off distance required

2.7.1 The take-off distance required is the distance required to reach a height of:

10.7 m (35 ft), for aeroplanes with two power-units,

15.2 m (50 ft), for aeroplanes with four power-units,

above the take-off surface, with the critical power-unit failing at the power failure point.

2.7.2 The heights mentioned above are those which can be just cleared by the aeroplane when following the relevant flight path in an unbanked attitude with the landing gear extended.

Note.— Paragraph 2.8 and the corresponding operating requirements, by defining the point at which the net take-off flight path starts as the 10.7 m (35 ft) height point, ensure that the appropriate net clearances are achieved.

2.8 Net take-off flight path

2.8.1 The net take-off flight path is the one-power-unit-inoperative flight path which starts at a height of 10.7 m (35 ft) at the end of the take-off distance required and extends to a height of at least 450 m (1 500 ft) calculated in accordance with the conditions of 2.9, the expected gradient of climb being diminished at each point by a gradient equal to:

0.5 per cent, for aeroplanes with two power-units,

0.8 per cent, for aeroplanes with four power-units.

2.8.2 The expected performance with which the aeroplane is credited in the take-off wing flap, take-off power condition, is available at the selected take-off safety speed and is substantially available at 9 km/h (5 kt) below this speed.

2.8.3 In addition the effect of significant turns is scheduled as follows:

Radius. The radius of a steady Rate 1 (180 degrees per minute) turn in still air at the various true airspeeds corresponding to the take-off safety speeds for each wing-flap setting used in establishing the net take-off flight path below the 450 m (1 500 ft) height point, is scheduled.

Performance change. The approximate reduction in performance due to the above turns is scheduled and corresponds to a change in gradient of

$\left[0.5\left(\frac{V}{185.2}\right)^2\right]$ % where V is the true airspeed in km/h; and

$\left[0.5\left(\frac{V}{100}\right)^2\right]$ % where V is the true airspeed in knots; and

2.9 Conditions

2.9.1 *Air speed*

2.9.1.1 In determining the take-off distance required, the selected take-off safety speed is attained before the end of the take-off distance required is reached.

2.9.1.2 In determining the net take-off flight path below a height of 120 m (400 ft), the selected take-off safety speed is maintained, i.e. no credit is taken for acceleration before this height is reached.

2.9.1.3 In determining the net take-off flight path above a height of 120 m (400 ft), the airspeed is not less than the selected take-off safety speed. If the aeroplane is accelerated after reaching a height of 120 m (400 ft) and before reaching a height of 450 m (1 500 ft), the acceleration is assumed to take place in level flight and to have a value equal to the true acceleration available diminished by an acceleration equivalent to a climb gradient equal to that specified in 2.8.1.

2.9.1.4 The net take-off flight path includes transition to the initial en-route configuration and airspeed. During all transition stages, the above provisions regarding acceleration are complied with.

2.9.2 *Wing flaps*

2.9.2.1 The wing flaps are in the same position (take-off position) throughout, except:

a) that the flaps may be moved at heights above 120 m (400 ft), provided that the airspeed specifications of 2.9.1 are met and that the take-off safety speed applicable to subsequent elements is appropriate to the new flap position;

b) the wing flaps may be moved before the earliest power failure point is reached, if this is established as a satisfactory normal procedure.

2.9.3 *Landing gear*

2.9.3.1 In establishing the accelerate-stop distance required and the take-off run required, the landing gear are extended throughout.

2.9.3.2 In establishing the take-off distance required, retraction of the landing gear is not initiated until the selected take-off safety speed has been reached, except that, when the selected take-off safety speed exceeds the minimum value prescribed in 2.2 retraction of the landing gear may be initiated when a speed greater than the minimum value prescribed in 2.2 has been reached.

2.9.3.3 In establishing the net take-off flight path, the retraction of the landing gear is assumed to have been initiated not earlier than the point prescribed in 2.9.3.2.

2.9.4 *Cooling*

For that part of the net take-off flight path before the 120 m (400 ft) height point, plus any transition element which starts at the 120 m (400 ft) height point, the cowl flap position is such that, starting the take-off at the maximum temperatures permitted for the start of take-off, the relevant maximum temperature limitations are not exceeded in the maximum anticipated air temperature conditions. For any subsequent part of the net take-off flight path, the cowl flap position and airspeed are such that the appropriate temperature limitations would not be exceeded in steady flight in the maximum anticipated air temperatures. The cowl flaps of all power-units at the start of the take-off are as above, and the cowl flaps of the inoperative power-unit may be assumed to be closed upon reaching the end of the take-off distance required.

2.9.5 *Power unit conditions*

2.9.5.1 From the starting point to the power failure point, all power-units may operate at maximum take-off power conditions. The operative power-units do not operate at maximum take-off power limitations for a period greater than that for which the use of maximum take-off power is permitted.

2.9.5.2 After the period for which the take-off power may be used, maximum continuous power limitations are not exceeded. The period for which maximum take-off power is used is assumed to begin at the start of the take-off run.

2.9.6 *Propeller conditions*

At the starting point, all propellers are set in the condition recommended for take-off. Propeller feathering or pitch coarsening is not initiated (unless it is by automatic or auto-selective means) before the end of the take-off distance required.

2.9.7 *Technique*

2.9.7.1 In that part of the net take-off flight path prior to the 120 m (400 ft) height point, no changes of configuration or power are made which have the effect of reducing the gradient of climb.

2.9.7.2 The aeroplane is not flown or assumed to be flown in a manner which would make the gradient of any part of the net take-off flight path negative.

2.9.7.3 The technique chosen for those elements of the flight path conducted in steady flight, which are not the subject of numerical climb specifications, are such that the net gradient of climb is not less than 0.5 per cent.

2.9.7.4 All information which it may be necessary to furnish to the pilot, if the aeroplane is to be flown in a manner consistent with the scheduled performance, is obtained and recorded.

2.9.7.5 The aeroplane is held on, or close to the ground until the point at which it is permissible to initiate landing gear retraction has been reached.

2.9.7.6 No attempt is made to leave the ground until a speed has been reached which is at least:

15 per cent above the minimum possible unstick speed with all power-units operating;

7 per cent above the minimum possible unstick speed with the critical power-unit inoperative;

except that these unstick speed margins may be reduced to 10 per cent and 5 per cent, respectively, when the limitation is due to landing gear geometry and not to ground stalling characteristics.

Note.— Compliance with this specification is determined by attempting to leave the ground at progressively lower speeds (by normal use of the controls except that up-elevator is applied earlier and more coarsely than is normal) until it has been shown to be possible to leave the ground at a speed which complies with these specifications, and to complete the take-off. It is recognized that during the test manoeuvre, the usual margin of control associated with normal operating techniques and scheduled performance information will not be available.

2.10 Methods of derivation

2.10.1 *General*

The take-off field lengths required are determined from measurements of actual take-offs and ground runs. The net take-off flight path is determined by calculating each section separately on the basis of performance data obtained in steady flight.

2.10.2 *Net take-off flight path*

Credit is not taken for any change in configuration until that change is complete, unless more accurate data are available to substantiate a less conservative assumption; ground effect is ignored.

2.10.3 *Take-off distance required*

Satisfactory corrections for the vertical gradient of wind velocity are made.

3. Landing

3.1 General

3.1.1 The landing distance required is determined:

a) for the following conditions:

1) sea level;

2) aeroplane mass equal to the maximum landing mass at sea level;

3) level, smooth, dry and hard landing surfaces (landplanes);

4) smooth water of declared density (seaplanes);

b) over selected ranges of the following variables:

1) atmospheric conditions, namely: altitude, or pressure-altitude and temperature;

2) aeroplane mass;

3) steady wind velocity parallel to the direction of landing;

4) uniform landing surface slope (landplanes);

5) nature of landing surface (landplanes);

6) water surface condition (seaplanes);

7) density of water (seaplanes);

8) strength of current (seaplanes).

3.2 Landing distance required

The landing distance required is the measured horizontal distance between that point on the landing surface at which the aeroplane is brought to a complete stop or, for seaplanes, to a speed of approximately 9 km/h (5 kt) and that point on the landing surface which the aeroplane cleared by 15.2 m (50 ft) multiplied by a factor of 1/0.7.

Note.— Some States have found it necessary to use a factor of 1/0.6 instead of 1/0.7.

3.3 Landing technique

3.3.1 In determining the measured landing distance:

a) immediately before reaching the 15.2 m (50 ft) height, a steady approach is maintained, landing gear fully extended, with an airspeed of at least $1.3V_{S_0}$;

Note.— See Example 1 for definition of V_{S_0}.

b) the nose of the aeroplane is not depressed in flight nor the forward thrust increased by application of engine power after reaching the 15.2 m (50 ft) height;

c) the power is not reduced in such a way that the power used for establishing compliance with the balked landing climb requirement would not be obtained within 5 seconds if selected at any point down to touch down;

d) reverse pitch or reverse thrust are not used when establishing the landing distance using this method and field length factor. Ground fine pitch is used if the effective drag/weight ratio in the airborne part of the landing distance is not less satisfactory than that of conventional piston-engine aeroplane;

Note.— This does not mean that reverse pitch or reverse thrust, or use of ground fine pitch, are to be discouraged.

e) the wing flap control is set in the landing position, and remains constant during the final approach, flare out and touch down, and on the landing surface at airspeeds above $0.9V_{S_0}$. When the aeroplane is on the landing surface and the airspeed has fallen to less than $0.9V_{S_0}$, change of the wing-flap-control setting is acceptable;

f) the landing is made in a manner such that there is no excessive vertical acceleration, no excessive tendency to bounce, and no display of any other undesirable handling characteristics, and such that its repetition does not require either an exceptional degree of skill on the part of the pilot, or exceptionally favourable conditions;

g) wheel brakes are not used in a manner such as to produce excessive wear of brakes or tires, and the operating pressures on the braking system are not in excess of those approved.

3.3.2 The gradient of the steady approach and the details of the technique used in determining the landing distance, together with such variations in the technique as are recommended for landing with the critical engine inoperative, and any appreciable variation in landing distance resulting therefrom, are entered in the flight manual.

Example 3

Purpose and scope

The purpose of the following example is to illustrate the level of performance intended by the provisions of Chapter 5 as applicable to turbine-powered subsonic transport type aeroplanes over 5 700 kg maximum certificated take-off mass having two or more engines. However, where relevant, it can be applied to all turbine or piston-engined subsonic aeroplanes having two, three or four engines. This example is shown to be compatible with principal national airworthiness codes in effect in 1969.

No study has been made of the applicability of this material to turbine-powered subsonic aeroplanes having characteristics other than those of the transport aeroplanes introduced into service up to 1969.

This example is not intended for application to aeroplanes having short take-off and landing (STOL) or vertical take-off and landing (VTOL) capabilities.

No detailed study has been made of the applicability of this example to operations in all-weather conditions. The validity of this example has not therefore been established for operations which may involve low decision heights and be associated with low minima operating techniques and procedures.

1. General

1.1 The provisions of 1 to 5 are to be complied with, unless deviations therefrom are specifically authorized by the State of Registry on the ground that the special circumstances of a particular case make a literal observance of these provisions unnecessary for safety.

1.2 Compliance with 1 to 5 is to be established using performance data in the flight manual and in accordance with other applicable operating requirements. In no case may the limitations in the flight manual be exceeded. However, additional limitations may be applied when operational conditions not included in the flight manual are encountered.

1.3 The procedures scheduled in the flight manual are to be followed except where operational circumstances require the use of modified procedures in order to maintain the intended level of safety.

Note.— See Part III, Section 1 of the Airworthiness Technical Manual *(Doc 9051) for the related airworthiness performance guidance material.*

2. Aeroplane take-off performance limitations

2.1 No aeroplane is taken off at a mass which exceeds the take-off mass specified in the flight manual for the altitude of the aerodrome and for the ambient temperature existing at the time of the take-off.

2.2 No aeroplane is taken off at a mass such that, allowing for normal consumption of fuel and oil in flight to the aerodrome of destination and to the destination alternate aerodromes, the mass on arrival will exceed the landing mass specified in the flight manual for the altitude of each of the aerodromes involved and for the ambient temperatures anticipated at the time of landing.

2.3 No aeroplane is taken off at a mass which exceeds the mass at which, in accordance with the minimum distances for take-off scheduled in the flight manual, compliance with 2.3.1 to 2.3.3 inclusive is shown. These distances correspond with the altitude of the aerodrome, the runway, stopway and clearway to be used, the runway slope, the stopway slope, the clearway plane slope, and the ambient temperature and wind existing at the time of take-off.

2.3.1 The take-off run required does not exceed the length of the runway.

2.3.2 The accelerate-stop distance required does not exceed the length of the runway plus the length of the stopway, where present.

2.3.3 The take-off distance required does not exceed the length of the runway, plus the length of the clearway, where present, except that the sum of the lengths of the runway and the clearway is in no case considered as being greater than 1.5 times the length of the runway.

2.4 Credit is not taken for the length of the stopway or the length of the clearway unless they comply with the relevant specifications in Annex 14.

Note.— In determining the length of the runway available, account is taken of the loss, if any, of runway length due to alignment of the aeroplane prior to take-off.

3. Take-off obstacle clearance limitations

3.1 No aeroplane is taken off at a mass in excess of that shown in the flight manual to correspond with a net take-off flight path which clears all obstacles either by at least a height of 10.7 m (35 ft) vertically or at least 90 m plus 0.125D laterally, where D is the horizontal distance the aeroplane has travelled from the end of take-off distance available, except as provided in 3.1.1 to 3.1.3 inclusive. In determining the allowable deviation of the net take-off flight path in order to avoid obstacles by at least the distances specified, it is assumed that the aeroplane is not banked before the clearance of the net take-off flight path above obstacles is at least 15.2 m (50 ft) and that the bank thereafter does not exceed 15 degrees. The net take-off flight path considered is for the altitude of the aerodrome and for the ambient temperature and wind component existing at the time of take-off.

3.1.1 Where the intended track does not include any change of heading greater than 15 degrees,

a) for operations conducted in VMC by day, or

b) for operations conducted with navigation aids such that the pilot can maintain the aeroplane on the intended track with the same precision as for operations specified in a),

obstacles at a distance greater than 300 m on either side of the intended track need not be cleared.

3.1.2 Where the intended track does not include any change of heading greater than 15 degrees for operations conducted in IMC, or in VMC by night, except as provided in 3.1.1 b); and where the intended track includes changes of heading greater than 15 degrees for operations conducted in VMC by day, obstacles at a distance greater than 600 m on either side of the intended track need not be cleared.

3.1.3 Where the intended track includes changes of heading greater than 15 degrees for operations conducted in IMC, or in VMC by night, obstacles at a distance greater than 900 m on either side of the intended track need not be cleared.

4. En-route limitations

4.1 General

4.1.1 At no point along the intended track, is an aeroplane having three or more engines to be more than 90 minutes at normal cruising speed away from an aerodrome at which the distance specifications for alternate aerodromes (see 5.2) are complied with and where it is expected that a safe landing can be made, unless it complies with 4.3.1.1.

Note.— For the authorization of extended range operations by aeroplanes with two turbine engines, see 4.7 of this Part.

4.2. One engine inoperative

4.2.1 No aeroplane is taken off at a mass in excess of that which, in accordance with the one-engine-inoperative en-route net flight path data shown in the flight manual, permits compliance either with 4.2.1.1 or 4.2.1.2 at all points along the route. The net flight path has a positive slope at 450 m (1 500 ft) above the aerodrome where the landing is assumed to be made after engine failure. The net flight path used is for the ambient temperatures anticipated along the route. In meteorological conditions where icing protection systems are to be operable, the effect of their use on the net flight path data is taken into account.

4.2.1.1 The slope of the net flight path is positive at an altitude of at least 300 m (1 000 ft) above all terrain and obstructions along the route within 9.3 km (5 NM) on either side of the intended track.

4.2.1.2 The net flight path is such as to permit the aeroplane to continue flight from the cruising altitude to an aerodrome where a landing can be made in accordance with 5.2, the net flight path clearing vertically, by at least 600 m (2 000 ft), all terrain and obstructions along the route within 9.3 km (5 NM) on either side of the intended track. The provisions of 4.2.1.2.1 to 4.2.1.2.5 inclusive are applied.

4.2.1.2.1 The engine is assumed to fail at the most critical point along the route, allowance being made for indecision and navigational error.

4.2.1.2.2 Account is taken of the effects of winds on the flight path.

4.2.1.2.3 Fuel jettisoning is permitted to an extent consistent with reaching the aerodrome with satisfactory fuel reserves, if a safe procedure is used.

4.2.1.2.4 The aerodrome, where the aeroplane is assumed to land after engine failure, is specified in the operational flight plan and it meets the appropriate aerodrome operating minima.

4.2.1.2.5 The consumption of fuel and oil after the engine becomes inoperative is that which is accounted for in the net flight path data shown in the flight manual.

4.3 Two engines inoperative

4.3.1 Aeroplanes which do not comply with 4.1 comply with 4.3.1.1.

4.3.1.1 No aeroplane is taken off at a mass in excess of that which according to the two-engines-inoperative en-route net flight path data shown in the flight manual, permits the aeroplane to continue flight from the point where two engines are assumed to fail simultaneously, to an aerodrome at which the landing distance specification for alternate aerodromes (see 5.2) is complied with and where it is expected that a safe landing can be made. The net flight path clears vertically, by at least 600 m (2 000 ft) all terrain and obstructions along the route within 9.3 km (5 NM) on either side of the intended track. The net flight path considered is for the ambient temperatures anticipated along the route. In altitudes and meteorological conditions where icing protection systems are to be operable, the effect of their use on the net flight path data is taken into account. The provisions of 4.3.1.1.1 to 4.3.1.1.5 inclusive apply.

4.3.1.1.1 The two engines are assumed to fail at the most critical point of that portion of the route where the aeroplane is at more than 90 minutes at normal cruising speed away from an aerodrome at which the landing distance specification for alternate aerodromes (see 5.2) is complied with and where it is expected that a safe landing can be made.

4.3.1.1.2 The net flight path has a positive slope at 450 m (1 500 ft) above the aerodrome where the landing is assumed to be made after the failure of two engines.

4.3.1.1.3 Fuel jettisoning is permitted to an extent consistent with 4.3.1.1.4, if a safe procedure is used.

4.3.1.1.4 The aeroplane mass at the point where the two engines are assumed to fail is considered to be not less than that which would include sufficient fuel to proceed to the aerodrome and to arrive there at an altitude of at least 450 m (1 500 ft) directly over the landing area and thereafter to fly for 15 minutes at cruise power and/or thrust.

4.3.1.1.5 The consumption of fuel and oil after the engines become inoperative is that which is accounted for in the net flight path data shown in the flight manual.

5. Landing limitations

5.1 Aerodrome of destination

5.1.1 No aeroplane is taken off at a mass in excess of that which, in accordance with the landing distances required as shown in the flight manual for the altitude of the aerodrome of intended destination, permits the aeroplane to be brought to rest at the aerodrome of intended destination within the effective length of the runway, this length being as declared by the aerodrome authorities with regard to the obstructions in the approach. The mass of the aeroplane is assumed to be reduced by the mass of the fuel and oil expected to be consumed in flight to the aerodrome of intended destination. Compliance is shown with 5.1.1.3 and with either 5.1.1.4 or 5.1.1.5.

5.1.1.1 The runway slope is assumed to be zero, unless the runway is usable in only one direction.

5.1.1.2 A runway condition (wet or dry) not more favourable than that expected is taken into account.

Note.— National authorities will need to develop suitable methods for dealing with accountability for wet and dry runways.

5.1.1.3 It is assumed that the aeroplane is landed on the most favourable runway and in the most favourable direction in still air.

5.1.1.4 It is assumed that the aeroplane is landed on the runway which is the most suitable for the wind conditions anticipated at the aerodrome at the time of landing, taking due account of the probable wind speed and direction, of the ground handling characteristics of the aeroplane, and of other conditions (i.e. landing aids, terrain, etc.).

5.1.1.5 If full compliance with 5.1.1.4 is not shown, the aeroplane may be taken off if a destination alternate aerodrome is designated which permits compliance with 5.2.

5.2 Destination alternate aerodrome

5.2.1 No aerodrome is designated as a destination alternate aerodrome unless the aeroplane, at the mass anticipated at the time of arrival at such aerodrome, can comply with 5.1, in accordance with the landing distance required as shown in the flight manual for the altitude of the alternate aerodrome and in accordance with other applicable operating requirements for the alternate aerodrome.

ATTACHMENT D. FLIGHT RECORDERS

Supplementary to 6.3

Introduction

The material in this Attachment concerns flight recorders intended for installation in aeroplanes engaged in international air navigation. Flight recorders comprise two systems — a flight data recorder and a cockpit voice recorder. Flight data recorders are classified as Type I, Type II and Type IIA depending upon the number of parameters to be recorded and the duration required for retention of the recorded information.

1. Flight data recorder (FDR)

1.1 General requirements

1.1.1 The recorder is to record continuously during flight time.

1.1.2 The recorder container is to:

a) be painted a distinctive orange or yellow colour;

b) carry reflective material to facilitate its location; and

c) have securely attached an automatically activated underwater locating device.

1.1.3 The recorder is to be installed so that:

a) the probability of damage to the recording is minimized. To meet this requirement it should be located as far aft as practicable. In the case of pressurized aeroplanes it should be located in the vicinity of the rear pressure bulkhead;

b) it receives its electrical power from a bus that provides the maximum reliability for operation of the recorder without jeopardizing service to essential or emergency loads; and

c) there is an aural or visual means for pre-flight checking that the recorder is operating properly.

1.2 Parameters to be recorded

1.2.1 *Type I flight data recorder.* This recorder will be capable of recording, as appropriate to the aeroplane, at least the 32 parameters in Table D-1. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.

1.2.2 *Types II and IIA flight data recorders.* These recorders will be capable of recording, as appropriate to the aeroplane, at least the first 15 parameters in Table D-1. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.

1.3 Additional information

1.3.1 A Type IIA recorder, in addition to a 30-minute recording duration, is to retain sufficient information from the preceding take-off for calibration purposes.

1.3.2 The measurement range, recording interval and accuracy of parameters on installed equipment is usually verified by methods approved by the appropriate certificating authority.

1.3.3 The manufacturer usually provides the national certificating authority with the following information in respect of the flight data recorder:

a) manufacturer's operating instructions, equipment limitations and installation procedures;

b) parameter origin or source and equations which relate counts to units of measurement; and

c) manufacturer's test reports.

1.3.4 The operator usually supplies position error curves for pitot-static parameters, at various angles of attack and side slip, for the calibration and read-out of the recordings.

2. Cockpit voice recorder (CVR)

2.1 General requirements

2.1.1 The recorder is to be designed so that it will record at least the following:

a) voice communication transmitted from or received in the aeroplane by radio;

b) aural environment on the flight deck;

c) voice communication of flight crew members on the flight deck using the aeroplane's interphone system;

d) voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and

e) voice communication of flight crew members using the passenger address system, if installed.

2.1.2 The recorder container is to:

a) be painted a distinctive orange or yellow colour;

b) carry reflective material to facilitate its location; and

c) have securely attached an automatically activated underwater locating device.

2.1.3 To aid in voice and sound discrimination, microphones in the cockpit are to be located in the best position for recording voice communications originating at the pilot and co-pilot stations and voice communications of other crew members on the flight deck when directed to those stations. This can best be achieved by wiring suitable boom microphones to record continuously on separate channels.

2.1.4 The recorder is to be installed so that:

a) the probability of damage to the recording is minimized. To meet this requirement it should be located as far aft as practicable. In the case of pressurized aeroplanes it should be located in the vicinity of the rear pressure bulkhead;

b) it receives its electrical power from a bus that provides the maximum reliability for operation of the recorder without jeopardizing service to essential or emergency loads;

c) there is an aural or visual means for pre-flight checking of the recorder for proper operation; and

d) if the recorder has a bulk erasure device, the installation should be designed to prevent operation of the device during flight time or crash impact.

2.2 Performance requirements

2.2.1 The recorder will be capable of recording on at least four tracks simultaneously except for the recorder in 6.3.6.2. To ensure accurate time correlation between tracks, the recorder is to record in an in-line format. If a bi-directional configuration is used, the in-line format and track allocation should be retained in both directions.

2.2.2 The preferred track allocation is as follows:

Track 1 — co-pilot headphones and live boom microphone

Track 2 — pilot headphones and live boom microphone

Track 3 — area microphone

Track 4 — time reference plus the third and fourth crew members' headphone and live microphone, if applicable.

Note.— Track 1 is located closest to the base of the recording head.

2.2.3 The recorder, when tested by methods approved by the appropriate certificating authority, will be demonstrated to be suitable for the environmental extremes over which it is designed to operate.

2.2.4 Means will be provided for an accurate time correlation between the flight data recorder and cockpit voice recorder. One method of achieving this is by superimposing the FDR time signal on Track 4 of the CVR.

2.3 Additional information

2.3.1 The manufacturer usually provides the national certificating authority with the following information in respect of the cockpit voice recorder:

a) manufacturer's operating instructions, equipment limitations and installation procedures; and

b) manufacturer's test reports.

Table D-1
Parameters for Flight Data Recorders

Serial number	Parameter	Measurement range	Recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)
1	Time (UTC when available, otherwise elapsed time)	24 hours	4	±0.125% per hour
2	Pressure-altitude	–300 m (–1 000 ft) to maximum certificated altitude of aircraft +1 500 m (+5 000 ft)	1	±30 m to ±200 m (±100 ft to ±700 ft)
3	Indicated airspeed	95 km/h (50 kt) to max V_{S_0} *(Note 1)* V_{S_0} to 1.2 V_D *(Note 2)*	1	±5% ±3%
4	Heading	360°	1	±2°
5	Normal acceleration	–3 g to +6 g	0.125	±1% of maximum range excluding datum error of ±5%
6	Pitch attitude	±75°	1	±2°
7	Roll attitude	±180°	1	±2°
8	Radio transmission keying	On-off (one discrete)	1	
9	Power on each engine *(Note 3)*	Full range	1 (per engine)	±2%
10	Trailing edge flap or cockpit control selection	Full range or each discrete position	2	±5% or as pilot's indicator
11	Leading edge flap or cockpit control selection	Full range or each discrete position	2	±5% or as pilot's indicator
12	Thrust reverser position	Stowed, in transit, and reverse	1 (per engine)	
13	Ground spoiler/speed brake selection	Full range or each discrete position	1	±2% unless higher accuracy uniquely required
14	Outside air temperature	Sensor range	2	±2°C
15	Autopilot/auto throttle/AFCS mode and engagement status	A suitable combination of discretes	1	

Note.— The preceding 15 parameters satisfy the requirements for a Type II FDR.

Serial number	Parameter	Measurement range	Recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)
16	Longitudinal acceleration	±1 g	0.25	±1.5% max range excluding datum error of ±5%
17	Lateral acceleration	±1 g	0.25	±1.5% max range excluding datum error of ±5%
18	Pilot input and/or control surface position-primary controls (pitch, roll, yaw) *(Note 4)*	Full range	1	±2° unless higher accuracy uniquely required
19	Pitch trim position	Full range	1	±3% unless higher accuracy uniquely required
20	Radio altitude	–6 m to 750 m (–20 ft to 2 500 ft)	1	±0.6 m (±2 ft) or ±3% whichever is greater below 150 m (500 ft) and ±5% above 150 m (500 ft)

Serial number	Parameter	Measurement range	Recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)
21	Glide path deviation	Signal range	1	±3%
22	Localizer deviation	Signal range	1	±3%
23	Marker beacon passage	Discrete	1	
24	Master warning	Discrete	1	
25	NAV 1 and 2 frequency selection *(Note 5)*	Full range	4	As installed
26	DME 1 and 2 distance *(Notes 5 and 6)*	0 – 370 km	4	As installed
27	Landing gear squat switch status	Discrete	1	
28	GPWS (ground proximity warning system)	Discrete	1	
29	Angle of attack	Full range	0.5	As installed
30	Hydraulics, each system (low pressure)	Discrete	2	
31	Navigation data (latitude/longitude, ground speed and drift angle) *(Note 7)*	As installed	1	As installed
32	Landing gear or gear selector position	Discrete	4	As installed

Note.— The preceding 32 parameters satisfy the requirements for a Type I FDR.

Notes.—

1. V_{S_0} stalling speed or minimum steady flight speed in the landing configuration.
2. V_D design diving speed.
3. Record sufficient inputs to determine power.
4. For aeroplanes with conventional control systems "or" applies. For aeroplanes with non-mechanical control systems "and" applies. In aeroplanes with split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately.
5. If signal available in digital form.
6. Recording of latitude and longitude from INS or other navigation system is a preferred alternative.
7. If signals readily available.

If further recording capacity is available, recording of the following additional information should be considered:

a) operational information from electronic display systems, such as electronic flight instrument systems (EFIS), electronic centralized aircraft monitor (ECAM) and engine indication and crew alerting system (EICAS). Use the following order of priority:

1) parameters selected by the flight crew relating to the desired flight path, e.g. barometric pressure setting, selected altitude, selected airspeed, decision height, and autoflight system engagement and mode indications if not recorded from another source;

2) display system selection/status, e.g. SECTOR, PLAN, ROSE, NAV, WXR, COMPOSITE, COPY, ETC.;

3) warnings and alerts;

4) the identity of displayed pages for emergency procedures and checklists;

b) retardation information including brake application for use in the investigation of landing overruns and rejected take-offs; and

c) additional engine parameters (EPR, N1, EGT, fuel flow, etc.).

ATTACHMENT E. EXTENDED RANGE OPERATIONS BY AEROPLANES WITH TWO TURBINE POWER-UNITS

Supplementary to 4.7

1. Purpose and scope

1.1 Introduction

The purpose of this Attachment is to give guidance on the value of the threshold time which is to be established in compliance with 4.7.1 of this Part and also to give guidance on the means of achieving the required level of safety envisaged by 4.7.2 of this Part where operations beyond the established threshold are approved.

1.2 Threshold time

It should be understood that the threshold time established in accordance with 4.7.1 is not an operating limit, but is a flight time from an adequate en-route alternate aerodrome beyond which the State of the Operator must give particular consideration to the aeroplane and the operation before granting authorization. Pending the acquisition of additional data for such operations by twin-engined commercial transport aeroplanes and taking into account the level of safety intended by 4.7.2, it is suggested that the threshold time be 60 minutes.

1.3 Basic concepts

In order to maintain the required level of safety on routes where an aeroplane with two power-units is permitted to operate beyond the threshold time, it is necessary that:

a) the airworthiness certification of the aeroplane type specifically permits operations beyond the threshold time, taking into account the aeroplane system design and reliability aspects;

b) the reliability of the propulsion system is such that the risk of double power-unit failure from independent causes is extremely remote;

c) any necessary special maintenance requirements are fulfilled;

d) specific flight dispatch requirements are met;

e) necessary in-flight operational procedures are established; and

f) specific operational authorization is granted by the State of the Operator.

2. Glossary of terms

Where the following terms are used in this Attachment, they have the meaning indicated:

Adequate alternate aerodrome. An adequate alternate aerodrome is one at which the landing performance requirements can be met and which is expected to be available, if required, and which has the necessary facilities and services, such as air traffic control, lighting, communications, meteorological services, navigation aids, rescue and fire-fighting services and one suitable instrument approach procedure.

Aeroplane system. An aeroplane system includes all elements of equipment necessary for the control and performance of a particular major function. It includes both the equipment specifically provided for the function in question and other basic related aeroplane equipment such as that required to supply power for the equipment operation. As used herein the power-unit is not considered to be an aeroplane system.

Extended range operation. Any flight by an aeroplane with two turbine power-unit where the flight time at the one power-unit inoperative cruise speed (in ISA and still air conditions), from a point on the route to an adequate alternate aerodrome, is greater than the threshold time approved by the State of the Operator.

Power-unit. A system consisting of an engine and all ancillary parts installed on the engine prior to installation on the aeroplane to provide and control power/thrust and for the extraction of energy for aeroplane systems, but not including independent short-period thrust-producing devices.

Propulsion system. A system consisting of a power-unit and all other equipment utilized to provide those functions necessary to sustain, monitor and control the power/thrust output of any one power-unit following installation on the airframe.

Suitable alternate aerodrome. A suitable alternate aerodrome is an adequate aerodrome where, for the anticipated time of use, weather reports, or forecasts, or any combination thereof, indicate that the weather conditions will be at or above the required aerodrome operating minima, and the runway surface condition reports indicate that a safe landing will be possible.

3. Airworthiness certification requirements for extended range operations

During the airworthiness certification procedure for an aeroplane type intended for extended range operations, special attention should be paid to ensuring that the required level of safety will be maintained under conditions which may be encountered during such operations, e.g. flight for extended periods following failure of an engine and/or essential systems. Information or procedures specifically related to extended range operations should be incorporated into the aeroplane flight manual, maintenance manual or other appropriate document.

Note.— Criteria for aeroplane systems performance and reliability for extended range operations are contained in the Airworthiness Technical Manual *(Doc 9051).*

4. Propulsion system maturity and reliability

4.1 Basic elements to be considered for the authorization of extended range operations are the maturity and reliability of the propulsion system. These should be such that the risk of complete loss of power from independent causes is extremely remote.

4.2 The only way to assess the maturity of the propulsion system and its reliability in service is to exercise engineering judgement, taking account of the world-wide experience with the power-unit.

4.3 For a propulsion system whose reliability has already been assessed, each national authority must evaluate the ability of the operator to maintain that level of reliability, taking into account the operator's record of reliability *vis-à-vis* power-units of closely related types.

5. Airworthiness modifications and maintenance programme requirements

Each operator's maintenance programme should ensure that:

a) the titles and numbers of all airworthiness modifications, additions and changes which were made to qualify aeroplane systems for extended range operations are provided to the State of Registry and, where applicable, to the State of the Operator;

b) any changes to maintenance and training procedures, practices or limitations established in the qualification for extended range operations are submitted to the State of the Operator and, where applicable, to the State of Registry before such changes are adopted;

c) a reliability reporting programme is developed and implemented prior to approval and continued after approval;

d) prompt implementation of required modifications and inspections which could affect propulsion system reliability is undertaken;

e) procedures are established which prevent an aeroplane from being dispatched for an extended range operation after power-unit shutdown or primary system failure on a previous flight until the cause of such failure has been positively identified and the necessary corrective action is completed. Confirmation that such corrective action has been effective may, in some cases, require the successful completion of a subsequent flight prior to dispatch on an extended range operation; and

f) a procedure is established to ensure that the airborne equipment will continue to be maintained at the level of performance and reliability required for extended range operations.

6. Flight dispatch requirements

In applying the general flight dispatch requirements of Chapter 4 particular attention should be paid to the conditions which might prevail during extended range operations, e.g. extended flight with one power-unit inoperative, major systems degradation, reduced flight altitude, etc. In addition to the requirement of 4.7.3, at least the following aspects should be considered:

a) pre-flight system serviceability;

b) communication and navigation facilities and capabilities;

c) fuel requirements; and

d) availability of relevant performance information.

7. Operational principles

An aeroplane which is engaged in an extended range operation should normally, in the event of:

a) shutdown of a power-unit, fly to and land at the nearest (in terms of the least flying time) aerodrome suitable for landing;

b) a single or multiple primary aeroplane system failure, fly to and land at the nearest suitable aerodrome unless it has been demonstrated, in view of the flight consequences of the failure and the probability and consequences of subsequent failures, that no substantial degradation of safety results from continuation of the planned flight; and

c) changes impacting the status of items on the minimum equipment list, the communications and navigation facilities, fuel and oil supply, en-route alternate aerodromes or aeroplane performance, make appropriate adjustments to the flight plan.

8. Operational authorization

In authorizing the operation of an aeroplane with two power-units on an extended range route in accordance with 4.7.2, the State of the Operator should, in addition to the requirements previously set forth in this Attachment, ensure that:

a) the operator's past experience and compliance record is satisfactory;

b) the operator has demonstrated that the flight can continue to a safe landing under the anticipated degraded operating conditions which would arise from:

1) total loss of thrust from one power-unit; or

2) total loss of power-unit generated electric power; or

3) any other condition which the State of the Operator considers to be equivalent in airworthiness and performance risk;

c) that the operator's crew training programme is adequate for the proposed operation; and

d) that documentation accompanying the authorization covers all relevant aspects.

ATTACHMENT F. AIR OPERATOR CERTIFICATE OR EQUIVALENT DOCUMENT

Supplementary to 4.2.1

1. The State regulations and rules for the operational certification of operators and the conduct of subsequent commercial air transport operations should be in conformity with the Annexes to the Convention on International Civil Aviation and have sufficient detail to ensure that compliance will result in the desired level of safety.

2. The State regulations should provide a framework of positive control and guidance but also allow the operator sufficient flexibility to develop and update instructions for the detailed guidance of personnel essential to the conduct of operations.

3. The State regulations should require the operator to submit detailed information on the organization, method of control and supervision of flight operations, training programme and maintenance arrangements as a basis for operational certification. As required by this Part, the operator's material should be submitted in the form of an operations manual and a maintenance manual containing at least the material specified in 11.1 and 11.3 and such other material as the State may require.

4. The State, in addition to assessing the operator's ability and competence, should guide the operator in regulatory, organizational and procedural matters. The State of the Operator should be satisfied concerning the operator's eligibility for operational certification. This includes the ability and competence to conduct safe and efficient operations and proof of compliance with applicable regulations.

5. The State should establish a system for both the certification and the continued surveillance of the operator to ensure that the required standards of operation are maintained.

Note.— Guidance on the operations manual is given in the manual Preparation of an Operations Manual *(Doc 9376).*

ATTACHMENT G. MINIMUM EQUIPMENT LIST (MEL)

Supplementary to 6.1.2

1. If deviations from the requirements of States in the certification of aircraft were not permitted an aircraft could not be flown unless all systems and equipment were operable. Experience has proved that some unserviceability can be accepted in the short term when the remaining operative systems and equipment provide for continued safe operations.

2. The State should indicate through approval of a minimum equipment list those systems and items of equipment that may be inoperative for certain flight conditions with the intent that no flight can be conducted with inoperative systems and equipment other than those specified.

3. A minimum equipment list, approved by the State of the Operator, is therefore necessary for each aircraft, based on the master minimum equipment list established for the aircraft type by the organization responsible for the type design in conjunction with the State of Design.

4. The State of the Operator should require the operator to prepare a minimum equipment list designed to allow the operation of an aircraft with certain systems or equipment inoperative provided an acceptable level of safety is maintained.

5. The minimum equipment list is not intended to provide for operation of the aircraft for an indefinite period with inoperative systems or equipment. The basic purpose of the minimum equipment list is to permit the safe operation of an aircraft with inoperative systems or equipment within the framework of a controlled and sound programme of repairs and parts replacement.

6. Operators are to ensure that no flight is commenced with multiple minimum equipment list items inoperative without determining that any interrelationship between inoperative systems or components will not result in an unacceptable degradation in the level of safety and/or undue increase in the flight crew workload.

7. The exposure to additional failures during continued operation with inoperative systems or equipment must also be considered in determining that an acceptable level of safety is being maintained. The minimum equipment list may not deviate from requirements of the flight manual limitations section, emergency procedures or other airworthi-ness requirements of the State of Registry or of the State of the Operator unless the appropriate airworthiness authority or the flight manual provides otherwise.

8. Systems or equipment accepted as inoperative for a flight should be placarded where appropriate and all such items should be noted in the aircraft technical log to inform the flight crew and maintenance personnel of the inoperative system or equipment.

9. For a particular system or item of equipment to be accepted as inoperative, it may be necessary to establish a maintenance procedure, for completion prior to flight, to de-activate or isolate the system or equipment. It may similarly be necessary to prepare an appropriate flight crew operating procedure.

10. The responsibilities of the pilot-in-command in accepting an aeroplane for operation with deficiencies in accordance with a minimum equipment list are specified in 4.3.1.

— END —

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

OPERATION OF AIRCRAFT

ANNEX 6

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

PART II
INTERNATIONAL GENERAL AVIATION — AEROPLANES

FIFTH EDITION OF PART II — JULY 1995

This edition incorporates all amendments adopted by the Council prior to 11 March 1995 and supersedes, on 9 November 1995, all previous editions of Part II of Annex 6.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-16	Incorporated in this Edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

ABBREVIATIONS AND SYMBOLS

(used in this Annex)

Abbreviations

A/H	Altitude/height
AFCS	Automatic flight control system
AGA	Aerodromes, air routes and ground aids
AIG	Accident investigation and prevention
ASIA/PAC	Asia/Pacific
ATC	Air traffic control
ATS	Air traffic services
cm	Centimetre
CVR	Cockpit voice recorder
DA/H	Decision altitude/height
DA	Decision altitude
DH	Decision height
DME	Distance measuring equipment
ECAM	Electronic centralized aircraft monitor
EFIS	Electronic flight instrument system
EGT	Exhaust gas temperature
EICAS	Engine indication and crew alerting system
ELBA	Emergency location beacon — aircraft
EPR	Engine pressure ratio
FDR	Flight data recorder
ft	Foot
g	Normal acceleration
GPWS	Ground proximity warning system
hPa	Hectopascal
IMC	Instrument meteorological conditions
INS	Inertial navigation systems
kg	Kilogram
km	Kilometre
m	Metre
MDA/H	Minimum descent altitude/height
MHz	Megahertz
MNPS	Minimum navigation performance specifications
MSL	Mean sea level
NAV	Navigation
NM	Nautical mile
N1	High pressure turbine speed
SAR	Search and rescue
UTC	Universal co-ordinated time
VD	Design diving speed
VFR	Visual flight rules
VHF	Very high frequency
VMC	Visual meteorological conditions
V_{So}	Stalling speed or the minimum steady flight speed in the landing configuration
WXR	Weather

Symbols

°C	Degrees Celsius

9/11/95

PUBLICATIONS

(referred to in this Annex)

Convention on International Civil Aviation (Doc 7300)

Nationality and Registration of Aircraft Operated by International Operating Agencies (Doc 8722)

International Regulations for Preventing Collisions at Sea

Annexes to the Convention on International Civil Aviation

Annex 1 — Personnel Licensing

Annex 2 — Rules of the Air

Annex 5 — Units of Measurement to be Used in Air and Ground Operations

Annex 6 — Operation of Aircraft
Part I — *International Commercial Air Transport — Aeroplanes*
Part III — *International Operations — Helicopters*

Annex 8 — Airworthiness of Aircraft

Annex 10 — Aeronautical Telecommunications
Volume I (Part I — *Equipment and Systems;*
(Part II — *Radio Frequencies*)

Annex 13 — Aircraft Accident Investigation

Annex 14 — Aerodromes
Volume I — *Aerodrome Design and Operations*

Annex 15 — Aeronautical Information Services

Annex 16 — Environmental Protection
Volume I — *Aircraft Noise*

Annex 18 — The Safe Transport of Dangerous Goods by Air

Procedures for Air Navigation Services

OPS — Aircraft Operations (Doc 8168)
Volume I — *Flight Procedures*
Volume II — *Construction of Visual and Instrument Flight Procedures*

RAC — Rules of the Air and Air Traffic Services (Doc 4444)

Regional Supplementary Procedures (Doc 7030)

Manuals

Accident/Incident Reporting Manual (ADREP Manual) (Doc 9156)

Airport Services Manual (Doc 9137)
Part 1 — *Rescue and Fire Fighting*
Part 8 — *Airport Operational Services*

Airworthiness Technical Manual (Doc 9051)

Manual of Civil Aviation Medicine (Doc 8984)

Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL290 and FL410 Inclusive (Doc 9574)

Manual on Required Navigation Performance (RNP) (Doc 9613)

ANNEX 6 — PART II
INTERNATIONAL GENERAL AVIATION — AEROPLANES

FOREWORD

Historical background

Standards and Recommended Practices for the Operation of Aircraft — International General Aviation were first adopted by the Council on 2 December 1968 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago, 1944) and designated as Annex 6, Part II, to the Convention. They became effective on 2 April 1969 and applicable on 18 September 1969.

Annex 6, Part II, was developed in the following manner: the Fifteenth Session of the Assembly, Montreal, June-July 1965, adopted Resolution A15-15: "Consideration of the needs of international general aviation in relation to the scope of ICAO technical activities". Subsequently, the Fourth Air Navigation Conference (Montreal, November-December 1965) recommended a series of factors which it considered should be taken into account in extending the scope of Annex 6 to meet the needs of general aviation in accordance with the directives of Assembly Resolution A15-15.

The Fourth Air Navigation Conference recommended that the International Standards and Recommended Practices to be developed for International General Aviation Operations exclude for the present aerial work operations. It was however clearly the view of the conference that the Annex should be framed in such a manner as to facilitate its extension to cover aerial work operations at a later date, should such extension prove desirable.

Based on the above considerations, draft International Standards and Recommended Practices for the Operation of International General Aviation Aircraft were developed by the Air Navigation Commission and, after amendment following the usual consultation with the Member States of the Organization, were adopted by the Council so as to become, together with the Foreword approved by the Council, the text of this Annex. In developing this material the Air Navigation Commission was guided by the following philosophies:

Presentation and conformity with Annex 6, Part I. The Annex should be, as nearly as practicable, equivalent in scope and conform as closely as possible to Annex 6 (now Annex 6, Part I).

Applicability. Although the definition of general aviation originally used in this Annex encompassed aerial work operations, these were specifically excluded from the provisions of this Annex by Chapter 2 — Applicability.

Level of safety. The Annex should ensure an acceptable level of safety to third parties (third parties meaning persons on the ground and persons in the air in other aircraft). Also, as some international general aviation operations will be performed:

a) by crews less experienced and less skilled;

b) by less reliable equipment;

c) to less rigorous standards; and

d) with greater freedom of action than in commercial air transport operations;

it has to be accepted that the passenger in international general aviation aircraft will not necessarily enjoy the same level of safety as the fare-paying passenger in commercial air transport. However, it was recognized that in ensuring an acceptable degree of safety for third parties, an acceptable level of safety for flight crews and passengers would be achieved.

Freedom of Action. The maximum freedom of action consistent with maintaining an acceptable level of safety should be granted to international general aviation.

Responsibility. The responsibility that devolves upon the operator in Annex 6, Part I, should, in Part II of the Annex, fall upon the pilot-in-command. Precedent for this course of action exists in Annex 2.

Consequent to the adoption of Annex 6, Part III, *International Operations — Helicopters*, an amendment to the title was introduced to indicate that Annex 6, Part II was applicable only to aeroplanes.

In 1986 the Air Navigation Commission commenced a review of Annex 6, Part II and concluded that the definition of general aviation should be revised to exclude aerial work thus recognizing that aerial work was a distinct aspect of civil aviation and recognizing the exclusion of aerial work from the applicability of Annex 6, Part II. As with the Fourth Air Navigation Conference in 1965, the Air Navigation

Commission was not aware of any degree of international aerial work operations which would necessitate the development of international Standards and Recommended Practices. The revised definitions for general aviation and aerial work and the revised applicability chapter were submitted to States in the usual manner and approved by the Council in March 1990.

Table A shows the origin of amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

The Standards and Recommended Practices of Annex 6, Part II are applicable to international general aviation operations with aeroplanes.

The Standards and Recommended Practices represent minimum provisions and, together with those of Annex 6 — Operation of Aircraft: Part I — International Commercial Air Transport — Aeroplanes, now cover the operation of all aeroplanes in international civil aviation, except in aerial work operations.

It will be noted that the Standards and Recommended Practices contained in Annex 6, Part II, when applied to the operation of large aeroplanes, are less stringent than those in Annex 6, Part I, applicable to the same or similar aeroplanes when used in commercial air transport operations. Nevertheless, it is considered that, in conjunction with existing provisions in Annexes 1 and 8, Annex 6, Part II, ensures an adequate level of safety for the operations envisaged for the large aeroplanes in question. In this connexion attention is drawn to the point that the entire performance standards of Annex 8 are applicable to all aeroplanes of over 5 700 kg mass intended for the carriage of passengers or cargo or mail for international air navigation, of which the prototype was submitted for certification on or after 13 December 1964. Moreover, by virtue of Annex 1 the holder of a private pilot licence, piloting an aircraft in excess of 5 700 kg unless as the sole occupant thereof is required to have a type rating entered on his licence. Since the certificates of airworthiness of the types of aeroplanes in question would preclude solo flight in all normal circumstances, it may be accepted that the private pilot of these aeroplanes must have a type rating entered on his licence.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provision of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.—Material comprising the Annex proper:

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

It is to be noted that some Standards in this Annex incorporate, by reference, other specifications having the status of Recommended Practices. In such cases, the text of the Recommended Practice becomes part of the Standard.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 6, Part II

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
1st Edition	Fifteenth Session of the Assembly (Resolution A15-15) and Fourth Air Navigation Conference		2 December 1968 2 April 1969 18 September 1969
1	Sixth Air Navigation Conference	a) The requirement for additional instruments in aeroplanes operated as controlled VFR flights in the en-route phase; and b) the permitting of aeroplanes, when unable to navigate by visual references to landmarks, to be navigated by equipment other than radio navigation equipment, e.g. solely by self-contained navigation means, provided that certain equipment capabilities are met, thus eliminating any requirement for the carriage of radio navigation equipment.	1 June 1970 1 October 1970 4 February 1971
2 (2nd Edition)	Special Meeting on Aircraft Noise in the Vicinity of Aerodromes	The inclusion of a specification for aeroplanes to be operated within the weight limitations imposed by the applicable Noise Certification Standards, except in prescribed circumstances, and to carry a document attesting noise certification.	2 April 1971 2 August 1971 6 January 1972
3	Seventh Air Navigation Conference	The inclusion of a Recommended Practice covering the design, carriage and installation of Emergency Location Beacons — Aircraft (ELBA) in such aeroplanes and on such flights as may be determined by the appropriate authority.	29 May 1973 1 October 1973 23 May 1974
4	Revision of Annex 12, the Air Navigation Commission's Study concerning interception of civil aircraft and the Council action in pursuance of Assembly Resolution A18-16	a) Provisions for the marking of break-in points on aircraft; b) provisions for reducing the risk for intercepted aircraft; c) the revision of the Introductory Note to Chapter 3 of the Annex. The revision points to a practical method for States to discharge their functions in the cases of lease, charter and interchange of aircraft in international operations.	4 February 1975 4 June 1975 9 October 1975
5	Studies by the Air Navigation Commission, Amendment 60 to Annex 3 and Amendment 30 to Annex 14	Requirements for the provision and use of flight crew safety harnesses; amplification of specifications for the type of timepiece required for operations in accordance with Instrument Flight Rules and controlled VFR flights; and revision of the definitions of Aerodrome and Meteorological information.	7 April 1976 7 August 1976 30 December 1976
6	ASIA/PAC Regional Air Navigation Meeting	The requirement for the carriage of survival radio equipment over those areas in which search and rescue would be especially difficult to be determined by States rather than regional air navigation agreement.	16 June 1976 16 October 1976 6 October 1977
7	Air Navigation Commission Study	Recommendation for the fitting of ground proximity warning systems to certain aeroplanes.	15 December 1977 15 April 1978 10 August 1978

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
8	Air Navigation Commission Study	Introduction of requirements for navigation equipment to meet minimum navigational performance specifications (MNPS).	2 April 1980 2 August 1980 27 November 1980
9	Air Navigation Commission Study	Revision of the provisions relating to exterior lights to align with new provisions in Annexes 2 and 8.	22 March 1982 22 July 1982 25 November 1982
10 (3rd Edition)	Seventh meeting of the Obstacle Clearance Panel, AGA Divisional Meeting (1981), amendments consequential to adoption of Annexes 5 and 18	Introduced provisions related to development and use of instrument approach procedures, authority and competence to taxi aeroplanes. Changes to the requirements for the carriage of dangerous goods as a result of adoption by the Council of Annex 18. Units of measurement were brought in line with the provisions of Annex 5 and the *Note* in Chapter 3 concerning lease, charter and interchange was updated. The term "aerodrome operating minima" was introduced in lieu of "aerodrome meteorological minima", and definitions of "decision altitude/height" and "minimum descent altitude/height" entered in Chapter 1.	20 May 1983 20 September 1983 24 November 1983
11	Accident Prevention and Investigation Divisional Meeting, AIG (1979)	Introduction of provisions relating to flight recorders. Introduction of related guidance material in an attachment.	8 March 1985 29 July 1985 21 November 1985
12	Air Navigation Commission	Carriage of information on board aircraft; communication equipment on 121.5 MHz.	14 March 1986 27 July 1986 20 November 1986
13	Seventh meeting of the Obstacle Clearance Panel, Air Navigation Commission studies	Supply and use of oxygen and pressurization failure warning; refuelling with passengers on board; provision of climb performance data with all engines operating.	14 March 1986 27 July 1986 20 November 1986
14 (4th Edition)	Air Navigation Commission review of the Annex, Stage I. Third meeting of the Visual Flight Rules Operations Panel. Air Navigation Commission Study	a) Revision of the definitions of aerial work and general aviation. Revision of the definition of alternate aerodrome to introduce take-off, en-route and destination alternate aerodromes. Introduction of a new definition for a commercial air transport operation and the definitions for flight plan and flight recorder; b) deletion of the reference to aerial work from the applicability; c) alignment with Annex 6, Part I, particularly with respect to flight recorder records subsequent to accidents or incidents and the requirement for a Mach number indicator; d) elimination of the term "controlled VFR flight"; e) introduction of guidance material concerning flight data recording of important operational information in aeroplanes with electronic displays.	19 March 1990 30 July 1990 15 November 1990

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
15	Fifth meeting of the Operations Panel, Seventh and Eighth meetings of the Review of the General Concept of Separation Panel, Accident Investigation Divisional Meeting (AIG/1992), Air Navigation Commission studies	a) Revision of definitions of aerodrome operating minima, decision altitude/height, minimum descent altitude/height and introduction of definition of obstacle clearance altitude/height; b) introduction of new definitions for emergency locator transmitters (ELTs) required navigation performance (RNP) and RNP type; c) introduction of the definition for the classification of instrument approach and landing operations; d) revision of the requirements concerning the use of engraving metal foil flight data recorders; e) introduction of carriage requirements for emergency locator transmitters (ELTs) to replace provisions regarding survival radio equipment and emergency location beacon — ELBA; f) introduction of a requirement that the navigation equipment carried shall enable the aircraft to proceed in accordance with RNP types prescribed for the intended route(s) or area(s) and provisions to permit the uniform implementation of 300 m (1 000 ft) VSM above FL 290.	21 March 1994 25 July 1994 10 November 1994
16 (5th Edition)	Air Navigation Commission studies, Fourteenth meeting of the Dangerous Goods Panel, editorial amendment, text alignment with Annex 6, Part I and/or Part III, consequential amendment	a) Introduction of revised definitions; b) inclusion of references to Article 35 of the Convention; c) revision of the provisions concerning operating facilities, briefing, aeroplane airworthiness and safety precautions, destination alternate aerodromes, limitations imposed by weather conditions, use of oxygen and safety harness; d) new provisions concerning all aeroplanes on all flights, all aeroplanes operated as VFR flights and ground proximity warning systems (GPWS); e) revision of the provisions concerning aeroplanes operated in accordance with instrument flight rules (IFR); f) revision of the provisions concerning the composition of the flight crew; and g) revision of the provisions concerning the carriage and use of oxygen.	10 March 1995 24 July 1995 9 November 1995

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

When the following terms are used in the Standards, Recommended Practices and Definitions for the operation of aeroplanes in international general aviation, they have the following meanings:

Aerial work. An aircraft operation in which an aircraft is used for specialized services such as agriculture, construction, photography, surveying, observation and patrol, search and rescue, aerial advertisement, etc.

Aerodrome. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome operating minima. The limits of usability of an aerodrome for:

a) take-off, expressed in terms of runway visual range and/or visibility and, if necessary, cloud conditions;

b) landing in precision approach and landing operations, expressed in terms of visibility and/or runway visual range and decision altitude/height (DA/H) as appropriate to the category of the operation; and

c) landing in non-precision approach and landing operations, expressed in terms of visibility and/or runway visual range, minimum descent altitude/height (MDA/H) and, if necessary, cloud conditions.

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Alternate aerodrome. An aerodrome to which an aircraft may proceed when it becomes either impossible or inadvisable to proceed to or to land at the aerodrome of intended landing. Alternate aerodromes include the following:

Take-off alternate. An alternate aerodrome at which an aircraft can land should this become necessary shortly after take-off and it is not possible to use the aerodrome of departure.

En-route alternate. An aerodrome at which an aircraft would be able to land after experiencing an abnormal or emergency condition while en route.

Destination alternate. An alternate aerodrome to which an aircraft may proceed should it become impossible or inadvisable to land at the aerodrome of intended landing.

Note.— The aerodrome from which a flight departs may also be an en-route or a destination alternate aerodrome for that flight.

Commercial air transport operation. An aircraft operation involving the transport of passengers, cargo or mail for remuneration or hire.

Dangerous goods. Articles or substances which are capable of posing significant risk to health, safety or property when transported by air.

Note 1.— Dangerous goods are classified in Annex 18, Chapter 3.

Decision altitude (DA) or decision height (DH). A specified altitude or height in the precision approach at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

Note 1.— Decision altitude (DA) is referenced to mean sea level and decision height (DH) is referenced to the threshold elevation.

Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In Category III operations with a decision height the required visual reference is that specified for the particular procedure and operation.

Note 3.— For convenience where both expressions are used they may be written in the form "decision altitude/height" and abbreviated "DA/H".

Emergency locator transmitter (ELT). A generic term describing equipment which broadcast distinctive signals on designated frequencies and, depending on application, may either sense a crash and operate automatically or be manually activated. An ELT may be any of the following:

Automatic fixed ELT (ELT(AF)). An ELT which is permanently attached to an aircraft.

Automatic portable ELT (ELT(AP)). An ELT which is rigidly attached to an aircraft but readily removable from the aircraft after a crash.

Automatically deployable ELT (ELT(AD)). An ELT which is rigidly attached to an aircraft and deployed automatically in response to a crash. Manual deployment is also provided.

Survival ELT (ELT(S)). An ELT which is removable from an aircraft, stowed so as to facilitate its ready use in an emergency and activated by survivors. Automatic activation may apply.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aircraft during flight time.

Flight manual. A manual, associated with the certificate of airworthiness, containing limitations within which the aircraft is to be considered airworthy, and instructions and information necessary to the flight crew members for the safe operation of the aircraft.

Flight plan. Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Flight recorder. Any type of recorder installed in the aircraft for the purpose of complementing accident/incident investigation.

Flight time. The total time from the moment an aircraft first moves under its own power for the purpose of taking off until the moment it comes to rest at the end of the flight.

Note.— Flight time as here defined is synonymous with the term "block to block" time or "chock to chock" time in general usage which is measured from the time an aircraft moves from the loading point until it stops at the unloading point.

General aviation operation. An aircraft operation other than a commercial air transport operation or an aerial work operation.

Instrument approach and landing operations. Instrument approach and landing operations using instrument approach procedures are classified as follows:

Non-precision approach and landing operations. An instrument approach and landing which does not utilize electronic glide path guidance.

Precision approach and landing operations. An instrument approach and landing using precision azimuth and glide path guidance with minima as determined by the category of operation.

Categories of precision approach and landing operations:

Category I (CAT I) operation. A precision instrument approach and landing with a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or a runway visual range not less than 550 m.

Category II (CAT II) operation. A precision instrument approach and landing with a decision height lower than 60 m (200 ft), but not lower than 30 m (100 ft), and a runway visual range not less than 350 m.

Category IIIA (CAT IIIA) operation. A precision instrument approach and landing with:

a) a decision height lower than 30 m (100 ft) or no decision height; and

b) a runway visual range not less than 200 m.

Category IIIB (CAT IIIB) operation. A precision instrument approach and landing with:

a) a decision height lower than 15 m (50 ft) or no decision height; and

b) a runway visual range less than 200 m but not less than 50 m.

Category IIIC (CAT IIIC) operation. A precision instrument approach and landing with no decision height and no runway visual range limitations.

Note.— Where decision height (DH) and runway visual range (RVR) fall into different categories of operation, the instrument approach and landing operation would be conducted in accordance with the requirements of the most demanding category (e.g. an operation with a DH in the range of CAT IIIA but with an RVR in the range of CAT IIIB would be considered a CAT IIIB operation or an operation with a DH in the range of CAT II but with an RVR in the range of CAT I would be considered a CAT II operation).

Instrument meteorological conditions (IMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling*, less than the minima specified for visual meteorological conditions.

Note.— The specified minima for visual meteorological conditions are contained in Chapter 4 of Annex 2.

*As defined in Annex 2.

Meteorological information. Meteorological report, analysis, forecast, and any other statement relating to existing or expected meteorological conditions.

Minimum descent altitude (MDA) or minimum descent height (MDH). A specified altitude or height in a non-precision approach or circling approach below which descent must not be made without the required visual reference.

Note 1.— Minimum descent altitude (MDA) is referenced to mean sea level and minimum descent height (MDH) is referenced to the aerodrome elevation or to the threshold elevation if that is more than 2 m (7 ft) below the aerodrome elevation. A minimum descent height for a circling approach is referenced to the aerodrome elevation.

Note 2.— The required visual reference means that section of the visual aids or of the approach area which should have been in view for sufficient time for the pilot to have made an assessment of the aircraft position and rate of change of position, in relation to the desired flight path. In the case of a circling approach the required visual reference is the runway environment.

Note 3.— For convenience when both expressions are used they may be written in the form "minimum descent altitude/height" and abbreviated "MDA/H".

Night. The hours between the end of evening civil twilight and the beginning of morning civil twilight or such other period between sunset and sunrise, as may be prescribed by the appropriate authority.

Note.— Civil twilight ends in the evening when the centre of the sun's disc is 6 degrees below the horizon and begins in the morning when the centre of the sun's disc is 6 degrees below the horizon.

Obstacle clearance altitude (OCA) or obstacle clearance height (OCH). The lowest altitude or the lowest height above the elevation of the relevant runway threshold or the aerodrome elevation as applicable, used in establishing compliance with appropriate obstacle clearance criteria.

Note 1.— Obstacle clearance altitude is referenced to mean sea level and obstacle clearance height is referenced to the threshold elevation or in the case of non-precision approaches to the aerodrome elevation or the threshold elevation if that is more than 2 m (7 ft) below the aerodrome elevation. An obstacle clearance height for a circling approach is referenced to the aerodrome elevation.

Note 2.— For convenience when both expressions are used they may be written in the form "obstacle clearance altitude/height" and abbreviated "OCA/H".

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Required navigation performance (RNP). A statement of the navigation performance accuracy necessary for operation within a defined airspace.

RNP type. A containment value expressed as a distance in nautical miles from the intended position within which flights would be for at least 95 per cent of the total flying time.

Example.— RNP 4 represents a navigation accuracy of plus or minus 7.4 km (4 NM) on a 95 per cent containment basis.

State of Registry. The State on whose register the aircraft is entered.

Note.— In the case of the registration of aircraft of an international operating agency on other than a national basis, the States constituting the agency are jointly and severally bound to assume the obligations which, under the Chicago Convention, attach to a State of Registry. See, in this regard, the Council Resolution of 14 December 1967 on Nationality and Registration of Aircraft Operated by International Operating Agencies *(Doc 8722).*

Visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, equal to or better than specified minima.

Note.— The specified minima are contained in Annex 2.

CHAPTER 2. APPLICABILITY

The Standards and Recommended Practices contained in Annex 6, Part II shall be applicable to international general aviation operations with aeroplanes.

Note 1.— Standards and Recommended Practices applicable to the operation of aeroplanes by operators authorized to conduct international commercial air transport operations are to be found in Annex 6, Part I.

Note 2.— Standards and Recommended Practices applicable to international commercial air transport operations or international general aviation operations with helicopters are to be found in Annex 6, Part III.

CHAPTER 3. GENERAL

Note.— Although the Convention on International Civil Aviation allocates to the State of Registry certain functions which that State is entitled to discharge, or obligated to discharge, as the case may be, the Assembly recognized, in Resolution A23-13, that the State of Registry may be unable to fulfil its responsibilities adequately in instances where aircraft are leased, chartered or interchanged — in particular without crew — by an operator of another State and that the Convention may not adequately specify the rights and obligations of the State of an operator in such instances until such time as Article 83 bis *of the Convention enters into force. Accordingly, the Council urged that if, in the above-mentioned instances, the State of Registry finds itself unable to discharge adequately the functions allocated to it by the Convention, it delegate to the State of the Operator, subject to acceptance by the latter State, those functions of the State of Registry that can more adequately be discharged by the State of the Operator. It is understood that pending entry into force of Article 83* bis *of the Convention the foregoing action will only be a matter of practical convenience and will not affect either the provisions of the Chicago Convention prescribing the duties of the State of Registry or any third State.*

3.1 The pilot-in-command shall comply with the relevant laws, regulations and procedures of the States in which the aeroplane is operated.

Note 1.— Compliance with more restrictive measures, not in contravention of the provisions of 3.1, may be required by the State of Registry.

Note 2.— Rules covering flight over the high seas are contained in Annex 2.

3.2 The pilot-in-command shall be responsible for the operation and safety of the aeroplane and for the safety of all persons on board, during flight time.

3.3 If an emergency situation which endangers the safety of the aeroplane or persons necessitates the taking of action which involves a violation of local regulations or procedures, the pilot-in-command shall notify the appropriate local authority without delay. If required by the State in which the incident occurs, the pilot-in-command shall submit a report on any such violation to the appropriate authority of such State; in that event, the pilot-in-command shall also submit a copy of it to the State of Registry. Such reports shall be submitted as soon as possible and normally within ten days.

3.4 The pilot-in-command shall be responsible for notifying the nearest appropriate authority by the quickest available means of any accident involving the aeroplane resulting in serious injury or death of any person or substantial damage to the aeroplane or property.

Note.— A definition of the term "serious injury" is contained in Annex 13, and an explanation of the term "substantial damage" is given in the Accident/Incident Reporting Manual (ADREP Manual) *(Doc 9156).*

3.5 **Recommendation.—** The pilot-in-command should have available on board the aeroplane essential information concerning the search and rescue services in the areas over which it is intended the aeroplane will be flown.

3.6 Dangerous goods.

Note 1.— Provisions for carriage of dangerous goods are contained in Annex 18

Note 2.— Article 35 of the Convention refers to certain classes of cargo restrictions.

CHAPTER 4. FLIGHT PREPARATION AND IN-FLIGHT PROCEDURES

4.1 Adequacy of operating facilities

The pilot-in-command shall not commence a flight unless it has been ascertained by every reasonable means available that the ground and/or water areas and facilities available and directly required for such flight and for the safe operation of the aeroplane are adequate, including communication facilities and navigation aids.

Note.— "Reasonable means" in this Standard is intended to denote the use, at the point of departure, of information available to the pilot-in-command either through official information published by the aeronautical information services or readily obtainable from other sources.

4.2 Aerodrome operating minima

The pilot-in-command shall not operate to or from an aerodrome using operating minima lower than those which may be established for that aerodrome by the State in which it is located, except with the specific approval of that State.

Note.— It is the practice in some States to declare, for flight planning purposes, higher minima for an aerodrome when nominated as an alternate, than for the same aerodrome when planned as that of intended landing.

4.3 Briefing

4.3.1 The pilot-in-command shall ensure that crew members and passengers are made familiar, by means of an oral briefing or by other means, with the location and the use of:

a) seat belts; and, as appropriate,

b) emergency exits;

c) life jackets;

d) oxygen dispensing equipment; and

e) other emergency equipment provided for individual use, including passenger emergency briefing cards.

4.3.2 The pilot-in-command shall ensure that all persons on board are aware of the location and general manner of use of the principal emergency equipment carried for collective use.

4.4 Aeroplane airworthiness and safety precautions

4.4.1 A flight shall not be commenced until the pilot-in-command is satisfied that:

a) the aeroplane is airworthy, duly registered and that appropriate certificates with respect thereto are aboard the aeroplane;

b) the instruments and equipment installed in the aeroplane are appropriate, taking into account the expected flight conditions;

c) any necessary maintenance has been performed in accordance with Chapter 8;

d) the mass of the aeroplane and centre of gravity location are such that the flight can be conducted safely, taking into account the flight conditions expected;

e) any load carried is properly distributed and safely secured; and

f) the aeroplane operating limitations, contained in the flight manual, or its equivalent, will not be exceeded.

4.4.2 **Recommendation.—** *The pilot-in-command should have sufficient information on climb performance with all engines operating to enable determination of the climb gradient that can be achieved during the departure phase for the existing take-off conditions and intended take-off technique.*

4.5 Weather reports and forecasts

Before commencing a flight the pilot-in-command shall be familiar with all available meteorological information appropriate to the intended flight. Preparation for a flight away from the vicinity of the place of departure, and for every flight under the instrument flight rules, shall include: 1) a study of available current weather reports and forecasts; and 2) the planning of an alternative course of action to provide for the eventuality that the flight cannot be completed as planned, because of weather conditions.

Note.— The requirements for flight plans are contained in Annex 2 — Rules of the Air *and* Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services *(PANS-RAC, Doc 4444).*

4.6 Limitations imposed by weather conditions

4.6.1 Flight in accordance with the visual flight rules

A flight, except one of purely local character in visual meteorological conditions, to be conducted in accordance with the visual flight rules shall not be commenced unless available current meteorological reports, or a combination of current reports and forecasts, indicate that the meteorological conditions along the route, or that part of the route to be flown under the visual flight rules, will, at the appropriate time, be such as to render compliance with these rules possible.

4.6.2 Flight in accordance with the instrument flight rules

4.6.2.1 *When a destination alternate aerodrome is required.* A flight to be conducted in accordance with the instrument flight rules shall not be commenced unless the available information indicates that conditions, at the aerodrome of intended landing and at least one destination alternate will, at the estimated time of arrival, be at or above the aerodrome operating minima.

4.6.2.2 *When no destination alternate aerodrome is required.* A flight to be conducted in accordance with the instrument flight rules to an aerodrome when no alternate aerodrome is required shall not be commenced unless:

a) a standard instrument approach procedure is prescribed for the aerodrome of intended landing; and

b) available current meteorological information indicates that the following meteorological conditions will exist from two hours before to two hours after the estimated time of arrival:

   1) a cloud base of at least 300 m (1 000 ft) above the minimum associated with the instrument approach procedure; and

   2) visibility of at least 5.5 km or of 4 km more than the minimum associated with the procedure.

4.6.3 A flight shall not be continued towards the aerodrome of intended landing unless the latest available meteorological information indicates that conditions at that aerodrome, or at least one destination alternate aerodrome, will, at the estimated time of arrival, be at or above the specified aerodrome operating minima.

4.6.4 Except in the case of emergency, an aeroplane shall not continue its approach-to-land beyond a point at which the limits of the aerodrome operating minima would be infringed.

4.6.5 A flight to be operated in known or expected icing conditions shall not be commenced unless the aeroplane is certificated and equipped to cope with such conditions.

4.7 Destination alternate aerodromes

For a flight to be conducted in accordance with the instrument flight rules, at least one destination alternate aerodrome shall be selected and specified in the flight plan, unless:

a) the duration of the flight and the meteorological conditions prevailing are such that there is reasonable certainty that, at the estimated time of arrival at the aerodrome of intended landing, and for a reasonable period before and after such time, the approach and landing may be made under visual meteorological conditions; or

b) the aerodrome of intended landing is isolated and there is no suitable destination alternate aerodrome.

4.8 Fuel and oil supply

4.8.1 A flight shall not be commenced unless, taking into account both the meteorological conditions and any delays that are expected in flight, the aeroplane carries sufficient fuel and oil to ensure that it can safely complete the flight, and, as applicable, the following special provisions are complied with:

4.8.1.1 *Flight in accordance with the instrument flight rules.* At least sufficient fuel and oil shall be carried to allow the aeroplane:

a) *when, in accordance with the exception contained in 4.6.2.2, a destination alternate aerodrome is not required,* to fly to the aerodrome to which the flight is planned and thereafter for a period of 45 minutes; or

b) *when a destination alternate aerodrome is required,* to fly to the aerodrome to which the flight is planned, thence to an alternate aerodrome, and thereafter for a period of 45 minutes.

Note.— Nothing in 4.8 precludes amendment of a flight plan in flight in order to re-plan the flight to another aerodrome, provided that the requirements of 4.8 can be complied with from the point where the flight is re-planned.

4.9 Oxygen supply

The pilot-in-command shall ensure that breathing oxygen is available to crew members and passengers in sufficient quantities for all flights at such altitudes where a lack of oxygen might result in impairment of the faculties of crew members or harmfully affect passengers.

Note.— Guidance on the carriage and use of oxygen is given in Attachment B.

4.10 Use of oxygen

All flight crew members, when engaged in performing duties essential to the safe operation of an aeroplane in flight, shall use breathing oxygen continuously whenever the circumstances prevail for which its supply has been required in 4.9.

4.11 In-flight emergency instruction

In an emergency during flight, the pilot-in-command shall ensure that all persons on board are instructed in such emergency action as may be appropriate to the circumstances.

4.12 Weather reporting by pilots

Recommendation.— *When weather conditions likely to affect the safety of other aircraft are encountered, they should be reported as soon as possible.*

4.13 Hazardous flight conditions

Recommendation.— *Hazardous flight conditions, other than those associated with meteorological conditions, encountered en route should be reported as soon as possible. The reports so rendered should give such details as may be pertinent to the safety of other aircraft.*

4.14 Fitness of flight crew members

The pilot-in-command shall be responsible for ensuring that a flight:

a) will not be commenced if any flight crew member is incapacitated from performing duties by any cause such as injury, sickness, fatigue, the effects of alcohol or drugs; and

b) will not be continued beyond the nearest suitable aerodrome when flight crew members' capacity to perform functions is significantly reduced by impairment of faculties from causes such as fatigue, sickness, lack of oxygen.

4.15 Flight crew members at duty stations

4.15.1 Take-off and landing

All flight crew members required to be on flight deck duty shall be at their stations.

4.15.2 En route

All flight crew members required to be on flight deck duty shall remain at their stations except when their absence is necessary for the performance of duties in connexion with the operation of the aeroplane, or for physiological needs.

4.15.3 Seat belts

All flight crew members shall keep their seat belts fastened when at their stations.

4.15.4 Safety harness

Recommendation.— *When safety harnesses are provided, any flight crew member occupying a pilot's seat should keep the safety harness fastened during the take-off and landing phases; all other flight crew members should keep their safety harnesses fastened during the take-off and landing phases unless the shoulder straps interfere with the performance of their duties, in which case the shoulder straps may be unfastened but the seat belt must remain fastened.*

Note.— Safety harness includes shoulder strap(s) and a seat belt which may be used independently.

4.16 Instrument flight procedures

4.16.1 One or more instrument approach procedures designed in accordance with the classification of instrument approach and landing operations shall be approved and promulgated by the State in which the aerodrome is located to serve each instrument runway or aerodrome utilized for instrument flight operations.

4.16.2 All aeroplanes operated in accordance with instrument flight rules shall comply with the instrument flight procedures approved by the State in which the aerodrome is located.

Note 1.— Definitions for the classification of instrument approach and landing operations are in Chapter 1.

Note 2.— Operational procedures recommended for the guidance of operations personnel involved in instrument flight operations are described in PANS-OPS (Doc 8168), Volume I.

Note 3.— Criteria for the construction of instrument flight procedures for the guidance of procedure specialists are provided in PANS-OPS (Doc 8168), Volume II.

4.17 Instruction — general

An aeroplane shall not be taxied on the movement area of an aerodrome unless the person at the controls:

a) has been duly authorized by the owner or in the case where it is leased the lessee, or a designated agent;

b) is fully competent to taxi the aeroplane;

c) is qualified to use the radio telephone if radio communications are required; and

d) has received instruction from a competent person in respect of aerodrome layout, and where appropriate, information on routes, signs, marking, lights, ATC signals and instructions, phraseology and procedures, and is able to conform to the operational standards required for safe aeroplane movement at the aerodrome.

4.18 Refuelling with passengers on board

4.18.1 **Recommendation.—** *An aeroplane should not be refuelled when passengers are embarking, on board or disembarking unless it is attended by the pilot-in-command or other qualified personnel ready to initiate and direct an evacuation of the aeroplane by the most practical and expeditious means available.*

4.18.2 **Recommendation.—** *When refuelling with passengers embarking, on board or disembarking, two-way communications should be maintained by aeroplane intercommunications system or other suitable means between the ground crew supervising the refuelling and the pilot-in-command or other qualified personnel required by 4.18.1.*

Note 1.— The provisions of 4.18.1 do not necessarily require the deployment of integral aeroplane stairs or the opening of emergency exits as a prerequisite to refuelling.

Note 2.— Provisions concerning aircraft refuelling are contained in Annex 14 and guidance on safe refuelling practices is contained in the Airport Services Manual, *Parts 1 and 8.*

Note 3.— Additional precautions are required when refuelling with fuels other than aviation kerosene or when refuelling results in a mixture of aviation kerosene with other aviation turbine fuels, or when an open line is used.

CHAPTER 5. AEROPLANE PERFORMANCE OPERATING LIMITATIONS

5.1 An aeroplane shall be operated:

a) in compliance with the terms of its airworthiness certificate or equivalent approved document;

b) within the operating limitations prescribed by the certificating authority of the State of Registry; and

c) within the mass limitations imposed by compliance with the applicable noise certification Standards in Annex 16, Volume I, unless otherwise authorized, in exceptional circumstances for a certain aerodrome or a runway where there is no noise disturbance problem, by the competent authority of the State in which the aerodrome is situated.

5.2 Placards, listings, instrument markings, or combinations thereof, containing those operating limitations prescribed by the certificating authority of the State of Registry for visual presentation, shall be displayed in the aeroplane.

Note.— The Standards of Annex 8 — Airworthiness of Aircraft, *Part III, apply to all aeroplanes of over 5 700 kg maximum certificated take-off mass intended for the carriage of passengers or cargo or mail in international air navigation.*

CHAPTER 6. AEROPLANE INSTRUMENTS AND EQUIPMENT

Note.— Specifications for the provision of aeroplane communication and navigation equipment are contained in Chapter 7.

6.1 All aeroplanes on all flights

6.1.1 General

In addition to the minimum equipment necessary for the issuance of a certificate of airworthiness, the instruments, equipment and flight documents prescribed in the following paragraphs shall be installed or carried, as appropriate, in aeroplanes according to the aeroplane used and to the circumstances under which the flight is to be conducted.

6.1.2 Instruments

An aeroplane shall be equipped with instruments which will enable the flight crew to control the flight path of the aeroplane, carry out any required procedural manoeuvre, and observe the operating limitations of the aeroplane in the expected operating conditions.

6.1.3 Equipment

6.1.3.1 *All aeroplanes on all flights.*

6.1.3.1.1 All aeroplanes on all flights shall be equipped with:

a) an accessible first-aid kit;

b) portable fire extinguishers of a type which, when discharged, will not cause dangerous contamination of the air within the aeroplane. At least one shall be located in:

1) the pilot's compartment; and

2) each passenger compartment that is separate from the pilot's compartment and not readily accessible to the pilot or co-pilot;

c) 1) a seat or berth for each person over an age to be determined by the State of Registry; and

2) a seat belt for each seat and restraining belts for each berth;

d) the following manuals, charts and information:

1) the flight manual or other documents or information concerning any operating limitations prescribed for the aeroplane by the certificating authority of the State of Registry, required for the application of Chapter 5;

2) current and suitable charts for the route of the proposed flight and all routes along which it is reasonable to expect that the flight may be diverted;

3) procedures, as prescribed in Annex 2, for pilots-in-command of intercepted aircraft; and

4) visual signals for use by intercepting and intercepted aircraft, as contained in Annex 2; and

e) spare electrical fuses of appropriate ratings for replacement of those accessible in flight.

6.1.3.1.2 **Recommendation.—** *All aeroplanes on all flights should be equipped with the ground-air signal codes for search and rescue purposes.*

6.1.3.1.3 **Recommendation.—** *All aeroplanes on all flights should be equipped with a safety harness for each flight crew member seat.*

Note.— Safety harness includes shoulder strap(s) and a seat belt which may be used independently.

6.1.4 Marking of break-in points

6.1.4.1 If areas of the fuselage suitable for break-in by rescue crews in an emergency are marked on an aeroplane, such areas shall be marked as shown below (see figure following). The colour of the markings shall be red or yellow, and if necessary they shall be outlined in white to contrast with the background.

6.1.4.2 If the corner markings are more than 2 m apart, intermediate lines 9 cm x 3 cm shall be inserted so that there is no more than 2 m between adjacent markings.

Note.— This Standard does not require any aeroplane to have break-in areas.

6.2 All aeroplanes operated as VFR flights

6.2.1 All aeroplanes when operated as VFR flights shall be equipped with:

a) a magnetic compass;

b) an accurate timepiece indicating the time in hours, minutes and seconds;

c) a sensitive pressure altimeter;

d) an airspeed indicator; and

e) such additional instruments or equipment as may be prescribed by the appropriate authority.

6.2.2 **Recommendation.—** *VFR flights which are operated as controlled flights should be equipped in accordance with 6.6.*

6.3 All aeroplanes on flights over water

6.3.1 Seaplanes

All seaplanes for all flights shall be equipped with:

a) one life jacket, or equivalent individual floatation device, for each person on board, stowed in a position readily accessible from his seat or berth;

b) equipment for making the sound signals prescribed in the International Regulations for Preventing Collisions at Sea, where applicable;

c) one anchor;

d) one sea anchor (drogue), when necessary to assist in manoeuvring.

Note.— "Seaplanes" includes amphibians operated as seaplanes.

6.3.2 Landplanes

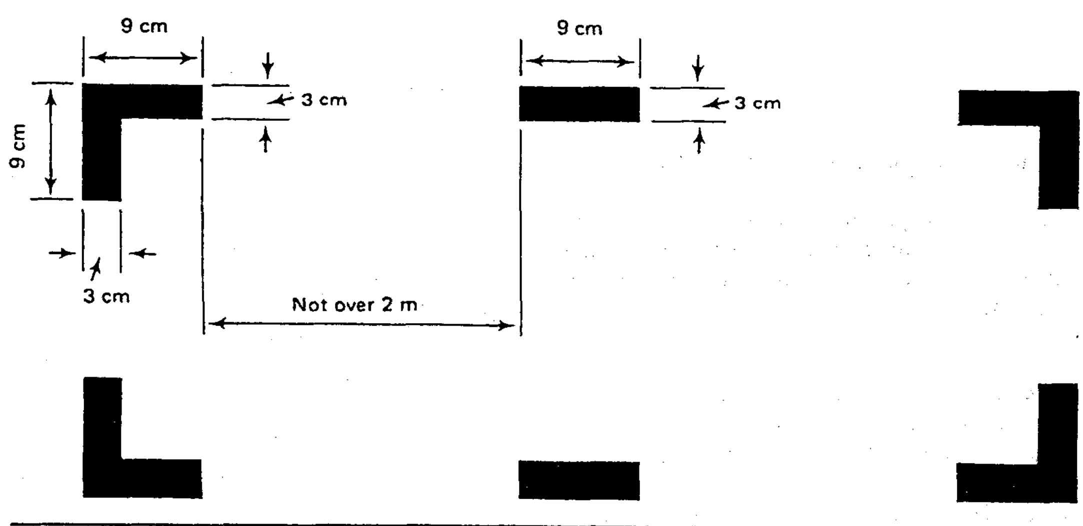
6.3.2.1 Single-Engine Aeroplanes.

Recommendation.— *All single-engine landplanes when flying en route over water beyond gliding distance from the shore should carry one life jacket or equivalent individual floatation device for each person on board, stowed in a position easily accessible from the seat or berth of the person for whose use it is provided.*

Note.— "Landplanes" includes amphibians operated as landplanes.

6.3.3 All aeroplanes on extended flights over water

All aeroplanes when operated on extended flights over water shall be equipped with:



MARKING OF BREAK-IN POINTS (see 6.1.4)

a) when the aeroplane may be over water at a distance of more than 93 km (50 NM) away from land suitable for making an emergency landing:

— one life jacket or equivalent individual floatation device for each person on board, stowed in a position easily accessible from the seat or berth of the person for whose use it is provided;

b) when over water away from land suitable for making an emergency landing at a distance of more than 185 km (100 NM), in the case of single-engine aeroplanes, and more than 370 km (200 NM), in the case of multi-engine aeroplanes capable of continuing flight with one engine inoperative:

1) life-saving rafts in sufficient numbers to carry all persons on board, stowed so as to facilitate their ready use in emergency, provided with such life-saving equipment including means of sustaining life as is appropriate to the flight to be undertaken; and

2) equipment for making the pyrotechnical distress signals described in Annex 2.

6.4 All aeroplanes on flights over designated land areas

Aeroplanes when operated across land areas which have been designated by the State concerned as areas in which search and rescue would be especially difficult, shall be equipped with such signalling devices and life-saving equipment (including means of sustaining life) as may be appropriate to the area overflown.

6.5 All aeroplanes on high altitude flights

6.5.1 All aeroplanes intended to be operated at high altitudes shall be equipped with oxygen storage and dispensing apparatus capable of storing and dispensing the oxygen supplies required in 4.9.

6.5.2 Aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 1990

Pressurized aeroplanes intended to be operated at flight altitudes at which the atmospheric pressure is less than 376 hPa shall be equipped with a device to provide positive warning to the flight crew of any dangerous loss of pressurization.

6.5.3 Aeroplanes for which the individual certificate of airworthiness is first issued before 1 January 1990

Recommendation.— *Pressurized aeroplanes intended to be operated at flight altitudes at which the atmospheric pressure is less than 376 Hpa should be equipped with a device to provide positive warning to the flight crew of any dangerous loss of pressurization.*

6.6 All aeroplanes operated in accordance with the instrument flight rules

All aeroplanes when operated in accordance with the instrument flight rules or when the aeroplane cannot be maintained in a desired attitude without reference to one or more flight instruments, shall be equipped with:

a) a magnetic compass;

b) an accurate timepiece indicating the time in hours, minutes and seconds;

c) a sensitive pressure altimeter;

Note.— Due to the long history of misreadings, the use of drum-pointer altimeters is not recommended.

d) an airspeed indicating system with a means of preventing malfunctioning due to either condensation or icing;

e) a turn and slip indicator;

f) an attitude indicator (artificial horizon);

g) a heading indicator (directional gyroscope);

Note.— The requirements of e), f) and g) above, may be met by combinations of instruments or by integrated flight director systems provided that the safeguards against total failure, inherent in the three separate instruments, are retained.

h) means of indicating whether the supply of power to the gyroscopic instruments is adequate;

i) a means of indicating in the flight crew compartment the outside air temperature;

j) a rate-of-climb and descent indicator; and

k) such additional instruments or equipment as may be prescribed by the appropriate authority.

6.7 All aeroplanes when operated at night

All aeroplanes, when operated at night, shall be equipped with:

a) all the equipment specified in 6.6;

b) the lights required by Annex 2 for aircraft in flight or operating on the movement area of an aerodrome;

Note.— Specifications for lights meeting the requirements of Annex 2 for navigation lights are contained in the Appendix. The general characteristics of lights are specified in Annex 8. Detailed specifications for lights meeting the requirements of Annex 2 for aircraft in flight or operating on the movement area of an aerodrome are contained in the Airworthiness Technical Manual *(Doc 9051).*

c) a landing light;

d) illumination for all flight instruments and equipment that are essential for the safe operation of the aeroplane;

e) lights in all passenger compartments; and

f) an electric torch for each crew member station.

6.8 All aeroplanes complying with the noise certification Standards in Annex 16, Volume I

An aeroplane shall carry a document attesting noise certification.

Note.— The attestation may be contained in any document, carried on board, approved by the State of Registry.

6.9 Turbine engine aeroplanes — ground proximity warning system (GPWS)

6.9.1 **Recommendation.**— *All turbine engine aeroplanes of a maximum certificated take-off mass in excess of 15 000 kg or authorized to carry more than 30 passengers should be equipped with a ground proximity warning system.*

6.9.2 All turbine engine aeroplanes of a maximum certificated take-off mass in excess of 5 700 kg or authorized to carry more than nine passengers shall be equipped with a ground proximity warning system on or after 1 January 1999.

6.9.3 A ground proximity warning system shall provide automatically a timely and distinctive warning to the flight crew when the aeroplane is in potentially hazardous proximity to the earth's surface.

6.9.4 On or after 1 January 1999 a ground proximity warning system shall provide, as a minimum, warnings of the following circumstances;

1) excessive descent rate;

2) excessive terrain closure rate;

3) excessive altitude loss after take-off or go-around;

4) unsafe terrain clearance while not in landing configuration;

a) gear not locked down;

b) flaps not in a landing position; and

5) excessive descent below the instrument glide path.

6.10 Flight recorders

Note 1.— Flight recorders comprise two systems, a flight data recorder and a cockpit voice recorder.

Note 2.— Detailed guidance on flight recorders is contained in Attachment A.

6.10.1 Flight data recorders — types

6.10.1.1 A Type I flight data recorder shall record the parameters required to determine accurately the aeroplane flight path, speed, attitude, engine power, configuration and operation.

6.10.1.2 A Type II flight data recorder shall record the parameters required to determine accurately the aeroplane flight path, speed, attitude, engine power and configuration of lift and drag devices.

6.10.1.3 The use of engraving metal foil flight data recorders shall be discontinued by 1 January 1995.

6.10.2 Flight data recorders — duration

Types I and II flight data recorders shall be capable of retaining the information recorded during at least the last 25 hours of their operation.

6.10.3 Flight data recorders — aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 1989

6.10.3.1 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg shall be equipped with a Type I flight data recorder.

6.10.3.2 **Recommendation.**— *All aeroplanes of a maximum certificated take-off mass of over 5 700 kg up to and including 27 000 kg should be equipped with a Type II flight data recorder.*

6.10.4 Cockpit voice recorders — aeroplanes for which the individual certificate of airworthiness is first issued on or after 1 January 1987

6.10.4.1 All aeroplanes of a maximum certificated take-off mass of over 27 000 kg shall be equipped with a cockpit voice recorder, the objective of which is the recording of the aural environment on the flight deck during flight time.

6.10.4.2 **Recommendation.—** *All aeroplanes of a maximum certificated take-off mass of over 5 700 kg up to and including 27 000 kg should be equipped with a cockpit voice recorder, the objective of which is the recording of the aural environment on the flight deck during flight time.*

6.10.5 Cockpit voice recorders — duration

6.10.5.1 A cockpit voice recorder shall be capable of retaining the information recorded during at least the last 30 minutes of its operation.

6.10.5.2 **Recommendation.—** *A cockpit voice recorder, installed in aeroplanes of a maximum certificated take-off mass of over 5 700 kg for which the individual certificate of airworthiness is first issued on or after 1 January 1990, should be capable of retaining the information recorded during at least the last two hours of its operation.*

6.10.6 Flight recorders — construction and installation

Flight recorders shall be constructed, located and installed so as to provide maximum practical protection for the recordings in order that the recorded information may be preserved, recovered and transcribed.

6.10.7 Flight recorders — operation

6.10.7.1 Flight recorders shall not be switched off during flight time.

6.10.7.2 **Recommendation.—** *To preserve flight recorder records, flight recorders should be de-activated upon completion of flight time following an accident or incident, and not re-activated prior to removal of these records.*

6.10.8 Flight recorder records

6.10.8.1 The pilot-in-command shall ensure, to the extent possible, in the event the aeroplane becomes involved in an accident, the preservation of all related flight recorder records, and if necessary the associated flight recorders, and their retention in safe custody pending their disposition as determined in accordance with Annex 13.

6.10.8.2 **Recommendation.—** *The pilot-in-command should ensure, to the extent possible, in the event the aeroplane becomes involved in an incident, the preservation of all related flight recorder records, and if necessary the associated flight recorders, and their retention in safe custody pending their disposition as determined in accordance with Annex 13.*

6.11 Mach number indicator

All aeroplanes with speed limitations expressed in terms of Mach number shall be equipped with a Mach number indicator.

Note.— This does not preclude the use of the airspeed indicator to derive Mach number for ATS purposes.

6.12 Emergency locator transmitter (ELT)

6.12.1 All aeroplanes operated on extended flights over water as described in 6.3.3 b) and when operated on flights over designated land areas as described in 6.4 shall be equipped with one ELT.

6.12.2 **Recommendation.—** *All aeroplanes should carry an automatically activated ELT.*

6.12.3 ELT equipment carried to satisfy the requirements of 6.12.1 and 6.12.2 shall operate in accordance with the relevant provisions of Annex 10, Volume I.

CHAPTER 7. AEROPLANE COMMUNICATION AND NAVIGATION EQUIPMENT

7.1 Communication equipment

7.1.1 An aeroplane to be operated in accordance with the instrument flight rules or at night shall be provided with radio communication equipment. Such equipment shall be capable of conducting two-way communication with those aeronautical stations and on those frequencies prescribed by the appropriate authority.

Note.— The requirements of 7.1.1 are considered fulfilled if the ability to conduct the communications specified therein is established during radio propagation conditions which are normal for the route.

7.1.2 When compliance with 7.1.1 requires that more than one communications equipment unit be provided, each shall be independent of the other or others to the extent that a failure in any one will not result in failure of any other.

7.1.3 An aeroplane to be operated in accordance with the visual flight rules, but as a controlled flight, shall, unless exempted by the appropriate authority, be provided with radio communication equipment capable of conducting two-way communication at any time during flight with such aeronautical stations and on such frequencies as may be prescribed by the appropriate authority.

7.1.4 An aeroplane to be operated on a flight to which the provisions of 6.3.3 or 6.4 apply shall, unless exempted by the appropriate authority, be provided with radio communication equipment capable of conducting two-way communication at any time during flight with such aeronautical stations and on such frequencies as may be prescribed by the appropriate authority.

7.1.5 The radio communication equipment required in accordance with 7.1.1 to 7.1.4 shall provide for communication on the aeronautical emergency frequency 121.5 MHz.

7.2 Navigation equipment

7.2.1 An aeroplane shall be provided with navigation equipment which will enable it to proceed:

a) in accordance with the flight plan;

b) in accordance with prescribed RNP types; and

c) in accordance with the requirements of air traffic services;

except when, if not so precluded by the appropriate authority, navigation for flights under the visual flight rules is accomplished by visual reference to landmarks at least every 110 km (60 NM).

Note.— Information on RNP and associated procedures is contained in the Manual on Required Navigation Performance (RNP) *(Doc 9613).*

7.2.2 For flights in defined portions of airspace where, based on Regional Air Navigation Agreement, minimum navigation performance specifications (MNPS) are prescribed, an aeroplane shall be provided with navigation equipment which:

a) continuously provides indications to the flight crew of adherence to or departure from track to the required degree of accuracy at any point along that track; and

b) has been authorized by the State of Registry for MNPS operations concerned.

Note.— The prescribed minimum navigation performance specifications and the procedures governing their application are published in Regional Supplementary Procedures *(Doc 7030).*

7.2.3 For flights in defined portions of airspace where, based on Regional Air Navigation Agreement, a vertical separation minimum (VSM) of 300 m (1 000 ft) is applied above FL 290, an aeroplane:

a) shall be provided with equipment which is capable of:

1) indicating to the flight crew the flight level being flown;

2) automatically maintaining a selected flight level;

3) providing an alert to the flight crew when a deviation occurs from the selected flight level. The threshold for the alert shall not exceed ±90 m (300 ft); and

4) automatically reporting pressure-altitude; and

b) shall be authorized by the State of Registry for operation in the airspace concerned.

7.2.4 The aeroplane shall be sufficiently provided with navigation equipment to ensure that, in the event of the failure of one item of equipment at any stage of the flight, the remaining equipment will enable the aeroplane to proceed in accordance with 7.2.1 and where applicable 7.2.2 and 7.2.3.

Note 1.— This requirement may be met by means other than the duplication of equipment.

Note 2.— Guidance material relating to aircraft equipment necessary for flight in airspace where a 300 m (1 000 ft) VSM is applied above FL 290 is contained in the Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive *(Doc 9574).*

7.2.5 On flights in which it is intended to land in instrument meteorological conditions, an aeroplane shall be provided with radio equipment capable of receiving signals providing guidance to a point from which a visual landing can be effected. This equipment shall be capable of providing such guidance for each aerodrome at which it is intended to land in instrument meteorological conditions and for any designated alternate aerodromes.

CHAPTER 8. AEROPLANE MAINTENANCE

Note on the application of this Chapter.— For the purpose of this Chapter "aeroplane" includes: powerplants, propellers, components, accessories, instruments, equipment and apparatus including emergency equipment.

8.1 Responsibility

8.1.1 The owner of an aeroplane, or in the case where it is leased, the lessee, shall be responsible for its maintenance in an airworthy condition when in use.

8.1.2 The owner of an aeroplane, or in the case where it is leased, the lessee, shall be responsible for ensuring, in so far as practicable, that:

a) all maintenance, overhaul, alterations and repairs which affect airworthiness, are performed as prescribed by the State of Registry;

b) maintenance personnel make appropriate entries in the aeroplane maintenance records certifying that the aeroplane is airworthy;

c) the maintenance release is completed and signed by a person or persons qualified in accordance with the provisions of Annex 1 to certify that the maintenance work has been completed satisfactorily and in accordance with the prescribed methods.

8.2 Qualification to certify as airworthy

Each person charged with the responsibility of certifying as to the airworthiness of an aeroplane shall be qualified in accordance with the provisions of Annex 1.

8.3 Maintenance records

8.3.1 The owner of an aeroplane shall keep a maintenance record of the following:

a) In respect of the entire aeroplane:

1) the current empty mass and the location of the centre of gravity when empty;

2) the addition or removal of equipment;

3) the kind and extent of the maintenance and alteration and the time in service and date when the work was performed;

4) chronological list of compliance with airworthiness directives and the methods of compliance.

b) In respect of the major components:

1) the total time in service;

2) the date of the last overhaul;

3) the time in service since the last overhaul;

4) the date of the last inspection.

c) In respect of those instruments and equipment, the serviceability and operating life of which are determined by their time in service:

1) such records of the time in service as are necessary to determine their serviceability or to compute their operating life;

2) the date of the last inspection.

8.3.2 The records referred to in 8.3.1 shall be kept for a period of 90 days after the end of the operating life of the unit to which they refer.

8.3.3 The lessee of an aeroplane shall comply with the requirements of 8.3.1 and 8.3.2, as applicable, while the aeroplane is leased.

Note.— Maintenance records or related documents, other than a valid certificate of airworthiness, need not be carried in the aeroplane during international flights.

CHAPTER 9. AEROPLANE FLIGHT CREW

9.1 Qualifications

The pilot-in-command shall ensure that the licences of each flight crew member have been issued or rendered valid by the State of Registry, and are properly rated and of current validity, and shall be satisfied that flight crew members have maintained competence.

9.2 Composition of the flight crew

The number and composition of the flight crew shall not be less than that specified in the flight manual or other documents associated with the certificate of airworthiness.

APPENDIX. LIGHTS TO BE DISPLAYED BY AEROPLANES

(Note.— See Chapter 6)

1. Terminology

When the following terms are used in this Appendix, they have the following meanings:

Angles of coverage.

a) Angle of coverage A is formed by two intersecting vertical planes making angles of 70 degrees to the right and 70 degrees to the left respectively, looking aft along the longitudinal axis to a vertical plane passing through the longitudinal axis.

b) Angle of coverage F is formed by two intersecting vertical planes making angles of 110 degrees to the right and 110 degrees to the left respectively, looking forward along the longitudinal axis to a vertical plane passing through the longitudinal axis.

c) Angle of coverage L is formed by two intersecting vertical planes, one parallel to the longitudinal axis of the aeroplane, and the other 110 degrees to the left of the first, when looking forward along the longitudinal axis.

d) Angle of coverage R is formed by two intersecting vertical planes, one parallel to the longitudinal axis of the aeroplane, and the other 110 degrees to the right of the first, when looking forward along the longitudinal axis.

Horizontal plane. The plane containing the longitudinal axis and perpendicular to the plane of symmetry of the aeroplane.

Longitudinal axis of the aeroplane. A selected axis parallel to the direction of flight at a normal cruising speed, and passing through the centre of gravity of the aeroplane.

Making way. An aeroplane on the surface of the water is "making way" when it is under way and has a velocity relative to the water.

Under command. An aeroplane on the surface of the water is "under command" when it is able to execute manoeuvres as required by the International Regulations for Preventing Collisions at Sea for the purpose of avoiding other vessels.

Under way. An aeroplane on the surface of the water is "under way" when it is not aground or moored to the ground or to any fixed object on the land or in the water.

Vertical planes. Planes perpendicular to the horizontal plane.

Visible. Visible on a dark night with a clear atmosphere.

2. Navigation lights to be displayed in the air

Note.— The lights specified herein are intended to meet the requirements of Annex 2 for navigation lights.

As illustrated in Figure 1, the following unobstructed navigation lights shall be displayed:

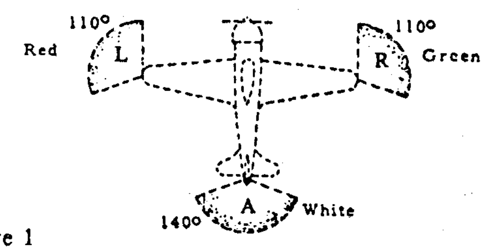


Figure 1

a) a red light projected above and below the horizontal plane through angle of coverage L;

b) a green light projected above and below the horizontal plane through angle of coverage R;

c) a white light projected above and below the horizontal plane rearward through angle of coverage A.

3. Lights to be displayed on the water

3.1 General

Note.— The lights specified herein are intended to meet the requirements of Annex 2 for lights to be displayed by aeroplanes on the water.

The International Regulations for Preventing Collisions at Sea require different lights to be displayed in each of the following circumstances:

a) when under way;

b) when towing another vessel or aeroplane;

c) when being towed;

d) when not under command and not making way;

e) when making way but not under command;

f) when at anchor;

g) when aground.

The lights required by aeroplanes in each case are described below.

3.2 When under way

As illustrated in Figure 2, the following appearing as steady unobstructed lights:

a) a red light projected above and below the horizontal through angle of coverage L;

b) a green light projected above and below the horizontal through angle of coverage R;

c) a white light projected above and below the horizontal through angle of coverage A; and

d) a white light projected through angle of coverage F.

The lights described in a), b) and c) should be visible at a distance of at least 3.7 km (2 NM). The light described in d) should be visible at a distance of 9.3 km (5 NM) when fitted to an aeroplane of 20 m or more in length or visible at a distance of 5.6 km (3 NM) when fitted to an aeroplane of less than 20 m in length.

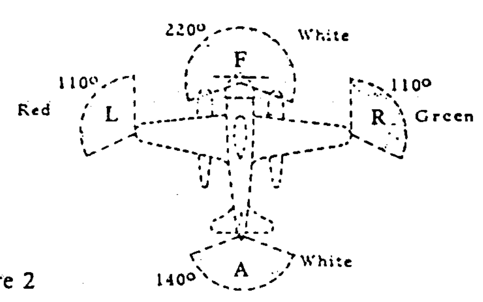


Figure 2

3.3 When towing another vessel or aeroplane

As illustrated in Figure 3, the following appearing as steady, unobstructed lights:

a) the lights described in 3.2 above;

b) a second light having the same characteristics as the light described in 3.2 d) and mounted in a vertical line at least 2 m above or below it; and

c) a yellow light having otherwise the same characteristics as the light described in 3.2 c) and mounted in a vertical line at least 2 m above it.

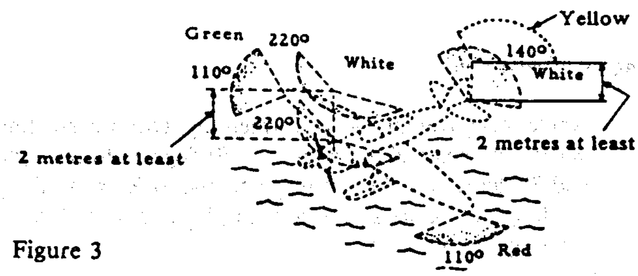


Figure 3

3.4 When being towed

The lights described in 3.2 a), b) and c) appearing as steady, unobstructed lights.

3.5 When not under command and not making way

As illustrated in Figure 4, two steady red lights placed where they can best be seen, one vertically over the other and not less than 1 m apart, and of such a character as to be visible all around the horizon at a distance of at least 3.7 km (2 NM).

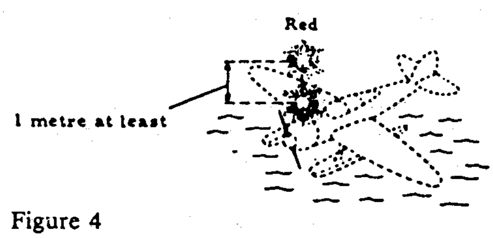


Figure 4

3.6 When making way but not under command

As illustrated in Figure 5, the lights described in 3.5 plus the lights described in 3.2 a), b) and c).

Note.— The display of lights prescribed in 3.5 and 3.6 above is to be taken by other aircraft as signals that the aeroplane showing them is not under command and cannot therefore get out of the way. They are not signals of aeroplanes in distress and requiring assistance.

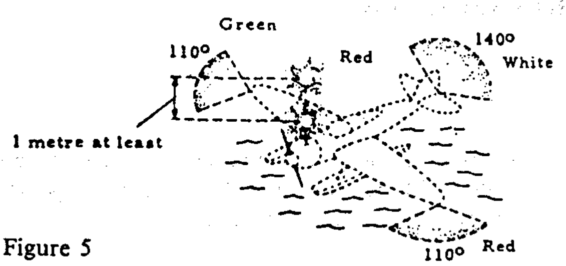


Figure 5

3.7 When at anchor

a) If less than 50 m in length, where it can best be seen, a steady white light (Figure 6), visible all around the horizon at a distance of at least 3.7 km (2 NM).

b) If 50 m or more in length, where they can best be seen, a steady white forward light and a steady white rear light (Figure 7) both visible all around the horizon at a distance of at least 5.6 km (3 NM).

c) If 50 m or more in span a steady white light on each side (Figures 8 and 9) to indicate the maximum span and visible, so far as practicable, all around the horizon at a distance of at least 1.9 km (1 NM).

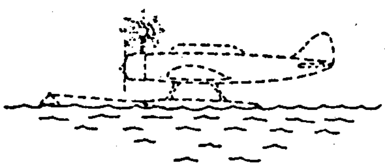


Figure 6

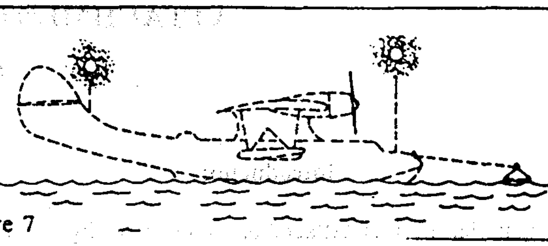
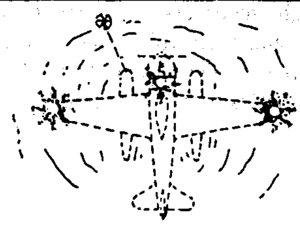
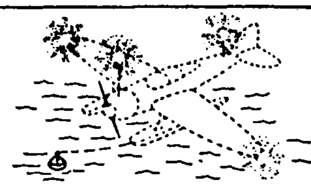


Figure 7



Less than 50 metres in length; 50 metres or more in span

Figure 8



50 metres or more in length; 50 metres or more in span

Figure 9

3.8 When aground

The lights prescribed in 3.7 and in addition two steady red lights in vertical line, at least 1 m apart so placed as to be visible all around the horizon.

ATTACHMENT A. FLIGHT RECORDERS

Supplementary to 6.10

Introduction

The material in this Attachment concerns flight recorders intended for installation in aeroplanes engaged in international air navigation. Flight recorders comprise two systems — a flight data recorder and a cockpit voice recorder. Flight data recorders are classified as Type I and Type II depending upon the number of parameters to be recorded.

1. Flight data recorder (FDR)

1.1 General requirements

1.1.1 The recorder is to record continuously during flight time.

1.1.2 The recorder container is to:

a) be painted a distinctive orange or yellow colour;

b) carry reflective material to facilitate its location; and

c) have securely attached an automatically activated underwater locating device.

1.1.3 The recorder is to be installed so that:

a) the probability of damage to the recording is minimized. To meet this requirement it should be located as far aft as practicable. In the case of pressurized aeroplanes it should be located in the vicinity of the rear pressure bulkhead;

b) it receives its electrical power from a bus that provides the maximum reliability for operation of the recorder without jeopardizing service to essential or emergency loads; and

c) there is an aural or visual means for pre-flight checking that the recorder is operating properly.

1.2 Parameters to be recorded

1.2.1 *Type I flight data recorder.* This recorder will be capable of recording, as appropriate to the aeroplane, at least the 32 parameters in Table A-1. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.

1.2.2 *Type II flight data recorder.* This recorder will be capable of recording, as appropriate to the aeroplane, at least the first 15 parameters in Table A-1. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.

1.3 Additional information

1.3.1 The measurement range, recording interval and accuracy of parameters on installed equipment is usually verified by methods approved by the appropriate certificating authority.

1.3.2 The manufacturer usually provides the national certificating authority with the following information in respect of the flight data recorder:

a) manufacturer's operating instructions, equipment limitations and installation procedures;

b) parameter origin or source and equations which relate counts to units of measurement; and

c) manufacturer's test reports.

1.3.3 The operator usually supplies position error curves for pitot-static parameters, at various angles of attack and side slip, for the calibration and read-out of the recordings.

2. Cockpit voice recorder (CVR)

2.1 General requirements

2.1.1 The recorder is to be designed so that it will record at least the following:

a) voice communication transmitted from or received in the aeroplane by radio;

b) aural environment on the flight deck;

c) voice communication of flight crew members on the flight deck using the aeroplane's interphone system;

d) voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and

e) voice communication of flight crew members using the passenger address system, if installed.

2.1.2 The recorder container is to:

a) be painted a distinctive orange or yellow colour;

b) carry reflective material to facilitate its location; and

c) have securely attached an automatically activated underwater locating device.

2.1.3 To aid in voice and sound discrimination, microphones in the cockpit are to be located in the best position for recording voice communications originating at the pilot and co-pilot stations and voice communications of other crew members on the flight deck when directed to those stations. This can best be achieved by wiring suitable boom microphones to record continuously on separate channels.

2.1.4 The recorder is to be installed so that:

a) the probability of damage to the recording is minimized. To meet this requirement it should be located as far aft as practicable. In the case of pressurized aeroplanes it should be located in the vicinity of the rear pressure bulkhead;

b) it receives its electrical power from a bus that provides the maximum reliability for operation of the recorder without jeopardizing service to essential or emergency loads;

c) there is an aural or visual means for pre-flight checking of the recorder for proper operation; and

d) if the recorder has a bulk erasure device, the installation should be designed to prevent operation of the device during flight time or crash impact.

2.2 Performance requirements

2.2.1 The recorder will be capable of recording on at least four tracks simultaneously. To ensure accurate time correlation between tracks, the recorder is to record in an in-line format. If a bi-directional configuration is used, the in-line format and track allocation should be retained in both directions.

2.2.2 The preferred track allocation is as follows:

Track 1 — co-pilot headphones and live boom microphone

Track 2 — pilot headphones and live boom microphone

Track 3 — area microphone

Track 4 — time reference plus the third and fourth crew member's headphone and live microphone, if applicable.

Note.— Track 1 is located closest to the base of the recording head.

2.2.3 The recorder, when tested by methods approved by the appropriate certificating authority, will be demonstrated to be suitable for the environmental extremes over which it is designed to operate.

2.2.4 Means will be provided for an accurate time correlation between the flight data recorder and cockpit voice recorder. One method of achieving this is by superimposing the FDR time signal on Track 4 of the CVR.

2.3 Additional information

2.3.1 The manufacturer usually provides the national certificating authority with the following information in respect of the cockpit voice recorder:

a) manufacturer's operating instructions, equipment limitations and installation procedures; and

b) manufacturer's test reports.

Table A-1
Parameters for Flight Data Recorders

Serial number	Parameter	Measurement range	Recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)
1	Time (UTC when available, otherwise elapsed time)	24 hours	4	±0.125% per hour
2	Pressure-altitude	–300 m (–1 000 ft) to maximum certificated altitude of aircraft +1 500 m (+5 000 ft)	1	±30 m to ±200 m (±100 ft to ±700 ft)
3	Indicated airspeed	95 km/h (50 kt) to max V_{S0} *(Note 1)* V_{S0} to 1.2 V_D *(Note 2)*	1	±5% ±3%
4	Heading	360°	1	±2°
5	Normal acceleration	–3 g to +6 g	0.125	±1% of maximum range excluding datum error of ±5%
6	Pitch attitude	±75°	1	±2°
7	Roll attitude	±180°	1	±2°
8	Radio transmission keying	On-off (one discrete)	1	
9	Power on each engine *(Note 3)*	Full range	1 (per engine)	±2%
10	Trailing edge flap or cockpit control selection	Full range or each discrete position	2	±5% or as pilot's indicator
11	Leading edge flap or cockpit control selection	Full range or each discrete position	2	±5% or as pilot's indicator
12	Thrust reverser position	Stowed, in transit, and reverse	1 (per engine)	
13	Ground spoiler/speed brake selection	Full range or each discrete position	1	±2% unless higher accuracy uniquely required
14	Outside air temperature	Sensor range	2	±2°C
15	Autopilot/auto throttle/AFCS mode and engagement status	A suitable combination of discretes	1	
Note.— The preceding 15 parameters satisfy the requirements for a Type II FDR.				
16	Longitudinal acceleration	±1 g	0.25	±1.5% max range excluding datum error of ±5%
17	Lateral acceleration	±1 g	0.25	±1.5% max range excluding datum error of ±5%
18	Pilot input and/or control surface position-primary controls (pitch, roll, yaw) *(Note 4)*	Full range	1	±2° unless higher accuracy uniquely required
19	Pitch trim position	Full range	1	±3% unless higher accuracy uniquely required
20	Radio altitude	–6 m to 750 m (–20 ft to 2 500 ft)	1	±0.6 m (±2 ft) or ±3% whichever is greater below 150 m (500 ft) and ±5% above 150 m (500 ft)

Serial number	Parameter	Measurement range	Recording interval (seconds)	Accuracy limits (sensor input compared to FDR read-out)
21	Glide path deviation	Signal range	1	±3%
22	Localizer deviation	Signal range	1	±3%
23	Marker beacon passage	Discrete	1	
24	Master warning	Discrete	1	
25	NAV 1 and 2 frequency selection *(Note 5)*	Full range	4	As installed
26	DME 1 and 2 distance *(Notes 5 and 6)*	0 – 370 km	4	As installed
27	Landing gear squat switch status	Discrete	1	
28	GPWS (ground proximity warning system)	Discrete	1	
29	Angle of attack	Full range	0.5	As installed
30	Hydraulics, each system (low pressure)	Discrete	2	
31	Navigation data (latitude/longitude, ground speed and drift angle) *(Note 7)*	As installed	1	As installed
32	Landing gear or gear selector position	Discrete	4	As installed

Note.— The preceding 32 parameters satisfy the requirements for a Type I FDR.

Notes.—

1. V_{S0} stalling speed or minimum steady flight speed in the landing configuration.
2. V_D design diving speed.
3. Record sufficient inputs to determine power.
4. For aeroplanes with conventional control systems "or" applies. For aeroplanes with non-mechanical control systems "and" applies. In aeroplanes with split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately.
5. If signal available in digital form.
6. Recording of latitude and longitude from INS or other navigation system is a preferred alternative.
7. If signals readily available.

If further recording capacity is available, recording of the following additional information should be considered:

a) operational information from electronic display systems, such as electronic flight instrument systems (EFIS), electronic centralized aircraft monitor (ECAM) and engine indication and crew alerting system (EICAS). Use the following order of priority:

1) parameters selected by the flight crew relating to the desired flight path, e.g. barometric pressure setting, selected altitude, selected airspeed, decision height, and autoflight system engagement and mode indications if not recorded from another source;

2) display system selection/status, e.g. SECTOR, PLAN, ROSE, NAV, WXR, COMPOSITE, COPY, ETC.;

3) warnings and alerts;

4) the identity of displayed pages for emergency procedures and checklists;

b) retardation information including brake application for use in the investigation of landing overruns and rejected take-offs; and

c) additional engine parameters (EPR, N1, EGT, fuel flow, etc.).

ATTACHMENT B. CARRIAGE AND USE OF OXYGEN

Supplementary to 4.9

Introduction

The performance of crew members and the well-being of passengers during flights at such altitudes where a lack of oxygen might result in impairment of faculties are of major concern. Research conducted in altitude chambers or by exposure to mountain elevations indicates that human tolerance could be related to the altitude concerned and the exposure time. The subject is dealt with in detail in the *Manual of Civil Aviation Medicine* (Doc 8984). In the light of the above and to further assist the pilot-in-command in providing the oxygen supply intended by 4.9, the following guidelines, which take into account the requirements already established in Annex 6, Part I, are considered relevant.

1. Oxygen supply

1.1 A flight to be operated at altitudes at which the atmospheric pressure in personnel compartments will be less than 700 hPa should not be commenced unless sufficient stored breathing oxygen is carried to supply:

a) all crew members and at least 10 per cent of the passengers for any period in excess of 30 minutes that the pressure in compartments occupied by them will be between 700 hPa and 620 hPa; and

b) all crew members and passengers for any period that the atmospheric pressure in compartments occupied by them will be less than 620 hPa.

1.2 A flight to be operated with a pressurized aeroplane should not be commenced unless a sufficient quantity of stored breathing oxygen is carried to supply all crew members and passengers, as is appropriate to the circumstances of the flight being undertaken, in the event of loss of pressurization, for any period that the atmospheric pressure in any compartment occupied by them would be less than 700 hPa. In addition, when an aeroplane is operated at flight altitudes at which the atmospheric pressure is less than 376 hPa, or which, if operated at flight altitudes at which the atmospheric pressure is more than 376 hPa and cannot descend safely within four minutes to a flight altitude at which the atmospheric pressure is equal to 620 hPa, there shall be no less than a 10-minute supply for the occupants of the passenger compartment.

2. Use of oxygen

2.1 All flight crew members, when engaged in performing duties essential to the safe operation of an aeroplane in flight, should use breathing oxygen continuously whenever the circumstances prevail for which its supply has been indicated to be necessary in 1.1 or 1.2.

2.2 All flight crew members of pressurized aeroplanes operating above an altitude where the atmospheric pressure is less than 376 hPa should have available at the flight duty station a quick donning type of mask which will readily supply oxygen upon demand.

Note.— Approximate altitudes in the Standard Atmosphere corresponding to the values of absolute pressure used in the text are as follows:

Absolute pressure	Metres	Feet
700 hPa	*3 000*	*10 000*
620 hPa	*4 000*	*13 000*
376 hPa	*7 600*	*25 000*

— END —

INTERNATIONAL STANDARDS

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

ANNEX 7
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

FOURTH EDITION — JULY 1981

This edition incorporates all amendments adopted by the Council prior to 31 March 1981 and supersedes, on 26 November 1981, all previous editions of Annex 7.

For information regarding the applicability of the Standards, see Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Bulletin* and in the monthly *Supplement to the Catalogue of ICAO Publications*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-4	Incorporated in this Edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

FOREWORD

Historical background

Annex 7 contains Standards adopted by the International Civil Aviation Organization as the minimum Standards for the display of marks to indicate appropriate nationality and registration which have been determined to comply with Article 20 of the Convention. Standards for Aircraft Nationality and Registration Marks were first adopted by the Council on 8 February 1949 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 7 to the Convention. They became effective on 1 July 1949. The Standards were based on recommendations of the first and second sessions of the Airworthiness Division held respectively in March 1946 and February 1947.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1. — *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2. — *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note.* There are no *Recommended Practices* in Annex 7.

Any reference to a portion of this document which is identified by a number and/or title includes all subdivisions of that portion.

Table A. — Amendments to Annex 7

Amendment	*Source(s)*	*Subject*	*Adopted Effective Applicable*
1st Edition	First (1946) and second (1947) sessions of the Airworthiness Division		8 February 1949 1 July 1949 1 November 1949
1 (2nd Edition)	Fifth meeting of the Airworthiness Committee (1962)	Location and size of aircraft nationality and registration marks.	12 November 1963 1 April 1964 1 August 1964
2	Air Navigation Commission study (1967)	Redefining of the term "aircraft" so that all air cushion type vehicles, such as hovercraft and ground effect machines, should not be classified as aircraft.	8 November 1967 8 March 1968 8 July 1968
3 (3rd Edition)	Council study (1969)	The amendment introduces definitions of the expressions "Common mark", "Common mark registering authority" and "International operating agency" and appropriate provisions to enable aircraft of international operating agencies of the kind contemplated in Article 77 of the Convention to be registered on other than a national basis.	23 January 1969 23 May 1969 18 September 1969
4 (4th Edition)	Air Navigation Commission study (1980), meeting of the Committee on Aircraft Noise (1979)	Unmanned free balloons. Change in the definition of "helicopter".	30 March 1981 30 July 1981 26 November 1981

INTERNATIONAL STANDARDS

1. — DEFINITIONS

When the following terms are used in the Standards for Aircraft Nationality and Registration Marks, they have the following meanings:

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface. (See Table I. — Classification of Aircraft.)

Airship. A power-driven lighter-than-air aircraft.

Balloon. A non-power-driven lighter-than-air aircraft.

Common mark. A mark assigned by the International Civil Aviation Organization to the common mark registering authority registering aircraft of an international operating agency on other than a national basis.

Note. — All aircraft of an international operating agency which are registered on other than a national basis will bear the same common mark.

Common mark registering authority. The authority maintaining the non-national register or, where appropriate, the part thereof, in which aircraft of an international operating agency are registered.

Fireproof material. A material capable of withstanding heat as well as or better than steel when the dimensions in both cases are appropriate for the specific purpose.

Glider. A non-power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Gyroplane. A heavier-than-air aircraft supported in flight by the reactions of the air on one or more rotors which rotate freely on substantially vertical axes.

Heavier-than-air aircraft. Any aircraft deriving its lift in flight chiefly from aerodynamic forces.

Helicopter. A heavier-than-air aircraft supported in flight chiefly by the reactions of the air on one or more power-driven rotors on substantially vertical axes.

International operating agency. An agency of the kind contemplated in Article 77 of the Convention.

Lighter-than-air aircraft. Any aircraft supported chiefly by its buoyancy in the air.

Ornithopter. A heavier-than-air aircraft supported in flight chiefly by the reactions of the air on planes to which a flapping motion is imparted.

Rotorcraft. A power-driven heavier-than-air aircraft supported in flight by the reactions of the air on one or more rotors.

State of Registry. The State on whose register the aircraft is entered.

2. — NATIONALITY, COMMON AND REGISTRATION MARKS TO BE USED

2.1 The nationality or common mark and registration mark shall consist of a group of characters.

2.2 The nationality or common mark shall precede the registration mark. When the first character of the registration mark is a letter it shall be preceded by a hyphen.

2.3 The nationality mark shall be selected from the series of nationality symbols included in the radio call signs allocated to the State of Registry by the International Telecommunication Union. The nationality mark shall be notified to the International Civil Aviation Organization.

2.4 The common mark shall be selected from the series of symbols included in the radio call signs allocated to the International Civil Aviation Organization by the International Telecommunication Union.

Note. — Assignment of the common mark to a common mark registering authority will be made by the International Civil Aviation Organization.

2.5 The registration mark shall be letters, numbers, or a combination of letters and numbers, and shall be that assigned by the State of Registry or common mark registering authority.

2.6 When letters are used for the registration mark, combinations shall not be used which might be confused with the five-letter combinations used in the International Code of Signals, Part II, the three-letter combinations beginning with Q used in the Q Code, and with the distress signal SOS, or other similar urgent signals for example XXX, PAN and TTT.

Note. — For reference to these codes see the currently effective International Telecommunications Regulations.

3. — LOCATION OF NATIONALITY, COMMON AND REGISTRATION MARKS

3.1. — General

The nationality or common mark and registration mark shall be painted on the aircraft or shall be affixed by any other means ensuring a similar degree of permanence. The marks shall be kept clean and visible at all times.

3.2. — Lighter-than-air aircraft

3.2.1 *Airships.* The marks on an airship shall appear either on the hull, or on the stabilizer surfaces. Where the marks appear on the hull, they shall be located lengthwise on each side of the hull and also on its upper surface on the line of symmetry. Where the marks appear on the stabilizer surfaces, they shall appear on the horizontal and on the vertical stabilizers; the marks on the horizontal stabilizer shall be located on the right half of the upper surface and on the left half of the lower surface, with the tops of the letters and numbers toward the leading edge; the marks on the vertical stabilizer shall be located on each side of the bottom half stabilizer, with the letters and numbers placed horizontally.

3.2.2 *Spherical balloons (other than unmanned free balloons).* The marks shall appear in two places diametrically opposite. They shall be located near the maximum horizontal circumference of the balloon.

3.2.3 *Non-spherical balloons (other than unmanned free balloons).* The marks shall appear on each side. They shall be located near the maximum cross-section of the balloon immediately above either the rigging band or the points of attachment of the basket suspension cables.

3.2.4 *Lighter-than-air aircraft (other than unmanned free balloons).* The side marks shall be visible both from the sides and from the ground.

3.2.5 *Unmanned free balloons.* The marks shall appear on the identification plate (see Section 8).

3.3. — Heavier-than-air aircraft

3.3.1 *Wings.* On heavier-than-air aircraft the marks shall appear once on the lower surface of the wing structure. They shall be located on the left half of the lower surface of the wing structure unless they extend across the whole of the lower surface of the wing structure. So far as is possible the marks shall be located equidistant from the leading and trailing edges of the wings. The tops of the letters and numbers shall be toward the leading edge of the wing.

3.3.2 *Fuselage (or equivalent structure) and vertical tail surfaces.* On heavier-than-air aircraft the marks shall appear either on each side of the fuselage (or equivalent structure) between the wings and the tail surface, or on the upper halves of the vertical tail surfaces. When located on a single vertical tail surface they shall appear on both sides. When located on multivertical tail surfaces they shall appear on the outboard sides of the outer surfaces.

3.3.3 *Special cases.* If a heavier-than-air aircraft does not possess parts corresponding to those mentioned in 3.3.1 and 3.3.2, the marks shall appear in a manner such that the aircraft can be identified readily.

4. — MEASUREMENTS OF NATIONALITY, COMMON AND REGISTRATION MARKS

The letters and numbers in each separate group of marks shall be of equal height.

4.1. — Lighter-than-air aircraft

4.1.1 The height of the marks on lighter-than-air aircraft other than unmanned free balloons shall be at least 50 centimetres.

4.1.2 The measurements of the marks related to unmanned free balloons shall be determined by the State of Registry, taking into account the size of the payload to which the identification plate is affixed.

4.2. — Heavier-than-air aircraft

4.2.1 *Wings.* The height of the marks on the wings of heavier-than-air aircraft shall be at least 50 centimetres.

4.2.2 *Fuselage (or equivalent structure) and vertical tail surfaces.* The height of the marks on the fuselage (or equivalent structure) and on the vertical tail surfaces of heavier-than-air aircraft shall be at least 30 centimetres.

4.2.3 *Special cases.* If a heavier-than-air aircraft does not possess parts corresponding to those mentioned in 4.2.1 and 4.2.2, the measurements of the marks shall be such that the aircraft can be identified readily.

5. — TYPE OF CHARACTERS FOR NATIONALITY, COMMON AND REGISTRATION MARKS

5.1 The letters shall be capital letters in Roman characters without ornamentation. Numbers shall be Arabic numbers without ornamentation.

5.2 The width of each character (except the letter I and the number 1), and the length of hyphens shall be two-thirds of the height of a character.

5.3 The characters and hyphens shall be formed by solid lines and shall be of a colour contrasting clearly with the background. The thickness of the lines shall be one-sixth of the height of a character.

5.4 Each character shall be separated from that which it immediately precedes or follows, by a space of not less than one-quarter of a character width. A hyphen shall be regarded as a character for this purpose.

6. — REGISTER OF NATIONALITY, COMMON AND REGISTRATION MARKS

Each Contracting State or common mark registering authority shall maintain a current register showing for each aircraft registered by that State or common mark registering authority, the information recorded in the certificate of registration (see Section 7). The register of unmanned free balloons shall contain the date, time and location of release, the type of balloon and the name of the operator.

7. — CERTIFICATE OF REGISTRATION

7.1 The certificate of registration, in wording and arrangement, shall be a replica of the following form (see below).

Note. — The size of the form is at the discretion of the State of Registry or common mark registering authority.

7.2 The certificate of registration shall be carried in the aircraft at all times.

8. — IDENTIFICATION PLATE

An aircraft shall carry an identification plate inscribed with at least its nationality or common mark and registration mark. The plate shall be made of fireproof metal or other fireproof material of suitable physical properties, and shall be secured to the aircraft in a prominent position near the main entrance, or in the case of an unmanned free balloon affixed conspicuously to the exterior of the payload.

9. — GENERAL

The provisions of this Annex shall not apply to meteorological pilot balloons used exclusively for meteorological purposes or to unmanned free balloons without a payload.

*	State *or* Common Mark Registering Authority Ministry Department or Service	*
CERTIFICATE OF REGISTRATION		
1. Nationality or Common Mark and Registration Mark	2. Manufacturer and Manufacturer's Designation of Aircraft	3. Aircraft Serial No. ....
4. Name of owner..		
5. Address of owner..		
6. It is hereby certified that the above described aircraft has been duly entered on the .... in accordance with the Convention on International Civil (name of register) Aviation dated 7 December 1944 and with the (†)..		
(Signature).. Date of issue............................ (†) Insert reference to applicable regulations.		
*		

* For use by the State of Registry or common mark registering authority.

Table I. – CLASSIFICATION OF AIRCRAFT

- AIRCRAFT
  - Lighter-than-air aircraft
    - Non-power-driven: balloon
      - Free balloon
        - Spherical free balloon
        - Non-spherical free balloon
      - Captive balloon
        - Spherical captive balloon
        - Non-spherical captive balloon[1]
    - Power-driven
      - Airship
        - Rigid airship
        - Semi-rigid airship
        - Non-rigid airship
  - Heavier-than-air aircraft
    - Non-power-driven
      - Glider
        - Land glider
        - Sea glider[2]
      - Kite[4]
    - Power-driven
      - Aeroplane
        - Landplane[3]
        - Seaplane[2]
        - Amphibian[2]
      - Rotorcraft
        - Gyroplane
          - Land gyroplane[3]
          - Sea gyroplane[2]
          - Amphibian gyroplane[2]
        - Helicopter
          - Land helicopter[3]
          - Sea helicopter[2]
          - Amphibian helicopter[2]
      - Ornithopter
        - Land ornithopter[3]
        - Sea ornithopter[2]
        - Amphibian ornithopter[2]

1. Generally designated "kite-balloon."
2. "Float" or "boat" may be added as appropriate.
3. Includes aircraft equipped with ski-type landing gear (substitute "ski" for "land").
4. For the purpose of completeness only.

26/11/81

END

AMENDMENT NO. 1

TO

SUPPLEMENT NO. 1 TO ANNEX 7 (FOURTH EDITION)

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

To incorporate Amendment No. 1 to Supplement No. 1:

1. Replace the following pages by the corresponding new pages dated 1/8/90:

   1 to 4.

2. Record this amendment on page ii of the Supplement.

1/8/90

SUPPLEMENT NO. 1

TO

ANNEX 7 (FOURTH EDITION)

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

1. The attached Supplement No. 1 supersedes the previous edition of Supplement No. 1 to Annex 7 dated 4 February 1985, and includes information notified by Contracting States up to 1 August 1988.

2. Supplement No. 1 should be inserted at the end of Annex 7, Fourth Edition.

1/8/88

AMENDMENT NO. 2*

TO

SUPPLEMENT NO. 2 TO ANNEX 7 (FOURTH EDITION)

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

To incorporate Amendment No. 2 to the Supplement:

1. Remove existing pages iii, v and vi.
2. Insert the attached pages in the appropriate places.
3. Record this amendment on page ii of Supplement No. 2.

17/12/85

* Amendment No. 1 issued in Russian only.

AMENDMENT NO. 3*

TO

SUPPLEMENT NO. 2 TO ANNEX 7 (FOURTH EDITION)

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

To incorporate Amendment No. 3 to Supplement No. 2:

1. Replace the following pages by the corresponding new pages dated 1/5/88:

iii to vi
Union of Soviet Socialist Republics.

2. Insert the following new pages dated 1/5/88:

Democratic People's Republic of Korea
Morocco
Poland.

3. Record this amendment on page ii of the Supplement.

*Amendment No. 1 was issued in Russian only.

1/5/88

AMENDMENT

TO SUPPLEMENT NO. 1 TO ANNEX 7, FOURTH EDITION

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

Please enter by hand the following amendments to Supplement No. 1 to Annex 7, Fourth Edition, dated 4/1/83.

1. Transmittal Note dated 4/1/83

Amend para 1 to read:

"1. The attached Supplement supersedes all previous editions of Supplement No. 1 to Annex 7."

2. Page 4, Table A

a) Amend the nationality mark for Vanuatu to read "YJ".

b) Insert the following after the entry for Zambia:

"Zimbabwe Z".

3. Page 5, Table B

a) Amend nationality mark for Vanuatu to read "YJ".

b) Insert the following before the entry for New Zealand:

"Z Zimbabwe".

4/8/83

SUPPLEMENT No. 1

TO

ANNEX 7, FOURTH EDITION

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

1. The attached Supplement supersedes all previous Supplements to Annex 7.

2. The Supplement should be inserted at the end of Annex 7, Fourth Edition.

4/1/83

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1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards and Recommended Practices of Annex 7, Fourth Edition, or have commented on their implementation as indicated herein:

State	Date of notification	Pages in Supplement	Date of publication
Bangladesh	11/6/81	1	4/2/85
Canada	28/6/82	1	4/2/85
Democratic People's Republic of Korea	24/11/87	1	1/5/88
Germany, Federal Republic of	22/7/81	1	4/2/85
Indonesia	22/8/81	1	4/2/85
Japan	19/2/82	1	4/2/85
Mali	23/3/81	1	4/2/85
Mauritius	17/9/81	1	4/2/85
Morocco	26/6/87	1	1/5/88
Netherlands, Kingdom of the	21/2/85	1	17/12/85
Papua New Guinea	-	1	4/2/85
Poland	6/11/87	1	1/5/88
Singapore	26/9/81	1	4/2/85
Spain	29/6/81	1	4/2/85
Union of Soviet Socialist Republics	4/1/88	1	1/5/88
United Kingdom	26/10/81	1	4/2/85
United States	11/8/81	1	4/2/85

2. Contracting States which have notified ICAO that no differences exist

State	Date of notification	State	Date of notification
Australia	2/7/87	Hungary	23/10/81
Austria	8/10/82	India	22/10/81
Bahamas	16/6/81	Iran, Islamic Republic of	17/6/81
Barbados	20/7/81	Kenya	23/6/81
Brazil	10/11/81	Malaysia	13/8/81
China	26/1/84	New Zealand	16/8/82
Czechoslovakia	24/7/81	Norway	2/7/81
Denmark	7/11/85	Phlippines	5/6/81
Finland	16/6/81	South Africa	20/8/81
France	22/1/82	Sweden	7/11/86
Gambia	9/11/83	Switzerland	28/9/81
Ghana	27/8/81	Uganda	31/3/82
Guyana	9/9/81	United Republic of Tanzania	6/7/81

3. Contracting States from which no information has been received

Afghanistan
Algeria
Angola
Antigua and Barbuda
Argentina
Bahrain
Belgium
Benin
Bolivia
Botswana
Brunei Darussalam
Bulgaria
Burkina Faso
Burma
Burundi
Cameroon
Cape Verde
Central African Republic
Chad
Chile
Colombia
Comoros
Congo
Cook Islands
Costa Rica
Côte d'Ivoire
Cuba
Cyprus
Democratic Kampuchea
Democratic Yemen
Djibouti
Dominican Republic
Ecuador
Egypt
El Salvador
Equatorial Guinea
Ethiopia
Fiji
Gabon
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Haiti
Honduras
Iceland
Iraq
Ireland
Israel
Italy
Jamaica
Jordan
Kiribati
Kuwait
Lao People's Democratic Republic
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Luxembourg
Madagascar
Malawi
Maldives
Malta
Marshall Islands
Mauritania
Mexico
Monaco
Mozambique
Nauru
Nepal
Nicaragua
Niger
Nigeria
Oman
Pakistan
Panama
Paraguay
Peru
Portugal
Qatar
Republic of Korea
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
Saudi Arabia
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
Solomon Islands
Somalia
Sri Lanka
Sudan
Suriname
Swaziland
Syrian Arab Republic
Thailand
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
United Arab Emirates
Uruguay
Vanuatu
Venezuela
Viet Nam
Yemen
Yugoslavia
Zaire
Zambia
Zimbabwe

4. Summary of differences

Paragraph	Difference notified by
Definitions	Indonesia
	Japan
2	USSR
2.3	Democratic People's Republic of Korea
3.2.1	Papua New Guinea
3.2.2	Japan
3.2.3	Japan
3.2.4	Japan
3.2.5	Germany, Federal Republic of
	Indonesia
	Japan
	Mauritius
	Netherlands, Kingdom of the
	United Kingdom
	United States
3.3.1	Bangladesh
	Mali
	Papua New Guinea
	USSR
	United States
3.3.2	USSR
4.1.2	Canada
	Germany, Federal Republic of
	Indonesia
4.2.1	United States
4.2.2	Canada
	Indonesia
	Mali
	Morocco
	Papua New Guinea
	United States
5.2	Canada
	Netherlands, Kingdom of the
5.3	Mali
	Netherlands, Kingdom of the
5.4	Netherlands, Kingdom of the
6	Germany, Federal Republic of
	Netherlands, Kingdom of the
	Poland
	Singapore
	United Kingdom
	United States
7	Spain
7.1	Spain
7.2	Spain
8	Germany, Federal Republic of
	Morocco
	Netherlands, Kingdom of the
	Poland
	Spain
	USSR
	United Kingdom
	United States

1/5/88

SUPPLEMENT NO. 1 TO ANNEX 7 (FOURTH EDITION)

AIRCRAFT NATIONALITY AND REGISTRATION MARKS

List of Aircraft Nationality and Common Marks, as notified to ICAO.

AUGUST 1988

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT NO. 1

No.	Date	Entered by	No.	Date	Entered by

AMENDMENTS TO ANNEX 7 ADOPTED OR APPROVED BY THE COUNCIL SUBSEQUENT TO FOURTH EDITION ISSUED JULY 1981

No.	Date of adoption or approval	Date applicable	No.	Date of adoption or approval	Date applicable

AIRCRAFT NATIONALITY AND COMMON MARKS

List of Aircraft Nationality and Common Marks as notified to ICAO

A. Nationality Marks arranged alphabetically by Contracting State

Afghanistan	YA
Algeria	7T
Angola	D2
Antigua and Barbuda	V2
Argentina	LQ, LV
Aruba	P4
Australia	VH
Austria	OE
Bahamas	C6
Bahrain	A9C
Bangladesh	S2
Barbados	8P
Belgium	OO
Belize	V3
Benin	TY
Bhutan	A5
Bolivia	CP
Botswana	A2
Brazil	PP, PT
Brunei Darussalam	V8
Bulgaria	LZ
Burkina Faso	XT
Burundi	9U
Cambodia	XU
Cameroon	TJ
Canada	C, CF
Cape Verde	D4
Central African Republic	TL
Chad	TT
Chile	CC
China	B
Colombia	HK
Comoros*	
Congo	TN
Cook Islands*	
Costa Rica	TI
Côte d'Ivoire	TU
Cuba	CU
Cyprus	5B
Czechoslovakia	OK
Democratic People's Republic of Korea	P
Denmark	OY
Djibouti	J2
Dominica	J7
Dominican Republic	HI
Ecuador	HC
Egypt	SU
El Salvador	YS
Equatorial Guinea	3C
Ethiopia	ET
Federated States of Micronesia*	
Fiji	DQ
Finland	OH
France	F
Gabon	TR
Gambia	C5
German Democratic Republic(1)	DDR
Germany, Federal Republic of	D
Ghana	9G
Greece	SX
Grenada	J3
Guatemala	TG
Guinea	3X
Guinea-Bissau*	
Guyana	8R
Haiti	HH
Honduras	HR
Hungary	HA
Iceland	TF
India	VT
Indonesia	PK
West Irian	PK
Iran, Islamic Republic of	EP
Iraq	YI
Ireland	EI, EJ
Israel	4X
Italy	I
Jamaica	6Y
Japan	JA
Jordan	JY
Kenya	5Y
Kiribati*	
Kuwait	9K

* Contracting States which have not notified ICAO of nationality marks.
(1) This mark differs from the provision in 2.3 of this Annex.

Lao People's Democratic Republic(1)	RDPL
Lebanon	OD
Lesotho	7P
Liberia	EL
Libyan Arab Jamahiriya	5A
Liechtenstein(2)	HB plus national emblem
Luxembourg	LX
Madagascar	5R
Malawi	7QY
Malaysia	9M
Maldives	8Q
Mali	TZ
Malta	9H
Marshall Islands*	
Mauritania	5T
Mauritius	3B
Mexico	XA, XB, XC
Monaco	3A
Mongolia*	
Morocco	CN
Mozambique	C9
Myanmar	XY, XZ
Nauru	C2
Nepal	9N
Netherlands, Kingdom of the	PH
Netherlands Antilles	PJ
New Zealand	ZK, ZL, ZM
Nicaragua	YN
Niger	5U
Nigeria	5N
Norway	LN
Oman	A40
Pakistan	AP
Panama	HP
Papua New Guinea	P2
Paraguay	ZP
Peru	OB
Philippines(1)	RP
Poland	SP
Portugal	CR, CS
Qatar	A7
Republic of Korea	HL
Romania	YR
Rwanda	9XR
Saint Kitts and Nevis	V4
Saint Lucia	J6
Saint Vincent and the Grenadines	J8
Samoa	5W
San Marino*	
Sao Tome and Principe	S9
Saudi Arabia	HZ
Senegal	6V, 6W
Seychelles	S7
Sierra Leone	9L
Singapore	9V
Solomon Islands	H4
Somalia	6O
South Africa	ZS, ZT, ZU
Spain	EC
Sri Lanka	4R
Sudan	ST
Suriname	PZ
Swaziland	3D
Sweden	SE
Switzerland(2)	HB plus national emblem
Syrian Arab Republic	YK
Thailand	HS
Togo	5V
Tonga	A3
Trinidad and Tobago	9Y
Tunisia	TS
Turkey	TC
Uganda	5X
Union of Soviet Socialist Republics(1)	CCCP
United Arab Emirates	A6
United Kingdom	G
Colonies and Protectorates	VP, VQ, VR
United Republic of Tanzania	5H
United States	N
Uruguay	CX
Vanuatu	YJ
Venezuela	YV
Viet Nam	XV
Yemen(3)	4W
Yugoslavia	YU
Zaire	9Q
Zambia	9J
Zimbabwe	Z

* Contracting States which have not notified ICAO of nationality marks.
(1) This mark differs from the provision in 2.3 of this Annex.
(2) For national emblems of Liechtenstein and Switzerland, see page 5.
(3) On 22 May 1990 Democratic Yemen and Yemen merged to form a single State. Since that date they have been represented as one Contracting State with the name "Yemen".

B. Arranged alphabetically by Nationality Marks

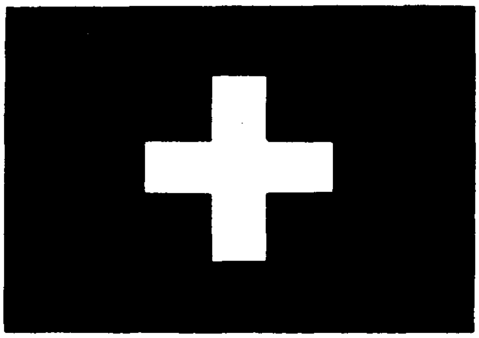
AP	Pakistan
A2	Botswana
A3	Tonga
A5	Bhutan
A6	United Arab Emirates
A7	Qatar
A9C	Bahrain
A40	Oman
B	China
C, CF	Canada
CC	Chile
CCCP	Union of Soviet Socialist Republics(1)
CN	Morocco
CP	Bolivia
CR, CS	Portugal
CU	Cuba
CX	Uruguay
C2	Nauru
C5	Gambia
C6	Bahamas
C9	Mozambique
D	Germany, Federal Republic of
DDR	German Democratic Republic(1)
DQ	Fiji
D2	Angola
D4	Cape Verde
EC	Spain
EI, EJ	Ireland
EL	Liberia
EP	Iran, Islamic Republic of
ET	Ethiopia
F	France
G	United Kingdom
HA	Hungary
HB plus national emblem	Switzerland(2)
HB plus national emblem	Liechtenstein(2)
HC	Ecuador
HH	Haiti
HI	Dominican Republic
HK	Colombia
HL	Republic of Korea
HP	Panama
HR	Honduras
HS	Thailand
HZ	Saudi Arabia
H4	Solomon Islands
I	Italy
JA	Japan
JY	Jordan
J2	Djibouti
J3	Grenada
J6	Saint Lucia
J7	Dominica
J8	Saint Vincent and the Grenadines
LN	Norway
LQ, LV	Argentina
LX	Luxembourg
LZ	Bulgaria
N	United States
OB	Peru
OD	Lebanon
OE	Austria
OH	Finland
OK	Czechoslovakia
OO	Belgium
OY	Denmark
P	Democratic People's Republic of Korea
PH	Netherlands, Kingdom of the
PJ	Netherlands Antilles
PK	Indonesia
PK	West Irian
PP, PT	Brazil
PZ	Suriname
P2	Papua New Guinea
P4	Aruba
RDPL	Lao People's Democratic Republic(1)
RP	Philippines(1)

(1) This mark differs from the provision in 2.3 of this Annex.
(2) For national emblems of Liechtenstein and Switzerland, see page 5.

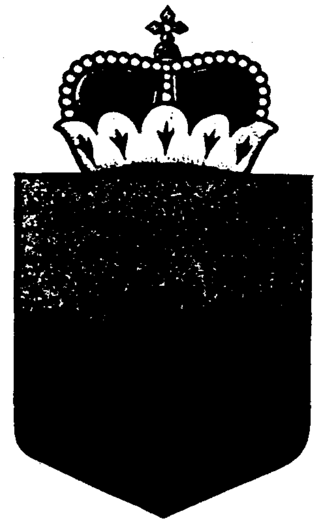
SE	Sweden
SP	Poland
ST	Sudan
SU	Egypt
SX	Greece
S2	Bangladesh
S7	Seychelles
S9	Sao Tome and Principe
TC	Turkey
TF	Iceland
TG	Guatemala
TI	Costa Rica
TJ	Cameroon
TL	Central African Republic
TN	Congo
TR	Gabon
TS	Tunisia
TT	Chad
TU	Côte d'Ivoire
TY	Benin
TZ	Mali
VH	Australia
VP, VQ, VR	United Kingdom Colonies and Protectorates
VT	India
V2	Antigua and Barbuda
V3	Belize
V4	Saint Kitts and Nevis
V8	Brunei Darussalam
XA, XB, XC	Mexico
XT	Burkina Faso
XU	Cambodia
XV	Viet Nam
XY, XZ	Myanmar
YA	Afghanistan
YI	Iraq
YJ	Vanuatu
YK	Syrian Arab Republic
YN	Nicaragua
YR	Romania
YS	El Salvador
YU	Yugoslavia
YV	Venezuela
Z	Zimbabwe
ZK, ZL, ZM	New Zealand
ZP	Paraguay
ZS, ZT, ZU	South Africa
3A	Monaco
3B	Mauritius
3C	Equatorial Guinea
3D	Swaziland
3X	Guinea
4R	Sri Lanka
4W	Yemen*
4X	Israel
5A	Libyan Arab Jamahiriya
5B	Cyprus
5H	United Republic of Tanzania
5N	Nigeria
5R	Madagascar
5T	Mauritania
5U	Niger
5V	Togo
5W	Samoa
5X	Uganda
5Y	Kenya
6O	Somalia
6V, 6W	Senegal
6Y	Jamaica
7P	Lesotho
7QY	Malawi
7T	Algeria
8P	Barbados
8Q	Maldives
8R	Guyana
9G	Ghana
9H	Malta
9J	Zambia
9K	Kuwait
9L	Sierra Leone
9M	Malaysia
9N	Nepal
9Q	Zaire
9U	Burundi
9V	Singapore
9XR	Rwanda
9Y	Trinidad and Tobago

* On 22 May 1990 Democratic Yemen and Yemen merged to form a single State. Since that date they have been represented as one Contracting State with the name "Yemen".

1/8/90



NATIONAL EMBLEM OF SWITZERLAND



NATIONAL EMBLEM OF LIECHTENSTEIN

C. List of Common Marks allocated by ICAO

International Operating Agency	Established by	State performing the function of State of Registry	Common Mark allocated
Arab Air Cargo	Jordan and Iraq	Jordan	4YB

- END -

1/8/88

UNION OF SOVIET SOCIALIST REPUBLICS

2 When an aircraft is entered into the USSR State Register of Civil Aircraft, it is assigned a State registration identification mark which appears on the aircraft. The identification marks for civil aircraft and the rules governing their emplacement are established by the USSR Ministry of Civil Aviation.

3.3.1 The marks must also appear on the upper surface of the wing.

3.3.2 The marks on the tail fin appear mainly in the lower part thereof.

8 Not implemented.

POLAND

6 Registration of unmanned free balloons with payload is not required. Such balloons are not in use in Poland thus far.

8 In the Polish regulations, there is no provision concerning unmanned free balloons because such balloons are not in use in Poland thus far.

MOROCCO

4.2.2 According to Moroccan regulations, the height of the marks on the fuselage must be as large as possible, while being no smaller than 15 cm and no larger than 4/5 of the median height of the fuselage (Article 2 of the Decree of 1963).

8 The identification plate is not mentioned in the Moroccan regulations.

DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

2.3 P is used for the nationality mark of the Democratic People's Republic of Korea.

NETHERLANDS, KINGDOM OF THE

5.2, 5.3 and 5.4	The enforcement of new regulations in the Netherlands precludes the implementation of these paragraphs. The Netherlands regulations are:
	<u>Article 6 - Height of Hyphen</u>
	The height of the hyphen shall be one-seventh of the height of the nationality and registration marks of the aircraft.
	<u>Article 7 - Type of Characters and Separation</u>
	The type and separation of letters, numbers and hyphens of the marks shall be in accordance with the Decree No. LI/11430 dated 24 March 1966, issued in pursuance of Article 6, paragraph 1 of the Netherlands Aviation Act.
	The letters and numbers shall be placed next to each other in a straight line. If necessary the registration mark may be placed below the nationality mark.
	The letter IJ shall be written as Y.
3.2.5, 6, 8	The marking of unmanned free balloons is not yet applied.

USSR

2	When an aircraft is entered on the State of Registry of Civil Aircraft of the Union of Soviet Socialist Republics, it is assigned a State registration mark which is painted or affixed on the aircraft. Civil aircraft registration marks and the regulations for depicting them on aircraft are established by the Ministry of Civil Aviation of the Union of Soviet Socialist Republics.
3.3.1	The marks must also appear on the upper surface of the wing.
3.3.2	The marks normally appear on the lower half of the vertical tail surface.
8	Not implemented.

INTERNATIONAL STANDARDS

AIRWORTHINESS OF AIRCRAFT

ANNEX 8

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

EIGHTH EDITION — JULY 1988

This edition incorporates all amendments adopted by the Council prior to 23 March 1988 and supersedes on 22 March 1991 all previous editions of Annex 8.

For information regarding the applicability of the Standards, *see* section 2 of Part II and 1.1 of Part III, and the Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Bulletin* and in the monthly *Supplement to the Catalogue of ICAO Publications*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-95	Incorporated in this edition		
96	10/11/94	16/2/95	

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

FOREWORD

Historical Background

Standards and Recommended Practices for the Airworthiness of Aircraft were adopted by the Council on 1 March 1949 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 8 to the Convention.

The Annex contained, in Part II, general airworthiness procedures applicable to all aircraft and in Part III, minimum airworthiness characteristics for aeroplanes provided, or to be provided, with certificates of airworthiness classifying them in an established ICAO category. Part I contained definitions.

At its fourth session, the Airworthiness Division collaborating with the Operations Division made recommendations concerning the use of a performance code as an alternative to the one contained in the Annex, in which the climb values had the status of Recommended Practices. Further, the Airworthiness Division made recommendations concerning certain aspects of the certification in ICAO categories. As a result of those recommendations, the Council approved the incorporation of the alternative performance code as Attachment A, but stated its belief that since agreement had not yet been reached upon Standards covering performance, there existed no basis for certification in ICAO Category A. It urged the Contracting States to refrain from such certification pending the becoming effective of Standards on performance or until such time as the Council decides on the basic policy on airworthiness.

The Assembly at its seventh session (June 1953) endorsed the action already taken by the Council and the Air Navigation Commission to initiate a fundamental study of ICAO policy on international airworthiness and directed the Council to complete the study as rapidly as practicable.

In pursuing such study the Air Navigation Commission was helped by an international body of experts designated as the "Airworthiness Panel", which contributed to the preparation of the work of the Third Air Navigation Conference.

As a result of these studies a revised policy on international airworthiness was developed and it was approved by the Council in 1956. According to this policy the principle of certification in an ICAO Category was abandoned. Instead, Annex 8 included broad Standards which defined, for application by the competent national authorities, the complete minimum international basis for the recognition by States of certificates of airworthiness for the purpose of the flight of aircraft of other States into or over their territories, thereby achieving, among other purposes, protection of other aircraft, third persons and property. It was considered that this met the obligation of the Organization under Article 37 of the Convention to adopt International Standards of airworthiness.

It was recognized that the ICAO Standards of airworthiness would not replace national regulations and that national codes of airworthiness containing the full scope and extent of detail considered necessary by individual States would be necessary as the basis for the certification of individual aircraft. Each State would establish its own comprehensive and detailed code of airworthiness, or would select a comprehensive and detailed code established by another Contracting State. The level of airworthiness defined by this code would be indicated by the Standards, supplemented, if necessary, by Acceptable Means of Compliance.

In application of those principles, the Annex was declared as constituting the minimum standards for the purpose of Article 33. It was also recognized that the Annex might, at the time of adoption, not include technical Standards for all classes of aircraft or even for all classes of aeroplanes, if the Council felt that no technical Standards were required at that time to render Article 33 operative. Furthermore, adoption or amendment of the Annex declared to be complete for the purpose of Article 33 did not constitute the end of ICAO's work in the airworthiness field, as there was a need to continue international collaboration in airworthiness matters.

A revised text for Annex 8 consistent with the above principles was prepared on the basis of the recommendations made by the Third Air Navigation Conference (Montreal, September-October 1956). Part III of the Annex was limited to broad Standards stating the objectives rather than the methods of realizing those objectives. However, to indicate by examples the level of airworthiness intended by some of the broad Standards, specifications of a more detailed and quantitative nature were included under the title "Acceptable Means of Compliance". These specifications were intended to assist the Contracting States in the establishment and application of comprehensive and detailed national airworthiness codes.

To adopt a code giving an appreciably lower level of airworthiness than that given in an Acceptable Means of

Compliance was considered to be a violation of the Standard supplemented by that Acceptable Means of Compliance.

The revised text for Annex 8 was included in the Fourth Edition of the Annex, which superseded the First, Second and Third Editions.

Another recommendation of the Third Air Navigation Conference led to the establishment by the Council in 1957 of the Airworthiness Committee, consisting of airworthiness experts with broad experience and selected from those Contracting States and International Organizations willing to contribute.

Present policy on international airworthiness. There had been some concern about the slow progress that had been made over the years with respect to developing supplementary airworthiness specifications in the form of Acceptable means of Compliance. It was noted that the majority of the Acceptable Means of Compliance in Annex 8 had been developed in 1957 and were therefore applicable to only those aeroplane types operating at that time. No effort had been made to update the specifications in these Acceptable Means of Compliance nor had there been any recommendations from the Airworthiness Committee for upgrading of any of the Provisional Acceptable Means of Compliance, which had been developed as potential material for full-fledged Acceptable Means of Compliance. The Air Navigation Commission therefore requested the Airworthiness Committee to review the progress made by it since its inception with a view to determining whether or not desired results had been achieved and to recommend any changes to improve the development of detailed airworthiness specifications.

The Airworthiness Committee at its Ninth Meeting (Montreal, November/December 1970) made a detailed study of the problems and recommended that the concept of developing airworthiness specifications in the form of Acceptable Means of Compliance and Provisional Acceptable Means of Compliance should be abandoned and a provision should be made for an airworthiness technical manual to be prepared and published by ICAO to include guidance material intended to facilitate the development and uniformity of national airworthiness codes by Contracting States.

The Air Navigation Commission reviewed the recommendations of the Airworthiness Committee in the light of the history of the development of the airworthiness policy approved by the Council in 1956. It came to the conclusion that the basic objectives and principles on which the ICAO airworthiness policy had been based were sound and did not require any significant change. It was also concluded that the main reason for the slow progress in the development of airworthiness specifications in the form of Acceptable Means of Compliance and Provisional Acceptable Means of Compliance was the degree of mandatory status to the former implied by the following statement included in the Forewords of the Fourth and Fifth Editions of Annex 8:

> "To adopt a code giving an appreciably lower level of airworthiness than that given in an Acceptable Means of Compliance would be a violation of the Standard supplemented by that Acceptable Means of Compliance."

Several approaches were examined by the Air Navigation Commission to eliminate this difficulty. Finally it came to the conclusion that the idea of developing airworthiness specifications in the form of Acceptable Means of Compliance and Provisional Acceptable Means of Compliance should be abandoned and ICAO should declare that the States' obligations, for the purpose of Article 33 of the Convention, shall be met by their compliance with the broad Standards in Annex 8 supplemented, as necessary, by airworthiness technical guidance material, devoid of all mandatory implications or obligations. Also the requirement that each Contracting State should either establish its own comprehensive and detailed code of airworthiness or select a comprehensive and detailed code established by another Contracting State, should be retained.

The Council on 15 March 1972 approved the above approach to form the basis for the present policy of ICAO in the field of airworthiness. According to this policy:

a) the objective of international airworthiness Standards is to define, for application by the competent national authorities, the minimum level of airworthiness constituting the international basis for the recognition by States under Article 33 of the Convention, of certificates of airworthiness for the purpose of the flight of aircraft of other States into or over their territories thereby achieving, among other things, protection of other aircraft, third parties and property;

b) the Standards developed to meet the objective stated in a) above are considered by the Council as meeting, in the necessary scope and detail, the obligations of the Organization under Article 37 of the Convention to adopt International Standards of airworthiness;

c) international airworthiness Standards adopted by the Council are recognized as being the complete international code necessary to bring into force and effect the rights and obligations which arise under Article 33 of the Convention;

d) the technical airworthiness Standards in Annex 8 shall be presented as broad specifications stating the objectives rather than the means of realizing these objectives; ICAO recognizes that national codes of airworthiness containing the full scope and extent of detail considered necessary by individual States are required as the basis for the certification by individual States of airworthiness of each aircraft;

e) to assist States in applying the Standards of Annex 8 and in developing their own comprehensive national codes in a uniform manner, detailed guidance material shall be developed and published expeditiously in the working languages of the Organization.

The Council also approved the issuance of the airworthiness guidance material under the title of "Airworthiness Technical Manual". It was understood that the guidance material will, before issuance, be examined by the Air Navigation Commission. It will however have no formal status and its main purpose would be to provide guidance to Contracting States in developing the detailed national airworthiness codes mentioned in 2.2 of Part II of the Annex.

A text for Annex 8 consistent with the policy on international airworthiness approved by the Council on 15 March 1972, was developed by the Air Navigation Commission.

Table A shows the origin of amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

The applicability of the Standards is indicated in section 2 of Part II and in 1.1 of Part III. The dates were established so as to take account of the provisions of Article 41 of the Convention. However, the Council has recommended that, as far as practicable, earlier dates be applied (see the Note under 1.1.2 of Part III).

Related Standards of Annex 6, Part I. Chapter 5 of Annex 6, Part I dealing with aeroplane performance operating limitations contains Standards that are complementary to the airworthiness Standards of Annex 8. Both state broad objectives. The Standards of Annex 6, Part I, Chapter 5, are supplemented by guidance material in the form of green page attachments which indicate by examples the level of performance intended by the Standards.

The Council has urged Contracting States not to impose on visiting aeroplanes operational requirements other than those established by the State of Registry, provided those requirements are not lower than the Standards of Chapter 5 of Annex 6, Part I, as amended by Amendment 2 and 2.2 of Part III of this edition of Annex 8.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each Amendment to this Annex.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional regulations that are important for the safety or regularity of air navigation. Wherever possible, the provisions of Part II of this Annex have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation. The provisions of Part III of this Annex, on the other hand, are applicable to aeroplanes through the medium of national codes more comprehensive and detailed than the Standards, so that the Council's Resolution of 13 April 1948 does not apply to Part III.

Information concerning the national codes establishing compliance with the Annex. States are invited to notify the Organization either of the establishment or of the selection of the comprehensive and detailed national codes mentioned in 2.2 of Part II. States that establish such codes are invited to forward a copy of each with its successive amendments, and any appropriate interpretation document concerning them. States that select codes of other Contracting States to comply with 2.2 of Part II are invited to indicate the codes that they intend to use.

Use of the guidance material in the Airworthiness Technical Manual. Contracting States are invited to note that the material in the *Airworthiness Technical Manual* is intended to guide them in the development of their detailed and comprehensive national codes with a view to introducing uniformity in those national codes. The material has no mandatory status and Contracting States are quite free to differ from it either in detail or in methods. States are also not required to notify any differences that may exist between their detailed national regulations and practices and the relevant material in the *Airworthiness Technical Manual.*

General Information

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated.

1. — *Material comprising the Annex proper*

a) *Standards and Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Provisions* governing the applicability of the Standards and Recommended Practices.

d) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

2. — *Material approved by the Council for publication in association with the Standards and Recommended Practices*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practice

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note.* There are no *Recommended Practices* in Annex 8.

In accordance with Annex 5, the International System of Units (SI) is used throughout this document.

Any reference to a portion of this document which is identified by a number includes all subdivisions of the portion.

Table A. Amendments to Annex 8

Amendment(s)	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
1st Edition	First and Second Sessions of the Airworthiness Division (1946 and 1947)	—	1 March 1949 1 August 1949 1 September 1949
1 to 63 (2nd Edition)	Third and Fourth Sessions of the Airworthiness Division (1949 and 1951)	—	26 January 1950 1 January 1951 1 February 1951
64 to 83	Third and Fourth Sessions of the Airworthiness Division (1949 and 1951)	—	13 November 1951 15 April 1952 15 May 1952
84 (3rd Edition)	Fourth Session of the Airworthiness Division (1951)	Incorporation of an alternative performance code as an attachment.	2 December 1952 1 May 1953 1 June 1953
85 (4th Edition)	Third Air Navigation Conference (1956)	Revised text consistent with new policy on international airworthiness approved by the Council; Part III of Annex 8 limited to broad Standards stating objectives with more detailed examples of the level of airworthiness intended being included as "Acceptable Means of Compliance".	13 June 1957 1 October 1957 1 December 1957 or 13 June 1960 depending on date of application for certification for the aeroplane
86 (5th Edition)	Fourth Meeting of the Airworthiness Committee	Amendment of Standards for navigation lights and introduction of requirements for anti-collision lights.	13 December 1961 1 April 1962 13 December 1964
87	Proposal of the United States Committee on the Extension to the Standard Atmosphere	Redefinition of the standard atmosphere.	12 November 1963 1 April 1964 12 November 1966
88	Consequence of Amendment 2 to Annex 7	Revised definition of aircraft; revision of 2.2.3.2 b) of Part III to cater for 3-engined aeroplanes.	8 November 1967 8 March 1968 22 August 1968
89	Consequence of the adoption of Annex 16	Introduction of a reference to noise certification Standards in Annex 16 and Annex 6.	2 April 1971 2 August 1971 6 January 1972
90	Ninth Meeting of the Airworthiness Committee (1970)	Deletion of two Acceptable Means of Compliance for aeroplane performance from the 5th Edition.	10 December 1971 10 April 1972 7 December 1972
91 (6th Edition)	Council action following Ninth Airworthiness Committee	New text consistent with revised policy on airworthiness; deletion of Acceptable Means of Compliance; guidance material henceforth to appear in the *Airworthiness Technical Manual.*	16 March 1973 30 July 1973 23 May 1974
92	Tenth Meeting of the Airworthiness Committee	Introduction of provisions relating to the transmission of continuing airworthiness information; addition of a note concerning lease, charter and interchange of aircraft.	3 April 1974 3 August 1974 27 February 1975
93	Study by the Air Navigation Commission	Revision of the provisions relating to exterior lights to align with new provisions in Annexes 2 and 6.	22 March 1982 22 July 1982 22 March 1985
22/3/91			
94 (7th Edition)	Fourteenth Meeting of the Airworthiness Committee (1981)	Introduction of a new provision relating to information on faults, malfunctions, defects and other occurrences and to include SI units in conformity with Annex 5 provisions.	6 December 1982 6 April 1983 24 November 1983
95 (8th Edition)	Proposal of States; Studies by the Council and Air Navigation Commission; Third Meeting of the HELIOPS Panel	Extension of the standard atmosphere; strengthened provisions relating to crash survival and fire protection; introduction of airworthiness provisions for helicopters.	22 March 1988 31 July 1988 22 March 1991
96	Third meeting of the Continuing Airworthiness Panel (CAP/3)	Introduction of responsibilities of State of Design and definition thereof; revision of responsibilities of parties involved in transfer of information relating to continuing airworthiness; addition of new requirements concerning provision of maintenance information.	22 March 1994 25 July 1994 10 November 1994

INTERNATIONAL STANDARDS

PART 1. DEFINITIONS

When the following terms are used in the Standards for the Airworthiness of Aircraft, they have the following meanings:

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Anticipated operating conditions. Those conditions which are known from experience or which can be reasonably envisaged to occur during the operational life of the aircraft taking into account the operations for which the aircraft is made eligible, the conditions so considered being relative to the meteorological state of the atmosphere, to the configuration of terrain, to the functioning of the aircraft, to the efficiency of personnel and to all the factors affecting safety in flight. Anticipated operating conditions do not include:

a) those extremes which can be effectively avoided by means of operating procedures; and

b) those extremes which occur so infrequently that to require the Standards to be met in such extremes would give a higher level of airworthiness than experience has shown to be necessary and practical.

Appropriate airworthiness requirement. The comprehensive and detailed airworthiness codes established by a Contracting State for the class of aircraft under consideration. (*See* 2.2 of Part II of this Annex.)

Approved. Accepted by a Contracting State as suitable for a particular purpose.

Configuration (as applied to the aeroplane). A particular combination of the positions of the moveable elements, such as wing flaps, landing gear, etc., which affect the aerodynamic characteristics of the aeroplane.

Critical power-unit(s). The power-unit(s) failure of which gives the most adverse effect on the aircraft characteristics relative to the case under consideration.

Design landing mass. The maximum mass of the aircraft at which, for structural design purposes, it is assumed that it will be planned to land.

Design take-off mass. The maximum mass at which the aircraft, for structural design purposes, is assumed to be planned to be at the start of the take-off run.

Design taxiing mass. The maximum mass of the aircraft at which structural provision is made for load liable to occur during use of the aircraft on the ground prior to the start of take-off.

Factor of safety. A design factor used to provide for the possibility of loads greater than those assumed, and for uncertainties in design and fabrication.

Final approach and take-off area (FATO). A defined area over which the final phase of the approach manoeuvre to hover or landing is completed and from which the take-off manoeuvre is commenced. Where the FATO is to be used by performance Class 1 helicopters, the defined area includes the rejected take-off area available.

Helicopter. A heavier-than-air aircraft supported in flight chiefly by the reactions of the air on one or more power-driven rotors on substantially vertical axes.

Landing surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft landing in a particular direction.

Limit loads. The maximum loads assumed to occur in the anticipated operating conditions.

Load factor. The ratio of a specified load to the weight of the aircraft, the former being expressed in terms of aerodynamic forces, inertia forces, or ground reactions.

Performance Class 1 helicopter. A helicopter with performance such that, in case of engine failure, it is able to land on the rejected take-off area or safely continue the flight to an appropriate landing area.

Performance Class 2 helicopter. A helicopter with performance such that, in case of engine failure, it is able to safely continue the flight, except when the failure occurs prior to a defined point after take-off or after a defined point before landing, in which cases a forced landing may be required.

Performance Class 3 helicopter. A helicopter with performance such that, in case of engine failure at any point in the flight profile, a forced landing must be performed.

Power-unit. A system of one or more engines and ancillary parts which are together necessary to provide thrust, independently of the continued operation of any other power-unit(s), but not including short period thrust-producing devices.

Pressure-altitude. An atmospheric pressure expressed in terms of altitude which corresponds to that pressure in the standard atmosphere.

Rendering (a Certificate of Airworthiness) valid. The action taken by a Contracting State, as an alternative to issuing its own Certificate of Airworthiness, in accepting a Certificate of Airworthiness issued by any other Contracting State as the equivalent of its own Certificate of Airworthiness.

Standard atmosphere. An atmosphere defined as follows:

a) the air is a perfect dry gas;

b) the physical constants are:

— Sea level mean molar mass:
$M_0 = 28.964420 \times 10^{-3}$ kg mol^{-1}
— Sea level atmospheric pressure:
$P_0 = 1013.250$ hPa
— Sea level temperature:
$t_0 = 15°C$
$T_0 = 288.15$ K
— Sea level atmospheric density:
$\rho_0 = 1.2250$ kg m^{-3}
— Temperature of the ice point:
$T_i = 273.15$ K
— Universal gas constant:
$R^* = 8.31432$ JK^{-1}mol^{-1}

c) the temperature gradients are:

Geopotential altitude (km)		*Temperature gradient (Kelvin per standard geopotential kilometre)*
From	*To*	
–5.0	11.0	–6.5
11.0	20.0	0.0
20.0	32.0	+1.0
32.0	47.0	+2.8
47.0	51.0	0.0
51.0	71.0	–2.8
71.0	80.0	–2.0

Note 1.— The standard geopotential metre has the value 9.80665 $m^2 s^{-2}$.

Note 2.— See Doc 7488 for the relationship between the variables and for tables giving the corresponding values of temperature, pressure, density and geopotential.

Note 3.— Doc 7488 also gives the specific weight, dynamic viscosity, kinematic viscosity and speed of sound at various altitudes.

State of Design. The State having jurisdiction over the organization responsible for the type design.

State of Manufacture. The State having jurisdiction over the organization responsible for the final assembly of the aircraft.

State of Registry. The State on whose register the aircraft is entered.

Take-off surface. That part of the surface of an aerodrome which the aerodrome authority has declared available for the normal ground or water run of aircraft taking off in a particular direction.

Ultimate load. The limit load multiplied by the appropriate factor of safety.

PART II. ADMINISTRATION

Note.— Although the Convention on International Civil Aviation allocates to the State of Registry certain functions which that State is entitled to discharge, or obligated to discharge, as the case may be, the Assembly recognized, in Resolution A23-13, that the State of Registry may be unable to fulfil its responsibilities adequately in instances where aircraft are leased, chartered or interchanged — in particular without crew — by an operator of another State and that the Convention may not adequately specify the rights and obligations of the State of an operator in such instances until such time as Article 83 bis *of the Convention enters into force. Accordingly, the Council urged that if, in the above-mentioned instances, the State of Registry finds itself unable to discharge adequately the functions allocated to it by the Convention, it delegate to the State of the operator, subject to acceptance by the latter State, those functions of the State of Registry that can more adequately be discharged by the State of the Operator. It is understood that pending entry into force of Article 83* bis *of the Convention the foregoing action will only be a matter of practical convenience and will not affect either the provisions of the Chicago Convention prescribing the duties of the State of Registry or any third State.*

1. CERTIFICATE OF AIRWORTHINESS

Note.— Certificate of Airworthiness as used in these Standards, is the Certificate of Airworthiness referred to in Article 31 of the Convention.

2. APPLICABILITY

2.1 The Standards of Part II are applicable as follows:

a) sections 4, 5 and 6 in respect of all aircraft, beginning 1 December 1957; and

b) sections 3, 7 and 8 and paragraph 2.2 in respect of all aircraft that are of types of which the prototype is submitted to appropriate national authorities for certification on or after 13 June 1960.

Note.— The applicability of the Standards in other parts of this Annex is stated in those parts.

2.2 A Contracting State shall not issue or render valid a Certificate of Airworthiness for which it intends to claim recognition pursuant to Article 33 of the Convention on International Civil Aviation, unless the aircraft complies with a comprehensive and detailed national airworthiness code established for that class of aircraft by the State of Registry or by any other Contracting State. This national code shall be such that compliance with it will ensure compliance with:

a) the Standards of Part II of this Annex; and

b) where applicable, with the Standards of Part III or Part IV of this Annex.

Where the design features of a particular aircraft render any of the Standards in Part III or Part IV inapplicable or inadequate, variations therefrom that are considered by the State of Registry to give at least an equivalent level of safety may be made.

Note.— An Airworthiness Technical Manual *(Doc 9051) containing guidance material has been published by ICAO. See the Foreword.*

3. PROOF OF COMPLIANCE WITH APPROPRIATE AIRWORTHINESS REQUIREMENTS

3.1 The Certificate of Airworthiness shall be issued by the Contracting State which approves the aircraft or by its authorized representatives on the basis of satisfactory evidence that the aircraft complies with the appropriate airworthiness requirements. Except when Certificates of Airworthiness are issued in accordance with 3.2, that State, or its authorized representatives, shall obtain such evidence in the manner prescribed in 3.1.1, 3.1.2 and 3.1.3.

3.1.1 There shall be an approved design consisting of such drawings, specifications, reports and documentary evidence as are necessary to show that the aircraft complies with the appropriate airworthiness requirements. Records shall be maintained to establish the identification of the aircraft with its approved design.

3.1.2 During the course of construction, the aircraft shall be inspected in accordance with a system of inspection approved by the State, to determine that it conforms in all essential respects with the approved design, and that its construction and assembly are satisfactory.

3.1.3 The aircraft shall be subjected to such flight tests as are deemed necessary by the State to show compliance with the appropriate airworthiness requirements.

3.2 When an aircraft possessing a valid Certificate of Airworthiness issued by a Contracting State is entered on the register of another Contracting State, the new State of Registry, when issuing another Certificate of Airworthiness or rendering the original certificate valid, may consider prior issuance of the Certificate of Airworthiness by a Contracting State as satisfactory evidence, in whole or in part, that the aircraft is airworthy and need not follow the procedure prescribed in 3.1.1, 3.1.2 and 3.1.3.

Note.— This applies both when the aircraft is registered for the first time and when the aircraft changes its nationality.

3.3 Contracting States, in addition to determining compliance with the appropriate airworthiness requirements for an aircraft, shall take whatever other steps they deem necessary to ensure that the Certificate of Airworthiness is withheld if the aircraft is known or suspected to have dangerous features not specifically guarded against by those requirements.

4. CONTINUING AIRWORTHINESS OF AIRCRAFT

4.1 Determination of continuing airworthiness

a) The continuing airworthiness of an aircraft shall be determined by the State of Registry in relation to the appropriate airworthiness requirements in force for that aircraft.

b) The State of Registry shall develop or adopt requirements to ensure the continued airworthiness of the aircraft during its service life.

Note 1.— These requirements will also cover maintenance requirements of Annex 6.

Note 2.— Guidance on continuing airworthiness requirements is contained in the Continuing Airworthiness Manual.

4.2 Information related to continuing airworthiness of aircraft

4.2.1 When a Contracting State first enters on its register an aircraft of a particular type for which it is not the State of Design and issues or validates a Certificate of Airworthiness in accordance with 2.2 of this Part, it shall advise the State of Design that it has entered such an aircraft on its register.

4.2.2 The State of Design of an aircraft shall transmit any generally applicable information which it has found necessary for the continuing airworthiness of the aircraft and for the safe operation of the aircraft (hereinafter called mandatory continuing airworthiness information) as follows:

a) to every Contracting State which has in accordance with 4.2.1 advised the State of Design that it has entered the aircraft on its register; and

b) to any other Contracting State upon request.

Note 1.— In 4.2, the term "mandatory continuing airworthiness information" is intended to include mandatory requirements for modification, replacement of parts or inspection of aircraft and amendment of operating limitations and procedures. Among such information is that issued by Contracting States in the form of airworthiness directives.

Note 2.— ICAO Circular 95 — The Continuing Airworthiness of Aircraft in Service *— provides the necessary information to assist Contracting States in establishing contact with competent authorities of other Contracting States, for the purpose of maintaining continuing airworthiness of aircraft in service.*

4.2.3 The State of Registry shall, upon receipt of mandatory continuing airworthiness information from the State of Design, adopt the mandatory information directly or assess the information received and take appropriate action.

4.2.4 Any Contracting State which has entered on its register an aircraft in respect of which that Contracting State is not the State of Design and for which it has issued or validated a Certificate of Airworthiness in accordance with 2.2 of this Part, shall ensure the transmission to the State of Design of all mandatory continuing airworthiness information originated in respect of that aircraft in the former Contracting State.

4.2.5 The State of Registry shall ensure that in respect of aircraft of over 5 700 kg maximum certificated take-off mass, there exists a system whereby information on faults, malfunctions, defects and other occurrences which cause or might cause adverse effects on the continuing airworthiness of the aircraft is transmitted to the organization responsible for the type design of that aircraft.

Note.— Guidance on interpretation of "the organization responsible for the type design" is contained in the Airworthiness Technical Manual *(Doc 9051).*

4.2.6 The State of Design shall ensure that, in respect of aircraft over 5 700 kg maximum certificated take-off mass, there exists a system for:

a) receiving information submitted in accordance with 4.2.5;

b) deciding if and when airworthiness action is needed;

c) developing the necessary airworthiness actions; and

d) promulgating the information on those actions including that required in 4.2.2.

4.2.7 The State of Design shall ensure that, in respect of aeroplanes over 5 700 kg maximum certificated take-off mass, there exists a continuing structural integrity programme to ensure the airworthiness of the aeroplane. The programme shall include specific information concerning corrosion prevention and control.

4.2.8 Each Contracting State shall establish, in respect of aircraft over 5 700 kg maximum certificated take-off mass, the type of service information that is to be reported to its airworthiness authority by operators, organizations responsible for type design and maintenance organizations. Procedures for reporting this information shall also be established.

4.2.9 Where the State of Manufacture of an aircraft is other than the State of Design there shall be an agreement acceptable to both States to ensure that the manufacturing organization co-operates with the organization responsible for the type design in assessing information received on experience with operating the aircraft.

5. VALIDITY OF CERTIFICATE OF AIRWORTHINESS

5.1 A Certificate of Airworthiness shall be renewed or shall remain valid, subject to the laws of the State of Registry, provided that the State of Registry shall require that the continuing airworthiness of the aircraft shall be determined by a periodical inspection at appropriate intervals having regard to lapse of time and type of service or, alternatively by means of a system of inspection, approved by the State, which will produce at least an equivalent result.

5.2 Method of rendering a Certificate of Airworthiness valid

When a State of Registry renders valid a Certificate of Airworthiness issued by another Contracting State, as an alternative to issuance of its own Certificate of Airworthiness, it shall establish validity by suitable authorization to be carried with the former Certificate of Airworthiness accepting it as the equivalent of the latter. The validity of the authorization shall not extend beyond the period of validity of the Certificate of Airworthiness, but whenever the period of validity of the Certificate of Airworthiness is renewed, the authorization may be renewed or another authorization issued by the State of Registry for a period corresponding to the period of validity of the Certificate of Airworthiness.

6. TEMPORARY LOSS OF AIRWORTHINESS

6.1 General

Any failure to maintain an aircraft in an airworthy condition as defined by the appropriate airworthiness requirements shall render the aircraft ineligible for operation until the aircraft is restored to an airworthy condition.

6.2 Damage to aircraft

When an aircraft has sustained damage, the State of Registry shall judge whether the damage is of a nature such that the aircraft is no longer airworthy as defined by the appropriate airworthiness requirements.

6.2.1 If the damage is sustained or ascertained when the aircraft is on the territory of another Contracting State, the authorities of the other Contracting State shall be entitled to prevent the aircraft from resuming its flight on the condition that they shall advise the State of Registry immediately, communicating to it all details necessary to formulate the judgement referred to in the introductory Standard of 6.2.

6.2.2 When the State of Registry considers that the damage sustained is of a nature such that the aircraft is no longer airworthy, it shall prohibit the aircraft from resuming flight until it is restored to an airworthy condition; the State of Registry may, however, in exceptional circumstances, prescribe particular limiting conditions to permit the aircraft to fly without fare-paying passengers to an aerodrome at which it can be restored to an airworthy condition, and the Contracting State that has originally, in accordance with 6.2.1, prevented the aircraft from resuming flights, shall permit such flight.

6.2.3 When the State of Registry considers that the damage sustained is of a nature such that the aircraft is still airworthy, the aircraft shall be allowed to resume its flight.

7. STANDARD FORM OF CERTIFICATE OF AIRWORTHINESS

The Certificate of Airworthiness shall contain the information indicated in the following form, and shall be generally similar to it (see Figure 1).

8. AIRCRAFT LIMITATIONS AND INFORMATION

Each aircraft shall be provided with a flight manual, placards, or other documents stating the approved limitations within which the aircraft is considered airworthy as defined by the appropriate airworthiness requirements, and additional instructions and information necessary for the safe operation of the aircraft.

*	*State of Registry* *Issuing Authority*	*
	CERTIFICATE OF AIRWORTHINESS	
1. Nationality and registration marks	2. Manufacturer and manufacturers' designation of aircraft	3. Aircraft serial number ....
4. Categories		
5. This Certificate of Airworthiness is issued pursuant to the Convention on International Civil Aviation dated 7 December 1944 and † .... in respect of the above-mentioned aircraft which is considered to be airworthy when maintained and operated in accordance with the foregoing and the pertinent operating limitations. Date of issue .... Signature .... † Insert reference to appropriate Airworthiness Code.		
6. **		

* For use of the State of Registry.

** This space shall be used either for periodic endorsement (giving date of expiry), or for a statement that the aircraft is being maintained under a system of continuous inspection.

Figure 1

22/3/91

PART III. AEROPLANES

CHAPTER 1. GENERAL

1.1 Applicability

1.1.1 The Standards of Part III, except for those specified in 8.4, are applicable in respect of all aeroplanes designated in 1.1.3, that are of types of which the prototype is submitted to the appropriate national authorities for certification on or after 13 June 1960.

1.1.2 The Standards specified in 8.4 of Part III are applicable in respect of all aeroplanes designated in 1.1.3 that are of types of which the prototype is submitted to the appropriate national authorities for certification on or after 22 March 1985.

Note.— The Council recognizes that the amended Standards relating to fire protection, crash survival and provisions for emergency are very important to safety and urges the implementation of the substance of these amended Standards, if feasible and practicable, before their applicability date of 22 March 1991.

1.1.3 The Standards of Part III shall apply to aeroplanes of over 5 700 kg maximum certificated take-off mass intended for the carriage of passengers or cargo or mail in international air navigation.

Note.— The following Standards do not include quantitative specifications comparable to those found in national airworthiness codes. In accordance with 2.2 of Part II, they are to be supplemented by national requirements prepared by Contracting States.

1.1.4 The level of airworthiness defined by the appropriate parts of the comprehensive and detailed national code referred to in 2.2 of Part II for the aeroplanes designated in 1.1.3 shall be at least substantially equivalent to the over-all level intended by the broad Standards of Part III.

1.1.5 Unless otherwise stated, the Standards apply to the complete aeroplane including power-units, systems and equipment.

1.2 Number of power-units

The aeroplane shall have not less than two power-units.

1.3 Limitations

1.3.1 Limiting conditions shall be established for the aeroplane, its power-units and its equipment (see 9.2). Compliance with the Standards of Part III shall be established assuming that the aeroplane is operated within the limitations specified. The limitations shall be sufficiently removed from any condition(s) prejudicial to the safety of the aeroplane to render the likelihood of accidents arising therefrom extremely remote.

1.3.2 Limiting ranges of mass, centre of gravity location, load distribution, speeds, and altitude or pressure-altitude shall be established within which compliance with all the pertinent Standards in Part III is shown, except that combinations of conditions which are fundamentally impossible to achieve need not be considered.

Note 1.— The maximum operating mass and centre of gravity limits may vary, for example, with each altitude and with each practicably separate operating condition, e.g. take-off, en route, landing.

Note 2.— The following items, for instance, may be considered as basic aeroplane limitations:

— *maximum certificated take-off mass*

— *maximum certificated taxiing mass*

— *maximum certificated landing mass*

— *maximum certificated zero fuel mass*

— *most forward and rearward centre of gravity positions in various configurations (take-off, en route, landing).*

Note 3.— Maximum operating mass may be limited by the application of Noise Certification Standards (see Annex 16 and Annex 6, Parts I and II).

1.4 Unsafe features and characteristics

The aeroplane shall not possess any feature or characteristic which renders it unsafe under the anticipated operating conditions.

1.5 Proof of compliance

1.5.1 Compliance with the appropriate airworthiness requirements shall be based on evidence either from tests, from calculations, or from calculations based on tests, provided that in each case the accuracy achieved will ensure a level of airworthiness equal to that which would be achieved were direct tests conducted.

1.5.2 The tests of 1.5.1 shall be such as to provide reasonable assurance that the aeroplane, its components, and equipment are reliable and function correctly under the anticipated operating conditions.

CHAPTER 2. FLIGHT

2.1 General

2.1.1 Compliance with the Standards prescribed in Chapter 2 shall be established by flight or other tests conducted upon an aeroplane or aeroplanes of the type for which a Certificate of Airworthiness is sought, or by calculations based on such tests, provided that the results obtained by calculations are equal in accuracy to, or conservatively represent, the results of direct testing.

2.1.2 Compliance with each Standard shall be established for all applicable combinations of aeroplane mass and centre of gravity position, within the range of loading conditions for which certification is sought.

2.1.3 Where necessary, appropriate aeroplane configurations shall be established for the determination of performance in the various stages of flight and for the investigation of the aeroplane's flying qualities.

2.2 Performance

2.2.1 General

2.2.1.1 Sufficient data on the performance of the aeroplane shall be determined and scheduled in the aeroplane flight manual to provide operators with the necessary information for the purpose of determining the total mass of the aeroplane on the basis of the values, peculiar to the proposed flight, of the relevant operational parameters, in order that the flight may be made with reasonable assurance that a safe minimum performance for that flight will be achieved.

2.2.1.2 The performance scheduled for the aeroplane shall not require exceptional skill or alertness on the part of the pilot.

2.2.1.3 The scheduled performance of the aeroplane shall be consistent with compliance with 1.3.1 and with the operation in logical combinations of those of the aeroplane's systems and equipment the operation of which may affect performance.

2.2.2 Minimum performance

At the maximum mass scheduled (see 2.2.3) for take-off and for landing as functions of the aerodrome elevation or pressure-altitude either in the standard atmosphere or in specified still air atmospheric conditions, and, for seaplanes, in specified conditions of smooth water, the aeroplane shall be capable of accomplishing the minimum performances specified in 2.2.2.1 and 2.2.2.2 respectively, not considering obstacles, or runway or water run length.

Note.— This Standard permits the maximum take-off mass and maximum landing mass to be scheduled in the aeroplane flight manual against, for example:

— aerodrome elevation, or

— pressure-altitude at aerodrome level, or

— pressure-altitude and atmospheric temperature at aerodrome level,

so as to be readily usable when applying the national code on aeroplane performance operating limitations.

2.2.2.1 *Take-off*

a) The aeroplane shall be capable of taking off assuming the critical power-unit to fail (see 2.2.3), the remaining power-units being operated within their take-off power limitations.

b) After the end of the period during which the take-off power may be used, the aeroplane shall be capable of continuing to climb, with the critical power-unit inoperative and the remaining power-units operated within their maximum continuous power limitations, up to a height that it can maintain and at which it can carry out a circuit of the aerodrome.

c) The minimum performance at all stages of take-off and climb shall be sufficient to ensure that under conditions of operation departing slightly from the idealized conditions for which data are scheduled (2.2.3), the departure from the scheduled values is not disproportionate.

2.2.2.2 *Landing*

a) Starting from the approach configuration and with the critical power-unit inoperative, the aeroplane shall be capable, in the event of a missed approach, of continuing the flight to a point from which a fresh approach can be made.

b) Starting from the landing configuration, the aeroplane shall be capable, in the event of a balked landing, of making a climb out, with all power-units operating.

2.2.3 Scheduling of performance

Performance data shall be determined and scheduled in the aeroplane flight manual so that their application by means of the operating rules to which the aeroplane is to be operated in accordance with 5.2 of Annex 6, Part I, will provide a safe relation between the performance of the aeroplane and the aerodromes and routes on which it is capable of being operated. Performance data shall be determined and scheduled for the following stages for the ranges of mass, altitude or pressure-altitude, wind velocity, gradient of the take-off and landing surface for landplanes, water surface conditions, density of water and strength of current for seaplanes, and for any other operational variables for which the aeroplane is to be certificated.

2.2.3.1 *Take-off.* The take-off performance data shall include the accelerate-stop distance and the take-off path.

2.2.3.1.1 *Accelerate-stop distance.* The accelerate-stop distance shall be the distance required to accelerate and stop, or, for a seaplane to accelerate and come to a satisfactorily low speed, assuming the critical power-unit to fail suddenly at a point not nearer to the start of the take-off than that assumed when determining the take-off path (see 2.2.3.1.2).

2.2.3.1.2 *Take-off path.* The take-off path shall comprise the ground or water run, initial climb and climb out, assuming the critical power-unit to fail suddenly during the take-off (see 2.2.3.1.1). The take-off path shall be scheduled up to a height that the aeroplane can maintain and at which it can carry out a circuit of the aerodrome. The climb out shall be made at a speed not less than the take-off safety speed as determined in accordance with 2.3.1.3.

2.2.3.2 *En route.* The en-route climb performance shall be the climb (or descent) performance with the aeroplane in the en-route configuration with:

a) the critical power-unit inoperative; and

b) the critical two power-units inoperative in the case of aeroplanes having three or more power-units.

The operating engines shall not exceed maximum continuous power.

2.2.3.3 *Landing.* The landing distance shall be the horizontal distance traversed by the aeroplane from a point on the approach flight path at a selected height above the landing surface to the point on the landing surface at which the aeroplane comes to a complete stop or, for a seaplane, comes to a satisfactorily low speed. The selected height above the landing surface and the approach speed shall be appropriately related to operating practices. This distance may be supplemented by such distance margin as may be necessary; if so, the selected height above the landing surface, the approach speed and the distance margin shall be appropriately interrelated and shall make provision for both normal operating practices and reasonable variations therefrom.

Note.— If the landing distance includes the distance margin specified in this Standard, it is not necessary to allow for the expected variations in the approach and landing techniques in applying 5.2.7.3 of Annex 6, Part I.

2.3 Flying qualities

The aeroplane shall comply with the Standards of 2.3 at all altitudes up to the maximum anticipated altitude relevant to the particular requirement in all temperature conditions relevant to the altitude in question and for which the aeroplane is approved.

2.3.1 Controllability

The aeroplane shall be controllable and manoeuvrable under all anticipated operating conditions and it shall be possible to make smooth transitions from one flight condition to another (e.g. turns, sideslips, changes of engine power, changes of aeroplane configurations) without requiring exceptional skill, alertness, or strength on the part of the pilot even in the event of failure of any power-unit. A technique for safely controlling the aeroplane shall be established for all stages of flight and aeroplane configurations for which performance is scheduled.

Note.— This Standard is intended, among other things, to relate to operation in conditions of no appreciable atmospheric turbulence and also to ensure that there is not undue deterioration of the flying qualities in turbulent air.

2.3.1.1 *Controllability on the ground (or water).* The aeroplane shall be controllable on the ground (or on the water) during taxiing, take-off, and landing under the anticipated operating conditions.

2.3.1.2 *Controllability during take-off.* The aeroplane shall be controllable in the event of sudden failure of the critical power-unit at any point in the take-off, when the aeroplane is handled in the manner associated with the scheduling of take-off paths and accelerate-stop distances.

2.3.1.3 *Take-off safety speed.* The take-off safety speeds assumed when the performance of the aeroplanes (after leaving the ground or water) during the take-off is determined shall provide an adequate margin above the stall and above the minimum speed at which the aeroplane remains controllable after sudden failure of the critical power-unit.

2.3.2 Trim

The aeroplane shall have such trim, and other characteristics as to ensure that the demands made on the pilot's attention and ability to maintain a desired flight condition are not excessive when account is taken of the stage of flight at which these demands occur and their duration. This shall apply both in normal operation and in the conditions associated with the failure of one or more power-units for which performance characteristics are established.

2.3.3 Stability

The aeroplane shall have such stability in relation to its other flight characteristics, performance, structural strength, and most probable operating conditions (e.g. aeroplane configurations and speed ranges) as to ensure that demands made on the pilot's powers of concentration are not excessive when the stage of the flight at which these demands occur and their duration are taken into account. The stability of the aeroplane shall not, however, be such that excessive demands are made on the pilot's strength or that the safety of the aeroplane is prejudiced by lack of manoeuvrability in emergency conditions.

2.3.4 Stalling

2.3.4.1 *Stall warning.* When the aeroplane is made to approach a stall both in straight and turning flight with all power-units operating and with one power-unit inoperative, clear and distinctive stall warning shall be apparent to the pilot with the aeroplane in all permissible configurations and powers, except those which are not considered to be essential for safe flying. The stall warning and other characteristics of the aeroplane shall be such as to enable the pilot to arrest the development of the stall after the warning begins and, without altering the engine power, to maintain full control of the aeroplane.

2.3.4.2 *Behaviour following a stall.* In any configuration and power in which it is considered that the ability to recover from a stall is essential the behaviour of the aeroplane following a stall shall not be so extreme as to make difficult a prompt recovery without exceeding the airspeed or strength limitations of the aeroplane. It shall be acceptable to throttle back the operating power-units during recovery from the stall.

2.3.4.3 *Stalling speeds.* The stalling speeds or minimum steady flight speeds in configurations appropriate for each stage of flight (e.g. take-off, en route, landing) shall be established. One of the values of the power used in establishing the stalling speeds shall be not more than that necessary to give zero thrust at a speed just above the stall.

2.3.5 Flutter and vibration

It shall be demonstrated by suitable tests that all parts of the aeroplane are free from flutter and excessive vibration in all aeroplane configurations under all speed conditions within the operating limitations of the aeroplane (see 1.3.2). There shall be no buffeting severe enough to interfere with control of the aeroplane, to cause structural damage or to cause excessive fatigue to the flight crew.

Note.— Buffeting as a stall warning is considered desirable and discouragement of this type of buffeting is not intended.

CHAPTER 3. STRUCTURES

3.1 General

The Standards of Chapter 3 apply to the aeroplane structure consisting of all portions of the aeroplane, the failure of which would seriously endanger the aeroplane.

3.1.1 Mass and mass distribution

Unless otherwise stated, all structural Standards shall be complied with when the mass is varied over the applicable range and is distributed in the most adverse manner, within the operating limitations on the basis of which certification is sought.

3.1.2 Limit loads

Except as might be otherwise qualified, the external loads and the corresponding inertia loads, or resisting loads obtained for the various loading conditions prescribed in 3.3, 3.4 and 3.5 shall be considered as limit loads.

3.1.3 Strength and deformation

In the various loading conditions prescribed in 3.3, 3.4 and 3.5 no part of the aeroplane structure shall sustain detrimental deformation at any load up to and including the limit load, and the aeroplane structure shall be capable of supporting the ultimate load.

3.2 Airspeeds

3.2.1 Design airspeeds

Design airspeeds shall be established for which the aeroplane structure is designed to withstand the corresponding manoeuvring and gust loads in accordance with 3.3. In establishing the design airspeeds, consideration shall be given to the following speeds:

a) V_A, the design manoeuvring speed;

b) V_B, the speed at which the maximum vertical gust velocity assumed in accordance with 3.3.2 can be withstood;

c) V_C, a speed not expected to be exceeded in normal cruising flight taking into account possible effects of upsets when flying in turbulent conditions;

d) V_D, maximum dive speed, sufficiently greater than the speed in c), to make it unlikely that such a design speed would be exceeded as a result of inadvertent speed increases in the anticipated operating conditions, taking into account the flying qualities and other characteristics of the aeroplane;

e) V_{E_1} to V_{E_n}, maximum speeds at which flaps and landing gears may be extended or other configuration changes be made.

The speeds V_A, V_B, V_C, and V_E in a), b), c) and e) shall be sufficiently greater than the stalling speed of the aeroplane to safeguard against loss of control in turbulent air.

3.2.2 Limiting airspeeds

Limiting airspeeds, based on the corresponding design airspeeds with safety margins, where appropriate, in accordance with 1.3.1 shall be included in the aeroplane flight manual as part of the operating limitations (see 9.2.2).

3.3 Flight loads

The flight loading conditions of 3.3.1, 3.3.2 and 3.5 shall be considered for the range of mass and mass distributions prescribed in 3.1.1 and at airspeeds established in accordance with 3.2.1. Asymmetrical as well as symmetrical loading shall be taken into account. The air, inertia, and other loads resulting from the specified loading conditions shall be distributed so as to approximate actual conditions closely or to represent them conservatively.

3.3.1 Manoeuvring loads

Manoeuvring loads shall be computed on the basis of manoeuvring load factors appropriate to the manoeuvres permitted by the operating limitations. They shall not be less than values which experience indicates will be adequate for the anticipated operating conditions.

3.3.2 Gust loads

Gust loads shall be computed for vertical and horizontal gust velocities and gradients which statistics or other evidence indicate will be adequate for the anticipated operating conditions.

3.4 Ground and water loads

The structure shall be able to withstand all the loads due to the reactions of the ground and water surface which are likely to arise during taxiing, take-off and landing.

3.4.1 Landing conditions

The landing conditions at the design take-off mass and at the design landing mass shall include such symmetrical and asymmetrical attitudes of the aeroplane at ground or water contact, such velocities of descent and such other factors, affecting the loads imposed upon the structure as might be present in the anticipated operating conditions.

3.5 Miscellaneous loads

In addition to or in conjunction with the manoeuvring and gust loads and with the ground and water loads, consideration shall be given to all other loads (flight control loads, cabin pressures, effects of engine operation, loads due to changes of configuration, etc.) which are likely to occur in the anticipated operating conditions.

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3.6 Flutter, divergence and vibration

The aeroplane structure shall be designed to be free from flutter, structural divergence (i.e. unstable structural distortion due to aerodynamic loading), and loss of control due to structural deformation, at speeds within and sufficiently beyond the operating limitations to comply with 1.3.1. Adequate strength shall be provided to withstand the vibration and buffeting that might occur in the anticipated operating conditions.

3.7 Fatigue strength

The strength and fabrication of the aeroplane shall be such as to ensure that the probability of disastrous fatigue failure of the aeroplane's structure under repeated loads and vibratory loads in the anticipated operating conditions is extremely remote.

CHAPTER 4. DESIGN AND CONSTRUCTION

4.1 General

Details of design and construction shall be such as to give reasonable assurance that all aeroplane parts will function effectively and reliably in the anticipated operating conditions. They shall be based upon practices which experience has proven to be satisfactory or which are substantiated by special tests or by other appropriate investigations or both.

4.1.1 Substantiating tests

The functioning of all moving parts essential to the safe operation of the aeroplane shall be demonstrated by suitable tests in order to ensure that they will function correctly under all operating conditions for such parts.

4.1.2 Materials

All materials used in parts of the aeroplane essential for its safe operation shall conform to approved specifications. The approved specifications shall be such that materials accepted as complying with the specifications will have the essential properties assumed in the design.

4.1.3 Fabrication methods

The methods of fabrication and assembly shall be such as to produce a consistently sound structure which shall be reliable with respect to maintenance of strength in service.

4.1.4 Protection

The structure shall be protected against deterioration or loss of strength in service due to weathering, corrosion, abrasion, or other causes, which could pass unnoticed, taking into account the maintenance the aeroplane will receive.

4.1.5 Inspection provisions

Adequate provision shall be made to permit any necessary examination, replacement, or reconditioning of parts of the aeroplane which require such attention, either periodically or after unusually severe operations.

4.1.6 Design features

Special consideration shall be given to design features which affect the ability of the flight crew to maintain controlled flight. This shall include at least the following:

a) *Controls and control systems.* The design of the controls and control systems shall be such as to minimize the possibility of jamming, inadvertent operations, and unintentional engagement of control surface locking devices.

b) *Crew environment.* The design of the flight crew compartment shall be such as to minimize the possibility of incorrect or restricted operation of the controls by the crew, due to fatigue, confusion or interference. Consideration shall be given at least to the following: layout and identification of controls and instruments, rapid identification of emergency situations, sense of controls, ventilation, heating and noise.

c) *Pilot vision.* The arrangement of the pilot compartment shall be such as to afford a sufficiently extensive, clear and undistorted field of vision for the safe operation of the aeroplane, and to prevent glare and reflections which would interfere with the pilot's vision. The design features of the pilot windshield shall permit under precipitation conditions sufficient vision for the normal conduct of flight and for the execution of approaches and landing.

d) *Provision for emergencies.* Means shall be provided which shall either automatically prevent or shall enable the flight crew to deal with emergencies resulting from foreseeable failures of equipment and systems the failure of which would endanger the aeroplane. Reasonable provisions shall be made for continuation of essential services following power-unit or system(s) failure(s) to the extent that such failure(s) are catered for in performance and operating limitations Standards in this Annex and in Annex 6, Parts I and II.

e) *Fire precautions.* The design of the aeroplane and the materials used in its manufacture including cabin interior furnishing materials replaced during major refurbishing shall be such as to minimize the possibility of in-flight and ground fires and also to minimize the production of smoke and toxic gases in the event of a fire. Means shall be provided to contain or to detect and extinguish such fires as might occur in such a way that no additional danger to the aeroplane is caused.

f) *Incapacitation of occupants.* Design precautions shall be taken to protect against possible instances of cabin depressurization and against the presence of smoke or other toxic gases which could incapaciate the occupants of the aeroplane.

4.1.7 Emergency landing provisions

4.1.7.1 Provisions shall be made in the design of the aeroplane to protect the occupants, in the event of an emergency landing, from fire and from the direct effects of deceleration forces as well as from injuries arising from the effect of deceleration forces on the aeroplane's interior equipment.

4.1.7.2 Facilities shall be provided for the rapid evacuation of the aeroplane in conditions likely to occur following an emergency landing. Such facilities shall be related to the passenger and crew capacity of the aeroplane.

4.1.7.3 The interior layout of the cabin and the position and number of emergency exits, including the means of locating and illuminating the escape paths and exits, shall be such as to facilitate rapid evacuation of the aeroplane in conditions likely to occur following an emergency landing.

4.1.7.4 On aeroplanes certificated for ditching conditions, provisions shall be made in the design to give maximum practicable assurance that safe evacuation from the aeroplane of passengers and crew can be executed in case of ditching.

4.1.8 Ground handling

Adequate provisions shall be made in the design to minimize the risk that ground handling operations (e.g. towing, jacking) may cause damage, which could pass unnoticed, to the parts of the aeroplane essential for its safe operation. The protection which any limitations and instructions for such operations might provide may be taken into account.

CHAPTER 5. ENGINES

5.1 Scope

The Standards of Chapter 5 shall apply to engines of all types which are used on the aeroplane as primary propulsion units.

5.2 Design, construction and functioning

The engine complete with accessories shall be designed and constructed so as to function reliably within its operating limitations under the anticipated operating conditions when properly installed in the aeroplane in accordance with Chapter 7 and, if applicable, fitted with a suitable propeller.

5.3 Declared ratings, conditions and limitations

The power ratings and the conditions of the atmosphere upon which they are based and all operating conditions and limitations, which are intended to govern the operation of the engine, shall be declared.

5.4 Tests

An engine of the type shall complete satisfactorily such tests as are necessary to verify the validity of the declared ratings conditions and limitations and to ensure that it will operate satisfactorily and reliably. The tests shall include at least the following:

a) *Power calibration*. Tests shall be conducted to establish the power or thrust characteristics of the engine when new and also after the tests in b) and c). There shall be no excessive decrease in power at the conclusion of all the tests specified.

b) *Operation*. Tests shall be conducted to ensure that starting, idling, acceleration, vibration, overspeeding and other characteristics are satisfactory and to demonstrate adequate margins of freedom from detonation, surge, or other detrimental conditions as may be appropriate to the particular type engine.

c) *Endurance*. Tests of sufficient duration shall be conducted at such powers, thrust, speeds and other operating conditions as are necessary to demonstrate reliability and durability of the engine. They shall also include operation under conditions in excess of the declared limits to the extent that such limitations might be exceeded in actual service.

CHAPTER 6. PROPELLERS

6.1 Scope

The Standards of Chapter 6 shall apply to propellers of all types.

6.2 Design, construction and functioning

The propeller assembly complete with accessories shall be designed and constructed so as to function reliably within its operating limitations under the anticipated operating conditions when properly fitted to the engine and installed in the aeroplane in accordance with Chapter 7.

6.3 Declared ratings, conditions and limitations

The power ratings and all operating conditions and limitations, which are intended to govern the operation of the propeller, shall be declared.

6.4 Tests

A propeller of the type shall complete satisfactorily such tests as are necessary to ensure that it will operate satisfactorily and reliably within the declared ratings, conditions and limitations. The texts shall include at least the following:

a) *Operation*. Tests shall be conducted to ensure that strength vibration and overspeeding characteristics are satisfactory and to demonstrate proper and reliable functioning of pitch changing and control mechanisms.

b) *Endurance*. Tests of sufficient duration shall be conducted at such powers, speeds and other operating conditions as are necessary to demonstrate reliability and durability of the propeller.

CHAPTER 7. POWERPLANT INSTALLATION

7.1 General

7.1.1 Applicable Standards

The powerplant installation shall comply with the Standards of Chapter 4 and with the Standards of this Chapter.

7.1.2 Compliance with engine and propeller limitations

The powerplant installation shall be so designed that the engines and propellers (if applicable) are capable of being used in the anticipated operating conditions. In conditions established in the aeroplane flight manual the aeroplane shall be capable of being operated without exceeding the limitations established for the engines and propellers in accordance with Chapters 5, 6 and 7.

7.1.3 Control of engine rotation

In those installations where continued rotation of an engine which had failed would increase the hazard of fire or of a serious structural failure, means shall be provided for the crew to stop the rotation of the engine in flight, or to reduce it to a safe level.

7.1.4 Engine restarting

Means shall be provided for restarting an engine at altitudes up to a declared maximum altitude.

7.2 Arrangement and functioning

7.2.1 Independence of power-units

The powerplant shall be arranged and installed so that each power-unit together with its associated systems is capable of being controlled and operated independently from the others and so that there is at least one arrangement of the powerplant and systems in which any failure, unless the probability of its occurrence is extremely remote, cannot result in a loss of more power than that resulting from complete failure of the critical power-unit.

7.2.2 Propeller vibration

The propeller vibration stresses shall be determined and shall not exceed values which have been found safe for operation within the operating limitations established for the aeroplane.

7.2.3 Cooling

The cooling system shall be capable of maintaining powerplant temperatures within the established limits (see 7.1.2) at ambient air temperatures up to the maximum air temperature appropriate to intended operation of the aeroplane. The maximum and, if necessary, minimum air temperature for which the powerplant has been established to be suitable shall be scheduled in the aeroplane flight manual.

7.2.4 Associated systems

The fuel, oil, air induction, and other systems associated with the powerplant, shall be capable of supplying each engine in accordance with its established requirements, under all conditions affecting the functioning of the systems (e.g. engine power, aeroplane attitudes and accelerations, atmospheric conditions, fluid temperatures) within the anticipated operating conditions.

7.2.5 Fire protection

For regions of the powerplant where the potential fire hazards are particularly serious because of the proximity of ignition sources to combustible materials, the following shall apply in addition to the general Standard of 4.1.6 e).

a) *Isolation.* Such regions shall be isolated by fire resisting material from other regions of the aeroplane where the presence of fire would jeopardize continued flight, taking into account the probable points of origin and paths of propagation of fire.

b) *Flammable fluids.* Flammable fluid system components located in such regions shall be capable of containing the fluid when exposed to fire conditions. Means shall be provided for the crew to shut off the flow of flammable fluids into such regions if a fire occurs.

c) *Fire protection.* There shall be provided a sufficient number of fire detectors so located as to ensure rapid detection of any fire which might occur in such regions.

d) *Fire extinguishment.* Such regions shall be provided with a fire extinguisher system capable of extinguishing any fire likely to occur therein, unless the degree of isolation, quantity of combustibles, fire resistance of the structure, and other factors, is such that any fire likely to occur in the region would not jeopardize the safety of the aeroplane.

CHAPTER 8. INSTRUMENTS AND EQUIPMENT

8.1 Required instruments and equipment

The aeroplane shall be provided with approved instruments and equipment necessary for the safe operation of the aeroplane in the anticipated operating conditions. These shall include the instruments and equipment necessary to enable the crew to operate the aeroplane within its operating limitations.

Note.— Instruments and equipment additional to the minimum necessary for the issuance of a Certificate of Airworthiness are prescribed in Annex 6, Parts I and II, for particular circumstances or on particular kinds of routes.

8.2 Installation

Instrument and equipment installations shall comply with the Standards of Chapter 4.

8.3 Safety and survival equipment

Prescribed safety and survival equipment which the crew or passengers are expected to use or operate at the time of an emergency shall be reliable, readily accessible and easily identified, and its method of operation shall be plainly marked.

*8.4 Navigation lights and anti-collision lights

8.4.1 The lights required by Annex 2 to be displayed by aeroplanes in flight or operating on the movement area of an aerodrome shall have intensities, colours, fields of coverage and other characteristics such that they furnish the pilot of another aircraft or personnel on the ground with as much time as possible for interpretation and for subsequent manoeuvre necessary to avoid a collision. In the design of such lights due account shall be taken of the conditions under which they may reasonably be expected to perform these functions.

Note 1.— It is likely that lights will be viewed against a variety of backgrounds, such as typical city lighting, clear starry sky, moonlit water and daytime conditions of low background luminance. Furthermore, collision risk situations are most likely to arise in terminal control areas in which aircraft are manoeuvring in the intermediate and lower flight levels at closing speeds that are unlikely to exceed 900 km/h (500 kt).

Note 2.— See Part III of the Airworthiness Technical Manual *(Doc 9051) for detailed technical specifications for exterior lights for aeroplanes.*

8.4.2 Lights shall be installed in aeroplanes so as to minimize the possibility that they will:

a) adversely affect the satisfactory performance of the flight crews' duties; or

b) subject an outside observer to harmful dazzle.

Note.— In order to avoid the effects mentioned in 8.4.2, it will be necessary in some cases to provide means whereby the pilot can switch off or reduce the intensity of the flashing lights.

* Please refer to 1.1.2 of this Part.

CHAPTER 9. OPERATING LIMITATIONS AND INFORMATION

9.1 General

The operating limitations within which compliance with the Standards of this Annex is determined, together with any other information necessary to the safe operation of the aeroplane, shall be made available by means of an aeroplane flight manual, markings and placards, and such other means as may effectively accomplish the purpose. The limitations and information shall include at least those prescribed in 9.2, 9.3 and 9.4.

9.2 Operating limitations

Limitations which there is a risk of exceeding in flight and which are defined quantitatively shall be expressed in suitable units and corrected if necessary for errors in measurements so that the flight crew can, by reference to the instruments available to them, readily determine when the limitations are reached.

9.2.1 Loading limitations

The loading limitations shall include all limiting mass, centres of gravity position, mass distributions, and floor loadings (see 1.3.2).

9.2.2 Airspeed limitations

The airspeed limitations shall include all speeds (see 3.2) which are limiting from the standpoint of structural integrity or flying qualities of the aeroplane, or from other considerations. These speeds shall be identified with respect to the appropriate aeroplane configurations and other pertinent factors.

9.2.3 Powerplant limitations

The powerplant limitations shall include all those established for the various powerplant components as installed in the aeroplane (see 7.1.2 and 7.2.3).

9.2.4 Limitations on equipment and systems

The limitations on equipment and systems shall include all those established for the various equipment and systems as installed in the aeroplane.

9.2.5 Miscellaneous limitations

Any necessary limitations with respect to conditions found to be prejudicial to the safety of the aeroplane (see 1.3.1).

9.2.6 Flight crew limitations

The flight crew limitations shall include the minimum number of flight crew personnel necessary to operate the aeroplane, having regard among other things to the accessibility to the appropriate crew members of all necessary controls and instruments and to the execution of the established emergency procedures.

Note.— See Annex 6 — Operation of Aircraft, *Parts I and II, for the circumstances in which the flight crew shall include members in addition to the minimum flight crew defined in this Annex.*

9.2.7 Flying time limitation after system or power-unit failure

The systems limitations shall include the maximum flying time for which system reliability has been established in relation to the approval of operations by aeroplanes with two turbine power-units beyond the threshold time established in accordance with 4.7 of Annex 6, Part I.

Note.— The maximum time established in accordance with 4.7 of Annex 6, Part I for a particular route may be less than that determined in accordance with 9.2.7 because of the operational considerations involved.

9.3 Operating information and procedures

9.3.1 Types of eligible operations

There shall be listed the particular types of operations, as may be defined in Annex 6, Parts I and II, to the Convention or be generally recognized, for which the aeroplane has been shown to be eligible by virtue of compliance with the appropriate airworthiness requirements.

9.3.2 Loading information

The loading information shall include the empty mass of the aeroplane, together with a definition of the condition of the aeroplane at the time of weighing, the corresponding centre of gravity position, and the reference point(s) and datum line(s) to which the centre of gravity limits are related.

Note.— Usually the empty mass excludes the mass of the crew and payload, and the usable fuel supply and the drainable oil; it includes the mass of all fixed ballast, unusable fuel supply, undrainable oil, total quantity of engine coolant and total quantity of hydraulic fluid.

9.3.3 Operating procedures

A description shall be given of normal and emergency operating procedures which are peculiar to the particular aeroplane and necessary for its safe operation. These shall include procedures to be followed in the event of failure of one or more power-units.

9.3.4 Handling information

Sufficient information shall be given on any significant or unusual features of the aeroplane characteristics. Those stalling speeds or minimum steady flight speeds required to be established by 2.3.4.3 shall be scheduled.

9.4 Performance information

The performance of the aeroplane shall be scheduled in accordance with 2.2. There shall be included information regarding the various aeroplane configurations and powers involved and the relevant speeds, together with information which would assist the flight crew in attaining the performance as scheduled.

9.5 Aeroplane flight manual

An aeroplane flight manual shall be made available. It shall identify clearly the specific aeroplane or series of aeroplanes with which it is related. The aeroplane flight manual shall include at least the limitations, information and procedures specified in this chapter.

9.6 Markings and placards

9.6.1 Markings and placards on instruments, equipment, controls, etc., shall include such limitations or information as necessary for the direct attention of the flight crew during flight.

9.6.2 Markings and placards, or instructions, shall be provided to give any information which is essential to the ground crew in order to preclude the possibility of mistakes in ground servicing (e.g. towing, refuelling) which could pass unnoticed and which could jeopardize the safety of the aeroplane in subsequent flights.

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CHAPTER 10. CONTINUING AIRWORTHINESS — MAINTENANCE INFORMATION

10.1 General

Information for use in developing procedures for maintaining the aeroplane in an airworthy condition shall be made available. The information shall include that described in 10.2, 10.3 and 10.4

10.2 Maintenance information

Maintenance information shall include a description of the aeroplane and recommended methods for the accomplishment of maintenance tasks. Such information shall include guidance on defect diagnosis.

10.3 Maintenance programme information

Maintenance programme information shall include the maintenance tasks and the recommended intervals at which these tasks are to be performed.

10.4 Maintenance information resulting from the type design approval

Maintenance tasks and frequencies that have been specified as mandatory by the State of Design in approval of the type design shall be identified as such.

PART IV. HELICOPTERS

CHAPTER 1. GENERAL

1.1 Applicability

1.1.1 The Standards of Part IV are applicable in respect of all helicopters designated in 1.1.2, that are of types of which the prototype is submitted to the appropriate national authorities for certification on or after 22 March 1991.

Note.— The Council recognizes that the Standards relating to fire protection, crash survival and provisions for emergency are very important to safety and urges the implementation of the substance of these Standards as soon as it is feasible and practicable before the applicable date.

1.1.2 The Standards of Part IV shall apply to helicopters intended for the carriage of passengers or cargo or mail in international air navigation.

Note.— The following Standards do not include quantitative specifications comparable to those found in national airworthiness codes. In accordance with 2.2 of Part II, they are to be supplemented by national requirements prepared by Contracting States.

1.1.3 The level of airworthiness defined by the appropriate parts of the comprehensive and detailed national code referred to in 2.2 of Part II for the helicopters designated in 1.1.2 shall be at least substantially equivalent to the over-all level intended by the broad Standards of Part IV.

1.1.4 Unless otherwise stated, the Standards apply to the complete helicopter including power-units, systems and equipment.

1.2 Limitations

1.2.1 Limiting conditions shall be established for the helicopter, its power-unit(s) and its equipment (see 9.2). Compliance with the Standards of Part IV shall be established assuming that the helicopter is operated within the limitations specified. The limitations shall be sufficiently removed from any condition(s) prejudicial to the safety of the helicopter to render the likelihood of accidents arising therefrom extremely remote.

1.2.2 Limiting ranges of mass, centre of gravity location, load distribution, speeds and ambient conditions shall be established within which compliance with all the pertinent Standards in Part IV is shown, except that combinations of conditions which are fundamentally impossible to achieve need not be considered.

Note 1.— The maximum operating mass and centre of gravity limits may vary, for example, with each altitude and with each practicably separate operating condition, e.g. take-off, en route, landing.

Note 2.— The following items, for instance, may be considered as basic helicopter limitations:

— maximum certificated take-off (including lift-off) mass

— maximum certificated ground-taxiing mass

— maximum certificated landing mass

— most forward, rearward, and lateral centre of gravity positions in various configurations

— maximum certificated cargo sling mass.

Note 3.— Maximum operating mass may be limited by the application of Noise Certification Standards (see Annex 16 and Annex 6, Part III).

1.3 Unsafe features and characteristics

The helicopter shall not possess any feature or characteristic which renders it unsafe under the anticipated operating conditions.

1.4 Proof of compliance

1.4.1 Compliance with the appropriate airworthiness requirements shall be based on evidence either from tests, calculations, calculations based on tests, or other methods provided that in each case the accuracy achieved will ensure a level of airworthiness equal to that which would be achieved were direct tests conducted.

1.4.2 The tests of 1.4.1 shall be such as to provide reasonable assurance that the helicopter, its components and equipment are reliable and function correctly under the anticipated operating conditions.

CHAPTER 2. FLIGHT

2.1 General

2.1.1 Compliance with the Standards prescribed in Chapter 2 shall be established by flight or other tests conducted upon a helicopter or helicopters of the type for which a Certificate of Airworthiness is sought, or by calculations (or other methods) based on such tests, provided that the results obtained by calculations (or other methods) are equal in accuracy to, or conservatively represent, the results of direct testing.

2.1.2 Compliance with each Standard shall be established for all applicable combinations of helicopter mass and centre of gravity position, within the range of loading conditions for which certification is sought.

2.1.3 Where necessary, appropriate helicopter configurations shall be established for the determination of performance in the various stages of flight and for the investigation of the helicopter's flying qualities.

2.2 Performance

2.2.1 General

2.2.1.1 Sufficient data on the performance of the helicopter shall be determined and scheduled in the helicopter flight manual to provide operators with the necessary information for the purpose of determining the total mass of the helicopter on the basis of the values, peculiar to the proposed flight, of the relevant operational parameters, in order that the flight may be made with reasonable assurance that a safe minimum performance for that flight will be achieved.

2.2.1.2 The performance scheduled for the helicopter shall not require exceptional skill or alertness on the part of the pilot.

2.2.1.3 The scheduled performance of the helicopter shall be consistent with compliance with 1.2.1 and with the operation in logical combinations of those of the helicopter's systems and equipment the operation of which may affect performance.

2.2.2 Minimum performance

At the maximum mass scheduled (see 2.2.3) for take-off and for landing as functions of the take-off or landing site elevation or pressure-altitude either in the standard atmosphere or in specified still air atmospheric conditions, and, for water operations, in specified conditions of smooth water, the helicopter shall be capable of accomplishing the minimum performances specified in 2.2.2.1 and 2.2.2.2 respectively, not considering obstacles, or final approach and take-off area length.

Note.— This Standard permits the maximum take-off mass and maximum landing mass to be scheduled in the helicopter flight manual against, for example at the take-off or landing site:

— elevation, or

— pressure-altitude, or

— pressure-altitude and atmospheric temperature,

so as to be readily usable when applying the national code on helicopter performance operating limitations.

2.2.2.1 *Take-off*

a) In the event of critical power-unit failure, at or after the take-off decision point (for performance Class 1) or the defined point after take-off (for performance Class 2), performance Classes 1 and 2 helicopters shall be capable of continuing safe flight, the remaining power-unit(s) being operated within the approved limitations.

b) The minimum performance at all stages of take-off and climb shall be sufficient to ensure that under conditions of operation departing slightly from the idealized conditions for which data are scheduled (2.2.3), the departure from the scheduled values is not disproportionate.

2.2.2.2 *Landing*

a) Starting from the approach configuration, in the event of critical power-unit failure at or before the landing decision point (performance Class 1) or the defined point before landing (performance Class 2), the helicopter shall be capable of continuing safe flight, the remaining power-unit(s) being operated within the approved limitations.

b) Starting from the landing configuration, the helicopter shall be capable, in the event of a balked landing, of making a climb out, with all power-units operating.

2.2.3 Scheduling of performance

Performance data shall be determined and scheduled in the helicopter flight manual so that their application by means of the operating rules to which the helicopter is to be operated in accordance with 5.1.2 of Annex 6, Part III, will provide a safe relation between the performance of the helicopter and the aerodromes, heliports and routes on which it is capable of being operated. Performance data shall be determined and scheduled for the following stages for the ranges of mass, altitude or pressure-altitude, wind velocity, and other ambient conditions and any other operational variables for which the helicopter is to be certificated, and additionally for amphibians, water surface conditions and strength of current.

2.2.3.1 *Take-off.* The take-off performance data shall include the take-off distance required and the take-off path. For performance Class 1 helicopters, it shall also include the rejected take-off distance required.

2.2.3.1.1 *Take-off decision point.* (For performance Class 1 helicopters only) The take-off decision point shall be the point in the take-off phase used in determining take-off performance and from which either a rejected take-off may be made or a take-off safely continued, with the critical power-unit inoperative.

2.2.3.1.2 *Take-off distance required.* (For performance Class 1 helicopters only) The take-off distance required shall be the horizontal distance required from the start of the take-off to the point at which V_{TOSS}, a selected height above the take-off surface, and a positive climb gradient are achieved, following failure of the critical power-unit at the take-off decision point, the remaining power-unit(s) operating within approved operating limits.

2.2.3.1.3 *Rejected take-off distance required.* (For performance Class 1 helicopters only) The rejected take-off distance required shall be the horizontal distance required from the start of the take-off to the point where the helicopter comes to a complete stop following a power-unit failure and rejection of the take-off at the take-off decision point.

2.2.3.1.4 *Take-off distance required.* (For performance Class 2 and 3 helicopters only) The take-off distance required shall be the horizontal distance required from the start of take-off to the point where the best rate of climb speed (Vy) or the best angle of climb speed (Vx) or a selected intermediate speed (provided this speed does not involve flight within the avoid areas of the height-velocity diagrams) and a selected height above the take-off surface are achieved, all engines operating at approved take-off power.

2.2.3.2 *En route.* The en-route performance shall be the climb, cruise, or descent performance with:

a) the critical power-unit inoperative;

b) the critical two power-units inoperative in the case of helicopters having three or more power-units; and

c) the operating engine(s) not exceeding the power for which they are certificated.

2.2.3.3 *Landing.* The landing performance data shall include the landing distance required and, for performance Class 1 helicopters, the landing decision point.

2.2.3.3.1 *Landing decision point.* (For performance Class 1 helicopters only) The landing decision point shall be the latest point in the approach phase from which either a landing may be made or a rejected landing (go-around) safely initiated, with the critical power-unit inoperative.

2.2.3.3.2 *Landing distance required.* Landing distance required shall be the horizontal distance required to land and come to a complete stop from a point on the approach flight path at a selected height above the landing surface.

2.3 Flying qualities

The helicopter shall comply with the Standards of 2.3 at all altitudes up to the maximum anticipated altitude relevant to the particular requirement in all temperature conditions relevant to the altitude in question and for which the helicopter is approved.

2.3.1 Controllability

The helicopter shall be controllable and manoeuvrable under all anticipated operating conditions and it shall be possible to make smooth transitions from one flight condition to another (e.g. turns, sideslips, changes of engine power, changes of helicopter configurations) without requiring exceptional skill, alertness, or strength on the part of the pilot even in the event of failure of any power-unit. A technique for safely controlling the helicopter shall be established for all stages of flight and helicopter configurations for which performance is scheduled.

Note.— This Standard is intended, among other things, to relate to operation in conditions of no appreciable atmospheric turbulence and also to ensure that there is no undue deterioration of the flying qualities in turbulent air.

2.3.1.1 *Controllability on the ground (or water).* The helicopter shall be controllable on the ground (or on the water) during taxiing, take-off and landing under the anticipated operating conditions.

2.3.1.2 *Controllability during take-off.* The helicopter shall be controllable in the event of sudden failure of the critical power-unit at any point in the take-off, when the helicopter is handled in the manner associated with the scheduling of the take-off data.

2.3.2 Characteristics of flight controls

The helicopter shall have such trim, and handling capabilities as to ensure that the demands made on the pilot's attention and ability to maintain a desired flight condition are not excessive when account is taken of the stage of flight at which these demands occur and their duration. In the event of a malfunction of the systems associated with the flight controls, there must not be any significant deterioration of the handling characteristics.

2.3.3 Stability

The helicopter shall have such stability in relation to its other flight characteristics, performance, structural strength, and most probable operating conditions (e.g. helicopter configurations and speed ranges) as to ensure that demands made on the pilot's powers of concentration are not excessive when the stage of the flight at which these demands occur and their duration are taken into account. The stability of the helicopter shall not, however, be such that excessive demands are made on the pilot's strength or that the safety of the helicopter is prejudiced by lack of manoeuvrability in emergency conditions.

2.3.4 Autorotation

2.3.4.1 *Rotor speed control.* The autorotation characteristics of the helicopter shall be such as to enable the pilot to control the rotor speed to within prescribed limits, and to maintain full control of the helicopter.

2.3.4.2 *Behaviour following a power loss.* The behaviour of the helicopter following a power loss shall not be so extreme as to make difficult a prompt recovery of rotor speed without exceeding the airspeed or strength limitations of the helicopter.

2.3.4.3 *Autorotation airspeeds.* The autorotation airspeeds recommended for maximum range and minimum rate of descent shall be established.

2.3.5 Flutter and vibration

It shall be demonstrated by suitable tests that all parts of the helicopter are free from flutter and excessive vibration in all helicopter configurations under all speed conditions within the operating limitations of the helicopter (see 1.2.2). There shall be no vibration severe enough to interfere with control of the helicopter, to cause structural damage or to cause excessive fatigue to the flight crew.

CHAPTER 3. STRUCTURES

3.1 General

The Standards of Chapter 3 apply to the helicopter structure consisting of all portions of the helicopter, the failure of which would seriously endanger the helicopter.

3.1.1 Mass and mass distribution

Unless otherwise stated, all structural Standards shall be complied with when the mass is varied over the applicable range and is distributed in the most adverse manner, within the operating limitations on the basis of which certification is sought.

3.1.2 Limit loads

Except as might be otherwise qualified, the external loads and the corresponding inertia loads, or resisting loads obtained for the various loading conditions prescribed in 3.4, 3.5 and 3.6 shall be considered as limit loads.

3.1.3 Strength and deformation

In the various loading conditions prescribed in 3.4, 3.5 and 3.6 no part of the helicopter structure shall sustain detrimental deformation at any load up to and including the limit load, and the helicopter structure shall be capable of supporting the ultimate load.

3.2 Airspeeds

3.2.1 Design airspeeds

Design airspeeds shall be established for which the helicopter structure is designed to withstand the corresponding manoeuvring and gust loads in accordance with 3.4.

3.2.2 Limiting airspeeds

Limiting airspeeds, based on the corresponding design airspeeds with safety margins, where appropriate, in accordance with 1.2.1 shall be included in the helicopter flight manual as part of the operating limitations (see 9.2.2). When airspeed limitations are a function of mass, mass distribution, altitude, rotor speed, power or other factors, airspeed limitations based on the critical combination of these factors shall be established.

3.3 Main rotor(s) rotational speed limits

A range of main rotor(s) speeds shall be established that:

a) with power on, provides adequate margin to accommodate the variations in rotor speed occurring in any appropriate manoeuvre, and is consistent with the kind of governor or synchronizer used; and

b) with power off, allows each appropriate autorotative manoeuvre to be performed throughout the ranges of airspeed and mass for which certification is requested.

3.4 Flight loads

The flight loading conditions of 3.4.1, 3.4.2 and 3.6 shall be considered for the range of mass and mass distributions prescribed in 3.1.1 and at airspeeds established in accordance with 3.2.1. Asymmetrical as well as symmetrical loading shall be taken into account. The air, inertia, and other loads resulting from the specified loading conditions shall be distributed so as to approximate actual conditions closely or to represent them conservatively.

3.4.1 Manoeuvring loads

Manoeuvring loads shall be computed on the basis of manoeuvring load factors appropriate to the manoeuvres permitted by the operating limitations. They shall not be less than values which experience indicates will be adequate for the anticipated operating conditions.

3.4.2 Gust loads

Gust loads shall be computed for vertical and horizontal gust velocities which statistics or other evidence indicate will be adequate for the anticipated operating conditions.

3.5 Ground and water loads

The structure shall be able to withstand all the loads due to the reactions of the ground or water surface, as applicable, which are likely to arise during start-up, ground and water taxiing, lift-off, touchdown and rotor braking.

3.5.1 Landing conditions

The landing conditions at the design take-off mass and at the design landing mass shall include such symmetrical and asymmetrical attitudes of the helicopter at ground or water contact, such velocities of descent and such other factors affecting the loads imposed upon the structure as might be present in the anticipated operating conditions.

3.6 Miscellaneous loads

In addition to or in conjunction with the manoeuvring and gust loads and with the ground and water loads, consideration shall be given to all other loads (flight control loads, cabin pressures, effects of engine operation, loads due to changes of configuration, loads due to external mass, etc.) which are likely to occur in the anticipated operating conditions.

3.7 Flutter, divergence and vibration

Each part of the helicopter structure shall be free from excessive vibration or oscillation (ground resonance, flutter, etc.) under each appropriate speed and power condition.

3.8 Fatigue strength

The strength and fabrication of the helicopter shall be such as to ensure that the probability of disastrous fatigue failure of the helicopter's structure under repeated loads and vibratory loads in the anticipated operating conditions is extremely remote.

Note.—This Standard can be complied with by the establishment of "safe lives" or "fail safe" characteristics of the structure, having regard to the reasonable expected load magnitudes and frequencies under the anticipated operating conditions and inspection procedures. For some parts of the structure it might be necessary to establish "fail safe" characteristics as well as "safe lives".

CHAPTER 4. DESIGN AND CONSTRUCTION

4.1 General

Details of design and construction shall be such as to give reasonable assurance that all helicopter parts will function effectively and reliably in the anticipated operating conditions. They shall be based upon practices which experience has proven to be satisfactory or which are substantiated by special tests or by other appropriate investigations or both.

4.1.1 Substantiating tests

The functioning of all moving parts essential to the safe operation of the helicopter shall be demonstrated by suitable tests in order to ensure that they will function correctly under all operating conditions for such parts.

4.1.2 Materials

All materials used in parts of the helicopter essential for its safe operation shall conform to approved specifications. The approved specifications shall be such that materials accepted as complying with the specifications will have the essential properties assumed in the design.

4.1.3 Fabrication methods

The methods of fabrication and assembly shall be such as to produce a consistently sound structure which shall be reliable with respect to maintenance of strength in service.

4.1.4 Protection

The structure shall be protected against deterioration or loss of strength in service due to weathering, corrosion, abrasion, or other causes, which could pass unnoticed, taking into account the maintenance the helicopter will receive.

4.1.5 Inspection provisions

Adequate provision shall be made to permit any necessary examination, replacement, or reconditioning of parts of the helicopter which require such attention, either periodically or after unusually severe operations.

4.1.6 Design features

Special consideration shall be given to design features which affect the ability of the flight crew to maintain controlled flight. This shall include at least the following:

a) *Controls and control systems.* The design of the controls and control systems shall be such as to minimize the possibility of jamming, inadvertent operations, and unintentional engagement of control surface locking devices.

   i) Each control and control system shall operate with the ease, smoothness and positiveness appropriate to its function; and

   ii) each element of each flight control system shall be designed to minimize the probability of any incorrect assembly that could result in the malfunction of the system.

b) *Crew environment.* The design of the flight crew compartment shall be such as to minimize the possibility of incorrect or restricted operation of the controls by the crew, due to fatigue, confusion or interference. Consideration shall be given at least to the following: lay-out and identification of controls and instruments, rapid identification of emergency situations, sense of controls, ventilation, heating and noise.

c) *Pilot vision.* The arrangement of the pilot compartment shall be such as to afford a sufficiently extensive, clear and undistorted field of vision for the safe operation of the helicopter, and to prevent glare and reflections which would interfere with the pilot's vision. The design features of the pilot windshield shall permit under precipitation conditions sufficient vision for the normal conduct of flight and for the execution of approaches and landing.

d) *Provision for emergencies.* Means shall be provided which shall either automatically prevent or shall enable the flight crew to deal with emergencies resulting from foreseeable failures of equipment and systems the failure of which would endanger the helicopter. Reasonable provisions shall be made for continuation of essential services following power-unit or system(s) failure(s) to the extent that such failure(s) are catered for in performance and operating limitations Standards in this Annex and in Annex 6, Part III.

e) *Fire precautions.* The design of the helicopter and the materials used in its manufacture including cabin interior furnishing materials replaced during major refurbishing shall be such as to minimize the possibility of in-flight and ground fires and also to minimize the production of smoke and toxic gases in the event of a fire. Means shall be provided to contain or to detect and extinguish, wherever possible, all accessible fires as might occur in such a way that no additional danger to the helicopter is caused.

f) *Incapacitation of occupants.* Design precautions shall be taken to protect against possible instances of cabin depressurization and against the presence of smoke or other toxic gases which could incapacitate the occupants of the helicopter.

4.1.7 Emergency landing provisions

Provisions shall be made in the design of the helicopter to protect the occupants from fire and effects of deceleration in the event of an emergency landing. Facilities shall be provided for rapid evacuation of the helicopter in conditions likely to occur following an emergency landing and such facilities shall be related to the passenger and crew capacity of the helicopter. On helicopters certificated for ditching conditions, provisions shall also be made in the design to give maximum practicable assurance that safe evacuation from the helicopter of passengers and crew can be executed in case of ditching.

4.1.8 Ground handling

Adequate provisions shall be made in the design to minimize the risk that ground handling operations (e.g. towing, jacking) may cause damage, which could pass unnoticed, to the parts of the helicopter essential for its safe operation. The protection which any limitations and instructions for such operations might provide may be taken into account.

CHAPTER 5. ENGINES

5.1 Scope

The Standards of Chapter 5 shall apply to engines of all types which are used on the helicopter as primary propulsion units.

5.2 Design, construction and functioning

The engine complete with accessories shall be designed and constructed so as to function reliably within its operating limitations under the anticipated operating conditions when properly installed in the helicopter in accordance with Chapter 6 and with the suitable rotor and power transmission installed.

5.3 Declared ratings, conditions and limitations

The power ratings and the conditions of the atmosphere upon which they are based and all operating conditions and limitations, which are intended to govern the operation of the engine, shall be declared.

5.4 Tests

An engine of the type shall complete satisfactorily such tests as are necessary to verify the validity of the declared ratings, conditions and limitations and to ensure that it will operate satisfactorily and reliably. The tests shall include at least the following:

a) *Power calibration.* Tests shall be conducted to establish the power characteristics of the engine when new and also after the tests in b) and c). There shall be no excessive decrease in power at the conclusion of all the tests specified.

b) *Operation.* Tests shall be conducted to ensure that starting, idling, acceleration, vibration, overspeeding and other characteristics are satisfactory and to demonstrate adequate margins of freedom from detonation, surge, or other detrimental conditions as may be appropriate to the particular type engine.

c) *Endurance.* Tests of sufficient duration shall be conducted at such powers, engine and rotor speeds and other operating conditions as are necessary to demonstrate reliability and durability of the engine. They shall also include operation under conditions in excess of the declared limits to the extent that such limitations might be exceeded in actual service.

CHAPTER 6. ROTOR AND POWER TRANSMISSION SYSTEMS AND POWERPLANT INSTALLATION

6.1 General

The powerplant installation, including rotor and power transmission system, shall comply with the Standards of Chapter 4 and with the Standards of this chapter.

6.2 Design, construction and functioning

The rotor and power transmission systems assembly complete with accessories shall be designed and constructed so as to function reliably within its operating limitations under the anticipated operating conditions when properly fitted to the engine and installed in the helicopter in accordance with this chapter.

6.3 Declared ratings, conditions and limitations

The power ratings and all operating conditions and limitations, which are intended to govern the operation of the rotor and power transmission systems, shall be declared.

6.3.1 Maximum and minimum rotor rotational speed limitations

Maximum and minimum speeds for the rotors in both power-on and power-off conditions shall be established. Any operating conditions (e.g. airspeed) which affect such maxima or minima shall be declared.

6.3.2 Rotor underspeed and overspeed warnings

When the helicopter is made to approach a rotor rotational speed limit, with or without power-units inoperative, clear and distinctive warnings shall be apparent to the pilot. The warnings and initial characteristics of the condition shall be such as to enable the pilot to arrest the development of the condition after the warning begins, and to recover the rotor rotational speed to within prescribed normal limits and to maintain full control of the helicopter.

6.4 Tests

Rotor and power transmission systems shall complete satisfactorily such tests as are necessary to ensure that they will operate satisfactorily and reliably within the declared ratings, conditions and limitations. The tests shall include at least the following:

a) *Operation.* Tests shall be conducted to ensure that strength vibration and overspeeding characteristics are satisfactory and to demonstrate proper and reliable functioning of pitch changing and control mechanisms and free wheel mechanisms.

b) *Endurance.* Tests of sufficient duration shall be conducted at such powers, engine and rotor speeds and other operating conditions as are necessary to demonstrate reliability and durability of the rotor and power transmission systems.

6.5 Compliance with engine and rotor and power transmission systems limitations

The powerplant installation shall be so designed that the engines and rotor and power transmission systems are capable of being used in the anticipated operating conditions. In conditions established in the helicopter flight manual the helicopter shall be capable of being operated without exceeding the limitations established for the engines and rotor and power transmission systems in accordance with Chapters 5 and 6.

6.6 Control of engine rotation

In those installations where continued rotation of an engine which had failed would increase the hazard of fire or of a serious structural failure, means shall be provided for the crew to stop the rotation of the engine in flight, or to reduce it to a safe level.

6.7 Engine restarting

Means shall be provided for restarting an engine at altitudes up to a declared maximum altitude.

6.8 Arrangement and functioning

6.8.1 Independence of power-units

For performance Class 1 and 2 helicopters, the powerplant shall be arranged and installed so that each power-unit together with its associated systems is capable of being controlled and operated independently from the others and so that there is at least one arrangement of the powerplant and systems in which any failure, unless the probability of its occurrence is extremely remote, cannot result in a loss of more power than that resulting from complete failure of the critical power-unit.

6.8.2 Rotor and power transmission systems vibration

The vibration stresses for the rotor and power transmission systems shall be determined and shall not exceed values which have been found safe for operation within the operating limitations established for the helicopter.

6.8.3 Cooling

The cooling system shall be capable of maintaining powerplant and power transmission systems temperatures within the established limits (see 6.5) at all ambient temperatures approved for operation of the helicopter. The maximum and minimum air temperatures for which the powerplant and power transmission systems have been established to be suitable shall be scheduled in the helicopter flight manual.

6.8.4 Associated systems

The fuel, oil, air induction, and other systems associated with each power-unit, each power transmission unit and each rotor, shall be capable of supplying the appropriate unit in accordance with its established requirements, under all conditions affecting the functioning of the systems (e.g. engine power setting, helicopter attitudes and accelerations, atmospheric conditions, fluid temperatures) within the anticipated operating conditions.

6.8.5 Fire protection

For designated fire zones where the potential fire hazards are particularly serious because of the proximity of ignition sources to combustible materials, the following shall apply in addition to the general Standard of 4.1.6 e).

a) *Isolation.* Such zones shall be isolated by fire resisting material from other zones of the helicopter where the presence of fire would jeopardize continued flight, taking into account the probable points of origin and paths of propagation of fire.

b) *Flammable fluids.* Flammable fluid system components located in such zones shall be capable of containing the fluid when exposed to fire conditions. Means shall be provided for the crew to shut off the flow of hazardous quantities of flammable fluids into such zones if a fire occurs.

c) *Fire protection.* There shall be provided a sufficient number of fire detectors so located as to ensure rapid detection of any fire which might occur in such zones.

d) *Fire extinguishment.* Such zones shall be provided with a fire extinguisher system capable of extinguishing any fire likely to occur therein, unless the degree of isolation, quantity of combustibles, fire resistance of the structure, and other factors, are such that any fire likely to occur in the zone would not jeopardize the safety of the helicopter.

CHAPTER 7. INSTRUMENTS AND EQUIPMENT

7.1 Required instruments and equipment

The helicopter shall be provided with approved instruments and equipment necessary for the safe operation of the helicopter in the anticipated operating conditions. These shall include the instruments and equipment necessary to enable the crew to operate the helicopter within its operating limitations.

Note.— Instruments and equipment additional to the minimum necessary for the issuance of a Certificate of Airworthiness are prescribed in Annex 6, Part III, for particular circumstances or on particular kinds of routes.

7.2 Installation

Instrument and equipment installations shall comply with the Standards of Chapter 4.

7.3 Safety and survival equipment

Prescribed safety and survival equipment which the crew or passengers are expected to use or operate at the time of an emergency shall be reliable, readily accessible and easily identified, and its method of operation shall be plainly marked.

7.4 Navigation lights and anti-collision lights

7.4.1 The lights required by Annex 2 to be displayed by helicopters in flight or operating on the movement area of an aerodrome or a heliport shall have intensities, colours, fields of coverage and other characteristics such that they furnish the pilot of another aircraft or personnel on the ground with as much time as possible for interpretation and for subsequent manoeuvre necessary to avoid a collision. In the design of such lights due account shall be taken of the conditions under which they may reasonably be expected to perform these functions.

Note 1.— It is likely that lights will be viewed against a variety of backgrounds, such as typical city lighting, clear starry sky, moonlit water and daytime conditions of low background luminance. Furthermore, collision risk situations are most likely to arise in terminal control areas in which aircraft are manoeuvring in the intermediate and lower flight levels at closing speeds that are unlikely to exceed 900 km/h (500 kt).

Note 2.— See Part IV of the Airworthiness Technical Manual *(Doc 9051) for detailed technical specifications for exterior lights for helicopters.*

7.4.2 Lights shall be installed in helicopters so as to minimize the possibility that they will:

a) adversely affect the satisfactory performance of the flight crews' duties; or

b) subject an outside observer to harmful dazzle.

Note.— In order to avoid the effects mentioned in 7.4.2, it will be necessary in some cases to provide means whereby the pilot can switch off or reduce the intensity of the flashing lights.

CHAPTER 8. ELECTRICAL SYSTEMS

The electrical system shall be so designed and installed as to ensure that it will perform its intended function under any forseeable operating conditions.

CHAPTER 9. OPERATING LIMITATIONS AND INFORMATION

9.1 General

The operating limitations within which compliance with the Standards of this Annex is determined, together with any other information necessary to the safe operation of the helicopter, shall be made available by means of a helicopter flight manual, markings and placards, and such other means as may effectively accomplish the purpose. The limitations and information shall include at least those prescribed in 9.2, 9.3 and 9.4.

9.2 Operating limitations

Limitations which there is a risk of exceeding in flight and which are defined quantitatively shall be expressed in suitable units and corrected if necessary for errors in measurements so that the flight crew can, by reference to the instruments available to them, readily determine when the limitations are reached.

9.2.1 Loading limitations

The loading limitations shall include all limiting mass, centres of gravity positions, mass distributions, and floor loadings (see 1.2.2).

9.2.2 Airspeed limitations

The airspeed limitations shall include all speeds (see 3.2) which are limiting from the standpoint of structural integrity or flying qualities of the helicopter, or from other considerations. These speeds shall be identified with respect to the appropriate helicopter configurations and other pertinent factors.

9.2.3 Powerplant and power transmission limitations

The powerplant limitations shall include all those established for the various powerplant and transmission components as installed in the helicopter.

9.2.4 Rotor limitations

Limitations on rotor speeds shall include maximum and minimum rotor speeds for power-off (autorotation) and power-on conditions.

9.2.5 Limitations on equipment and systems

The limitations on equipment and systems shall include all those established for the various equipment and systems as installed in the helicopter.

9.2.6 Miscellaneous limitations

Any necessary limitations with respect to conditions found to be prejudicial to the safety of the helicopter (see 1.2.1).

9.2.7 Flight crew limitations

The flight crew limitations shall include the minimum number of flight crew personnel necessary to operate the helicopter, having regard among other things to the accessibility to the appropriate crew members of all necessary controls and instruments and to the execution of the established emergency procedures.

Note.— See Annex 6 — Operation of Aircraft, *Part III, for the circumstances in which the flight crew shall include members in addition to the minimum flight crew defined in this Annex.*

9.3 Operating information and procedures

9.3.1 Types of eligible operations

There shall be listed the particular types of operations, as may be defined in Annex 6, Part III, to the Convention or be generally recognized, for which the helicopter has been shown to be eligible by virtue of compliance with the appropriate airworthiness requirements.

9.3.2 Loading information

The loading information shall include the empty mass of the helicopter, together with a definition of the condition of the helicopter at the time of weighing, the corresponding centre of gravity position, and the reference point(s) and datum line(s) to which the centre of gravity limits are related.

Note.— Usually the empty mass excludes the mass of the crew and payload, and the usable fuel supply and the *drainable oil; it includes the mass of all fixed ballast, unusable fuel supply, undrainable oil, total quantity of engine coolant and total quantity of hydraulic fluid.*

9.3.3 Operating procedures

A description shall be given of normal and emergency operating procedures which are peculiar to the particular helicopter and necessary for its safe operation. These shall include procedures to be followed in the event of failure of one or more power-units.

9.3.4 Handling information

Sufficient information shall be given on any significant or unusual features of the helicopter characteristics.

9.4 Performance information

The performance of the helicopter shall be scheduled in accordance with 2.2. There shall be included information regarding the various helicopter configurations and powers involved and the relevant speeds, together with information which would assist the flight crew in attaining the performance as scheduled.

9.5 Helicopter flight manual

A helicopter flight manual shall be made available. It shall identify clearly the specific helicopter or series of helicopters with which it is related. The helicopter flight manual shall include at least the limitations, information and procedures specified in this chapter.

9.6 Markings and placards

9.6.1 Markings and placards on instruments, equipment, controls, etc., shall include such limitations or information as necessary for the direct attention of the flight crew during flight.

9.6.2 Markings and placards, or instructions, shall be provided to give any information which is essential to the ground crew in order to preclude the possibility of mistakes in ground servicing (e.g. towing, refuelling, etc.) which could pass unnoticed and which could jeopardize the safety of the helicopter in subsequent flights.

— END —

22/3/91

SUPPLEMENT TO

ANNEX 8 — AIRWORTHINESS OF AIRCRAFT

(Eighth Edition)

1. The attached Supplement supersedes all previous Supplements to Annex 8 and includes differences notified by Contracting States up to 8 April 1994.

2. This Supplement should be inserted at the end of Annex 8, Eighth Edition. Additional differences and revised comments received from Contracting States will be issued at intervals as amendments to this Supplement.

SUPPLEMENT TO ANNEX 8 — EIGHTH EDITION

AIRWORTHINESS OF AIRCRAFT

Differences between the national regulations and practices of States and the corresponding International Standards contained in Annex 8, as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

APRIL 1994

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS

No.	*Date*	*Entered by*	*No.*	*Date*	*Entered by*

AMENDMENTS TO ANNEX 8 ADOPTED OR APPROVED BY THE COUNCIL

No.	*Date of adoption or approval*	*Date applicable*	*No.*	*Date of adoption or approval*	*Date applicable*

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards of Annex 8, Eighth Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
Egypt	15/8/88	1	8/4/94
Japan	13/8/91	1-2	8/4/94
Marshall Islands	5/3/93	1	8/4/94
Mexico	19/3/90	1	8/4/94
United States	25/2/91	1	8/4/94

2. Contracting States which have notified ICAO that no differences exist

State	*Date of notification*	*State*	*Date of notification*
Australia	4/4/91	Finland	18/1/91
Bahrain	9/6/88	Germany	6/2/91
Bangladesh	10/8/89	Guyana	23/9/88
Barbados	20/4/88	Iceland	20/3/89
Canada	31/1/91	Indonesia	30/3/92
Chile	28/6/88	Peru	28/4/88
Denmark	8/1/91	Solomon Islands	18/8/88
Ethiopia	4/1/91	Uruguay	16/6/89

3. Contracting States from which no information has been received

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Argentina
Armenia
Austria
Azerbaijan
Bahamas
Belarus
Belgium
Cuba
Cyprus
Czech Republic
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Ecuador
El Salvador
Equatorial Guinea
Eritrea
Estonia
Fiji

Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Liberia
Libyan Arab Jamahiriya
Lithuania
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Mauritania
Mauritius
Micronesia, Federated States of

Cameroon
Cape Verde
Central African Republic
Chad
China
Colombia
Comoros
Congo
Cook Islands
Costa Rica
Côte d'Ivoire
Croatia
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Singapore
Slovakia
Slovenia
Somalia
South Africa
Spain
Sri Lanka

France
Gabon
Gambia
Georgia
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Haiti
Honduras
Hungary
India
Iran, Islamic Republic of
Iraq
Ireland
Israel
Italy
Jamaica
Jordan
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Monaco
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nauru
Nepal
Netherlands, Kingdom of the
New Zealand
Nicaragua
Niger
Nigeria
Norway
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Philippines
Poland
Portugal
Qatar
Republic of Korea
Republic of Moldova
Romania
Russian Federation
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syrian Arab Republic
Tajikistan
Thailand
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Arab Emirates
United Kingdom
United Republic of Tanzania
Uzbekistan
Vanuatu
Venezuela
Viet Nam
Yemen
Zaire
Zambia
Zimbabwe

4. Paragraphs with respect to which differences have been notified

Paragraph	*Differences notified by*
PART I	
Definitions	Japan Mexico United States
PART II	
2.1	Marshall Islands
4.2.1	Marshall Islands Mexico
4.2.2	Marshall Islands
4.2.3	Marshall Islands Mexico
5.2	Marshall Islands
PART III	
1.1.3	United States
PART IV	
1.2.2	Egypt
2.2.1	Japan United States
2.2.2	Egypt Japan United States
2.2.3.1	Japan United States
2.2.3.1.1	Japan United States
2.2.3.1.2	Japan United States
2.2.3.1.3	Japan United States
2.2.3.1.4	Japan United States
2.2.3.2	Japan United States
2.2.3.3	Japan
2.2.3.3.1	Japan United States
6.3.2	Japan
6.7	Japan
7.4.2	Japan United States

8/4/94

EGYPT

PART IV

Chapter 1

1.2.2, Note 2 Egypt considers maximum certificated side hoist mass to be a basic limitation because helicopters have side hoists.

Chapter 2

2.2.2 Egypt considers it necessary to schedule minimum performance for hovering with and without ground effect because helicopters can hover with and without ground effect.

JAPAN

PART I

Definitions *Performance Class 1, 2 and 3 helicopters.* Large helicopters (heavier than 2 700 kg) are classified as either Category TA or TB on the basis of weight and performance capabilities. There is no classification scheme for all other helicopters (2 700 kg or less).

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

PART IV

Chapter 2

2.2.1 As stated in the difference with respect to the definitions of classes of helicopters in Part I, classifications in our country are based on weight as well as performance.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

2.2.2 As stated in the difference with respect to the definitions of classes of helicopters in Part I, classifications in our country are based on weight as well as performance.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

2.2.3.1 to 2.2.3.1.4 For Category TB helicopters, only take-off distance is required to be included in the performance data while take-off distance, path and rejected take-off distance information is required for Category TA helicopters. There are no comparable requirements for helicopters weighing less than 2 700 kg.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

2.2.3.2 En-route performance is based solely on climb performance both for all engines operating and one engine inoperative situations (Category TA/TB). There is no comparable requirement for helicopters weighing less than 2 700 kg.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

2.2.3.3 The landing decision point (LDP) is required for Category TA helicopters only.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

2.2.3.3.1 The landing decision point (LDP) is required for Category TA helicopters only.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

Chapter 6

6.3.2 Installation of rotor overspeed warnings is not required with respect to any category of helicopters.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

6.7 Engine restart capability is not required for Category TB helicopters and helicopters weighing less than 2 700 kg.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

Chapter 7

7.4.2 Minimum acceptable intensities are prescribed for navigation lights and anti-collision lights, i.e. no reduction below these levels is possible.

Remark: The Japanese airworthiness requirements are basically equivalent to the United States Federal Aviation Regulations.

MARSHALL ISLANDS

PART II

2.1 Standards applicable to all aircraft.

4.2.1 Not issued.

4.2.2 Not issued.

4.2.3 Not issued.

5.2 Not issued.

MEXICO

PART I

Definitions *Performance Class 1, 2 and 3 helicopters.* National regulations do not classify helicopters by performance. Criteria for helicopter performance are based on certification and the manufacturer's manuals.

PART II

4.2.1 National regulations do not envisage the notification of aircraft registration to the State of Manufacture, nor the disclosure of information on the airworthiness of each aircraft. Information regarding aircraft airworthiness is obtained directly from the manufacturer and its compliance is monitored by inspections.

4.2.3 National regulations do not envisage the notification of aircraft registration to the State of Manufacture, nor the disclosure of information on the airworthiness of each aircraft. Information regarding aircraft airworthiness is obtained directly from the manufacturer and its compliance is monitored by inspections.

PART I

Definitions — *Performance Class 1, 2 and 3 helicopters.* Large helicopters (heavier than 6 000 lb) are classified as either Category A or B on the basis of weight, passenger-carrying capacity and auxiliary systems as well as performance capabilities. There is no classification scheme for all other helicopters (6 000 lb or less).

PART III

Chapter 1

1.1.3 — Effective 17 October 1979, the United States certificated certain aeroplanes at weights in excess of 5 700 kg (12 566 lb) that do not fully meet the ICAO Airworthiness Standards of Part III. The Airworthiness Certificate of aeroplanes that do not meet ICAO Standards will be endorsed as follows:

"This aeroplane at weights in excess of 5 700 kg does not meet the airworthiness requirements of ICAO, as prescribed by Annex 8 to the Convention on International Civil Aviation."

PART IV

Chapter 2

2.2.1 — As stated in the difference with respect to the definitions of classes of helicopters in Part I, United States classifications are based on other factors as well as performance.

2.2.2 — As stated in the difference with respect to the definitions of classes of helicopters in Part I, United States classifications are based on other factors as well as performance.

2.2.3.1 to 2.2.3.1.4 — For Category B helicopters, only take-off distance is required to be included in the performance data while take-off distance, path and rejected take-off distance information is required for Category A helicopters. There are no comparable requirements for helicopters weighing less than 6 000 pounds.

2.2.3.2 — En-route performance is based solely on climb performance both for all engines operating and one engine inoperative situations (Categories A and B). There is no comparable requirement for helicopters weighing less than 6 000 pounds.

2.2.3.3.1 — The landing decision point (LDP) is required for Category A helicopters only.

Chapter 7

7.4.2 — Minimum acceptable intensities are prescribed for navigation lights and anti-collision lights, i.e. no reduction below these levels is possible.

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

FACILITATION

ANNEX 9

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

NINTH EDITION — JULY 1990

This edition incorporates all amendments adopted by the Council prior to 5 December 1989 and supersedes, on 15 November 1990, all previous editions of Annex 9.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Bulletin* and in the monthly *Supplement to the Catalogue of ICAO Publications*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-14	Incorporated in this Edition		
15	11/11/93	9/10/93	

CORRIGENDA			
No.	Date of issue	Date entered	Entered by
1	Incorporated in this Edition		

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15/11/90

FOREWORD

Historical Background

Standards and Recommended Practices on Facilitation were first adopted by the Council on 25 March 1949, pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago, 1944), and designated as Annex 9 to the Convention with the title "Standards and Recommended Practices — Facilitation". They became effective on 1 September 1949. The Standards and Recommended Practices were based on recommendations of the First and Second Sessions of the Facilitation Division, held at Montreal in February 1946 and at Geneva in June 1948. They were expanded and amended comprehensively as a result of subsequent Sessions of the Division, i.e., the Third Session, held at Buenos Aires in December 1951, the Fourth Session, held at Manila in October 1955, the Fifth Session, held at Rome in December 1959, the Sixth Session, held at Mexico City in March — April 1963, the Seventh Session, held at Montreal in May 1968, the Eighth Session, held at Dubrovnik in March 1973 and the Ninth Session held at Montreal in April — May 1979. As a result of the Division's Recommendations for amendment of Annex 9 and Council's action thereon, the Second Edition of Annex 9 became effective on 1 March 1953, the Third Edition on 1 November 1956, the Fourth Edition on 1 November 1960, the Fifth Edition on 1 April 1964, the Sixth Edition on 1 April 1969, the Seventh Edition on 15 April 1974 and the Eighth Edition on 15 July 1980.

Ninth Edition.— The present edition incorporates, *inter alia,* provisions arising from recommendations of the Tenth Session of the Facilitation Division (Montreal, September 1988) which again resulted in a comprehensive expansion and amendment of Annex 9. This Ninth Edition of Annex 9 became effective on 30 July 1990 and is to become applicable on 15 November 1990.

The Standards and Recommended Practices on Facilitation are the outcome of Article 37 of the Convention, which provides, *inter alia,* that the "International Civil Aviation Organization shall adopt and amend from time to time, as may be necessary, international standards and recommended practices and procedures dealing with . . . customs and immigration procedures . . . and such other matters concerned with the safety, regularity and efficiency of air navigation as may from time to time appear appropriate". The policy with respect to the implementation by States of the Standards and Recommended Practices on Facilitation is strengthened by Article 22 of the Convention, which expresses the obligation accepted by each Contracting State "to adopt all practicable measures, through the issuance of special regulations or otherwise, to facilitate and expedite navigation by aircraft between the territories of Contracting States, and to prevent unnecessary delays to aircraft, crews, passengers, and cargo, especially in the administration of the laws relating to immigration, quarantine, customs and clearance", and by Article 23 of the Convention, which expresses the undertaking of each Contracting State "so far as it may find practicable, to establish customs and immigration procedures affecting international air navigation in accordance with the practices which may be established or recommended from time to time pursuant to this Convention".*

In addition to the Standards and Recommended Practices of Annex 9, the Organization's FAL Programme is based on the FAL Resolutions of the Sixteenth and Twenty-sixth Sessions of the Assembly, Council's Statement of 26 November 1965 on the *Aims of ICAO in the Field of Facilitation* (Doc 7891) and B-type recommendations of FAL Division Sessions which are those recommendations which do not suggest amendments to the Annex provisions. Certain of these B-type recommendations which have the character of guidance material are published in the Attachment to this edition of Annex 9. Other B-type recommendations encouraging States to improve facilitation in general and comply with certain provisions of this Annex will be published in the form of a Circular.

Applicability

As indicated in Chapter 1, Section B, the Standards and Recommended Practices in this document apply to all categories of aircraft operation except where a particular provision specifically refers to one type of operation without mentioning other types of operations.

The Standards and Recommended Practices on Facilitation inevitably take two forms: first a "negative" form, e.g., that States shall not impose more than certain maximum requirements in the way of paperwork, restrictions of freedom of movement, etc., and second a "positive" form, e.g., that States shall provide certain minimum facilities for passenger convenience, for traffic which is merely passing through, etc. Whenever a question arises under a "negative" provision, it is assumed that States will, wherever possible, relax their requirements below the maximum set forth in the Standards and Recommended Practices. Wherever there is a "positive" provision, it is assumed that States will, wherever possible, furnish more than the minimum set forth in the Standards and Recommended Practices.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the

* A number of other articles of the Convention have special pertinence to the provision of the FAL Annex and have been taken into account in its preparation. In particular, persons responsible for the implementation of the provisions of this Annex should be familiar with the following articles in addition to Articles 22 and 23:
Article 10, Landing at Customs Airport;
Article 11, Applicability of Air Regulations;
Article 13, Entry and Clearance Regulations;
Article 14, Prevention of Spread of Disease;
Article 16, Search of Aircraft;
Article 24, Customs Duty;
Article 29, Documents carried in Aircraft.

Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each Amendment to this Annex.

Attention of States is also drawn to the provision of Annex 15 related to the publication of significant differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

General Information

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined, in the case of this Annex, as follows:

Standard: Any specification, the uniform observance of which has been recognized as practicable and as necessary to facilitate and improve some aspect of international air navigation, which has been adopted by the Council pursuant to Article 54 (*l*) of the Convention, and in respect of which non-compliance must be notified by States to the Council in accordance with Article 38.

Recommended Practice: Any specification, the observance of which has been recognized as generally practicable and as highly desirable to facilitate and improve some aspect of international air navigation, which has been adopted by the Council pursuant to Article 54 (*l*) of the Convention, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but it is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the words **Recommended Practice;** *Notes* have been printed in light face italics, the status being indicated by the prefix *Note.*

Any reference to a portion of this document which is identified by a number includes all subdivisions of the portion.

Throughout this Annex, the use of the male gender should be understood to include male and female persons.

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS AND APPLICABILITY

A. Definitions

When the following terms are used in the Standards and Recommended Practices on Facilitation, they have the following meanings:

Aircraft equipment. Articles, other than stores and spare parts of a removable nature, for use on board an aircraft during flight, including first-aid and survival equipment.

Airline. As provided in Article 96 of the Convention, any air transport enterprise offering or operating a scheduled international air service.

Airline and operators' documents. Air waybills/consignment notes, passenger tickets and boarding passes, bank and agent settlement plan documents, excess baggage tickets, miscellaneous charges orders (M.C.O.), damage and irregularity reports, baggage and cargo labels, timetables, and weight and balance documents, for use by airlines and operators.

Authorized agent. A responsible person who represents an operator and who is authorized by or on behalf of such operator to act on all formalities connected with the entry and clearance of the operator's aircraft, crew, passengers, cargo, mail, baggage or stores.

Baggage. Personal property of passengers or crew carried on an aircraft by agreement with the operator.

Cargo. Any property carried on an aircraft other than mail, stores and accompanied or mishandled baggage.

Crew member. A person assigned by an operator to duty on an aircraft during flight time.

Direct transit area. A special area established in connexion with an international airport, approved by the public authorities concerned and under their direct supervision, for accommodation of traffic which is pausing briefly in its passage through the Contracting State.

Direct transit arrangements. Special arrangements approved by the public authorities concerned by which traffic which is pausing briefly in its passage through the Contracting State may remain under their direct control.

Disembarkation. The leaving of an aircraft after a landing, except by crew or passengers continuing on the next stage of the same through-flight.

Disinsecting. The operation in which measures are taken to kill the insect vectors of human disease present in aircraft and in containers (International Health Regulations (1969), Third Annotated Edition (1983), Part I, Article 1).

Embarkation. The boarding of an aircraft for the purpose of commencing a flight, except by such crew or passengers as have embarked on a previous stage of the same through-flight.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aircraft during flight time.

Free airport. An international airport at which, provided they remain within a designated area until removal by air to a point outside the territory of the State, crew, passengers, baggage, cargo, mail and stores may be disembarked or unladen, may remain and may be trans-shipped, without being subjected to any customs charges or duties and to any examination, except for aviation security or for appropriate narcotics control measures.

Free zone. An area where merchandise, whether of domestic or foreign origin, may be admitted, deposited, stored, packed, exhibited, sold, processed or manufactured, and from which such merchandise may be removed to a point outside the territory of the State without being subjected to customs duties, internal consumer taxes or to inspection except for aviation security or for appropriate narcotics control measures. Merchandise of domestic origin admitted into a free zone may be deemed to be exported. When removed from a free zone into the territory of the State, the merchandise is subjected to customs and other required entry procedures.

General aviation operation. An aircraft operation other than a commercial air transport operation or an aerial work operation.

Ground equipment. Articles of a specialized nature for use in the maintenance, repair and servicing of an aircraft on the ground, including testing equipment and cargo- and passenger-handling equipment.

Inadmissible person. A person who is or will be refused admission to a State by its authorities.

Infected area. Defined on epidemiological principles by the health administration reporting the disease in its country and need not correspond to administrative boundaries. It is that part of its territory which, because of population characteristics, density and mobility and/or vector and animal reservoir potential, could support transmission of the reported disease (International Health Regulations (1969), Third Annotated Edition (1983), Part I, Article 1).

A list of infected areas notified by health administrations is published in the World Health Organization's Weekly Epidemiological Record.

International airport. Any airport designated by the Contracting State in whose territory it is situated as an airport of entry and departure for international air traffic, where the formalities incident to customs, immigration, public health, animal and plant quarantine and similar procedures are carried out.

Lading. The placing of cargo, mail, baggage or stores on board an aircraft to be carried on a flight, except such cargo, mail, baggage or stores as have been laden on a previous stage of the same through-flight.

Mail. Dispatches of correspondence and other objects tendered by and intended for delivery to postal administrations.

Mishandled baggage. Baggage involuntarily, or inadvertently, separated from passengers or crew.

Narcotics control. Measures to control the illicit movement of narcotics and psychotropic substances by air.

Operator. A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Public authorities. The agencies or officials of a Contracting State responsible for the application and enforcement of the particular laws and regulations of that State which relate to any aspect of these Standards and Recommended Practices.

Security equipment. Devices of a specialized nature for use, individually or as part of a system, in the prevention or detection of acts of unlawful interference with civil aviation and its facilities.

Spare parts. Articles of a repair or replacement nature for incorporation in an aircraft, including engines and propellers.

State of Registry. A Contracting State on whose register the aircraft is entered.

Stores. Articles of a readily consumable nature for use or sale on board an aircraft during flight, including commissary supplies.

Temporary visitor (visitor). Any person, who disembarks and enters the territory of a Contracting State other than that in which that person normally resides; remains there lawfully as prescribed by that Contracting State for legitimate non-immigrant purposes, such as touring, recreation, sports, health, family reasons, study, religious pilgrimages, or business; and does not take up any gainful occupation during his stay in the territory visited.

Through-flight. A particular operation of aircraft, identified by the operator by the use throughout of the same symbol, from point of origin via any intermediate points to point of destination.

Unaccompanied baggage. Baggage which is transported as cargo and may or may not be carried on the same aircraft with the person to whom it belongs.

Unclaimed baggage. Baggage which arrives at an airport and is not picked up or claimed by a passenger.

Unidentified baggage. Baggage at an airport with or without a baggage tag which is not picked up by or identified with a passenger.

Unlading. The removal of cargo, mail, baggage or stores from an aircraft after a landing, except cargo, mail, baggage or stores continuing on the next stage of the same through-flight.

Visitor. (See *temporary visitor.)*

B. Applicability

The provision of these Standards and Recommended Practices apply to all categories of aircraft operation except where a particular provision specifically refers to one type of operation without mentioning other types of operations.

CHAPTER 2. ENTRY AND DEPARTURE OF AIRCRAFT

A. General

2.1 Governmental regulations and procedures applicable to the clearance of aircraft shall be no less favourable than those applied to other forms of transportation.

2.2 Contracting States shall make provision whereby procedures for the clearance of aircraft, including those normally applied for aviation security purposes, as well as those appropriate for narcotics control, will be applied and carried out in such a manner as to retain the advantage of speed inherent in air transport.

Note 1.— With respect to application of aviation security measures, attention is drawn to Annex 17 and to the ICAO Security Manual.

Note 2.— With respect to application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

2.3 No documents, other than those provided for in this Chapter, shall be required by the public authorities from operators for the entry and departure of aircraft.

Note.— It is part of the intention of this provision that standard forms shall not be varied by the inclusion of national markings thereon.

B. Description, Purpose and Use of Aircraft Documents

2.4 Contracting States shall not require the presentation of the General Declaration when this information can be readily obtained in an alternative and acceptable manner.

2.4.1 A Contracting State which continues to require the presentation of a General Declaration shall limit its requirements to the items and shall follow the format set forth in Appendix 1 — General Declaration.

2.4.2 When a Contracting State has eliminated the Passenger Manifest and no longer requires the General Declaration (except for purposes of attestation) it shall accept, at the option of the operator, either a General Declaration or an appropriate attestation, signed by the authorized agent or pilot-in-command, on one page only of the Cargo Manifest. The attestation on the Cargo Manifest can be provided by means of a rubber stamp.

2.4.3 A Contracting State which continues to require the presentation of the General Declaration shall accept it when signed by either the authorized agent or the pilot-in-command, but may, when necessary, require the health section thereof to be signed by a crew member when the General Declaration itself has been signed by a non-crew member.

2.4.4 Contracting States shall not require the General Declaration, where it continues to be in use, to be signed or stamped by clearance control authorities for the purpose of outbound or inbound clearance.

2.5 Where Contracting States require the presentation on entry and departure of aircraft of information relating to crew members, such information shall be limited to the number of crew on board. Where the General Declaration continues to be required, this information shall be provided in the column headed "Total number of crew".

2.6 Contracting States shall not normally require the presentation of a Passenger Manifest, but when this type of information is required it may also be provided in an alternative and acceptable manner.

Note.— If the type of information referred to in 2.6 above is required it should be limited to the items shown in the format of a Passenger Manifest set forth in Appendix 2.

2.6.1 **Recommended Practice.—** *In Contracting States where the presentation of a list of passenger names is not required, public authorities should not require more information than the number of passengers embarking or disembarking, as the case may be, and the number going through the airport on the same flight. Where the General Declaration continues to be required, this information should be provided in the column headed "Number of Passengers on this Stage".*

Note.— It is the aim to eliminate from the General Declaration, as soon as possible, any notation in respect of passengers.

2.7 **Recommended Practice.—** *Contracting States should not require the presentation of the Cargo Manifest, when this information can be readily obtained in an alternative and acceptable manner.*

2.8 A Contracting State which continues to require the presentation of a Cargo Manifest shall, apart from the information indicated in the heading of the format of the Cargo Manifest set forth in Appendix 3, not require more than the following three items:

a) the air waybill number;

b) the number of packages related to each air waybill number; and

c) the nature of the goods.

The Cargo Manifest shall be accepted either when it follows the above-mentioned format, or a clear and understandable format adapted to electronic data-processing techniques.

Note.— It is part of the intention of this provision that, for the purpose of reporting air cargo on arrival to the authorities, operators be given the following options subject to the agreement of the governments concerned:

a) submission of the Cargo Manifest as per Appendix 3 when prepared by the station of loading abroad, or

b) preparation and submission of the Cargo Manifest on arrival on the basis of shipments actually landed, or

c) submission of the information required in the Cargo Manifest in a different way, such as direct transmission into a computer, teletype listings, or one copy of the air waybill per shipment.

2.8.1 **Recommended Practice.—** *Contracting States should dispense with the requirement for information concerning the nature of goods in the Cargo Manifest. A Contracting State should require the information listed on the Manifest only once.*

2.8.2 **Recommended Practice.—** *Contracting States which continue to require information about the nature of goods in the Cargo Manifest should use a plain language description of the goods. When Cargo Manifest data are transmitted by electronic data interchange, the description of goods should conform to internationally recognized standards.*

2.9 Contracting States shall not require the presentation of a written declaration of the mail other than the form AV 7 prescribed in the Acts in force of the Universal Postal Union. Operators carrying mail shall, upon the request of the customs authorities, present to them for inspection and return a copy of the aforementioned AV 7 mail form in cases where it has not otherwise been made available for customs clearance purposes by the postal authorities.

2.10 Contracting States shall not require the presentation of a written declaration of stores remaining on board aircraft. In respect of stores laden on or unladen from an aircraft, Contracting States which continue to require the presentation of a written declaration of such stores shall limit the information required to an absolute minimum, and simplify their clearance to the greatest possible extent.

2.11 Contracting States shall not require the presentation of a list of the number of pieces of accompanied baggage. Operators carrying baggage shall, upon request from the authorities, provide them with any available information where it has not otherwise been provided for customs clearance purposes by the passenger.

C. Outbound Procedures

2.12 Contracting States shall not require the authorized agent or pilot-in-command to deliver to the public authorities concerned, before departure of the aircraft, more than:

a) two copies of the General Declaration, when used;

b) two copies of the Cargo Manifest, when used, listing cargo, including unaccompanied baggage, laden according to points of unlading;

c) two copies of a simple stores list, when used, listing stores laden.

2.13 If the aircraft is not embarking passengers or lading cargo, mail, stores or baggage, no aircraft document shall be required except the General Declaration (which shall so state) or, if the provisions of 2.4.2 apply, the Cargo Manifest.

Note.— If the General Declaration is not required, this information can be supplied in the alternative manner referred to in 2.4.

2.14 When it will facilitate aircraft departure, Contracting States shall permit those operators that have provided a sufficiently conclusive statistical basis for obtaining such permission the use of standard baggage weights for each piece of baggage or for the aggregate of baggage for each passenger on given services.

D. Inbound Procedures

2.15 Contracting States shall not require the authorized agent or pilot-in-command to deliver to the public authorities concerned, on arrival of the aircraft, more than:

a) three copies of the General Declaration, when used;

b) three copies of the Cargo Manifest, when used, listing cargo, including unaccompanied baggage, unladen according to points of lading;

c) two copies of a simple stores list, when used, listing stores unladen.

2.16 If the aircraft is not disembarking passengers or unlading cargo, mail, stores or baggage, no aircraft document shall be required except the General Declaration (which shall so state) or, if the provisions of 2.4.2 apply, the Cargo Manifest.

Note.— If the General Declaration is not required, this information can be supplied in the alternative manner referred to in 2.4.

E. Consecutive Stops at Two or More International Airports in the Same Contracting State

2.17 Contracting States shall not require documents or procedures for entry or departure of aircraft which are different from or in excess of those prescribed in this Chapter in the case where aircraft stop at two or more international airports within their territories without intermediate landing in the territory of another State.

Note.— During the interval (which may be of some duration in the case of many private flights) between the time when all inbound procedures have been completed and outbound procedures are begun, it is assumed that Contracting States normally will allow aircraft to land at other than international airports in their territories and will require no further documentation or procedures of the nature referred to in this Chapter.

F. Completion of Aircraft Documents

2.18 **Recommended Practice.—** *Documents for entry and departure of aircraft should be accepted if furnished in either English, French, Russian or Spanish. Any Contracting State may require an oral or written translation into its own language.*

2.19 Typewriting shall not be required in filling out the documents referred to in this Chapter 2. Handwritten block lettering in ink or indelible pencil, or documents produced by electronic data-processing techniques, in legible and understandable form shall be accepted in all cases.

2.20 No visa shall be required, nor shall any visa or other fee be collected, in connexion with the use of any documentation required for the entry or departure of aircraft.

2.21 At the time the documents are being checked, the public authorities concerned shall either accord the authorized agent or pilot-in-command, where this can be done without undue delay, an opportunity to correct, or shall themselves correct, any errors which they are satisfied are of a purely clerical nature and were not made with intent to violate the laws of the Contracting State.

2.22 In the event of errors being found in documents, the operator or authorized agent shall not be subjected to penalties if he satisfies the public authorities concerned that the error was inadvertent and not of a serious nature.

G. Disinsecting of Aircraft

2.23 When disinsecting is required by a Contracting State as a public health measure, that requirement shall be deemed to have been met by discharging into those portions of the aircraft which may carry insects from one area to another, an insecticide of a strength, formula and method of dispersal recommended by the World Health Organization and acceptable to that State, such insecticide to be effectively discharged from dispensers conforming to WHO specifications as follows:

a) into the flight deck and into those portions of the aircraft which cannot be reached when the aircraft is moving, as near as possible to the time of the aircraft's last departure before entering the State and in sufficient time to avoid delaying such departure; and

b) into those portions of the aircraft which can be reached when the aircraft is moving, after the time of the aircraft's last departure before entering the State, either:

   1) by means of an aerosol spray, or any equivalent system, while the aircraft is taxiing from the ramp to the runway for take-off, or

   2) if the aircraft is suitably equipped, by means of an automatic dispersal of vapour while the aircraft is flying, but as far in advance as possible and at least thirty minutes prior to first landing, or

   3) by other equally effective means;

c) or, by means of a residual treatment with permethrin of the interior surfaces of an aircraft, in accordance with the recommendations of the World Health Organization (WHO).

Note.— When the carriage by air of filled aerosol dispensers is required, for instance on multi-sector flights, the aerosol dispensers should be packed in accordance with ICAO's Technical Instructions for the Safe Transport of Dangerous Goods by Air *(Doc 9284).*

2.24 **Recommended Practice.—** *When disinsecting as a public health measure has been properly performed pursuant to 2.23 and has been recorded on the General Declaration or in the Certificate of Residual Disinsection set forth in Appendix 4, if the disinsecting procedure indicated in c) of 2.23 above has been followed, it should be accepted by all Contracting States as evidence that effective disinsecting has* *been carried out for preventing the spread of all insect vectors of human diseases for whose destruction the insecticide is effective.*

Note 1.— If the General Declaration is not required, this information can be supplied in the alternative manner referred to in 2.4.

Note 2.— When disinsecting is carried out by residual treatment of permethrin, the appropriate government authority should issue a "Certificate of Residual Disinsection" conforming to the form shown in Appendix 4, which should be part of the aircraft documentation for the period of effectiveness of the certificate, and should be shown to health authorities on request.

2.25 When disinsecting as a public health measure has been properly performed pursuant to 2.23, passengers and crew on arrival shall, except in special circumstances, be allowed to disembark immediately from the aircraft.

2.26 **Recommended Practice.**— *Contracting States should ensure that all personnel in charge of disinsecting receive appropriate information concerning the way in which to perform such disinsecting effectively.*

2.27 **Recommended Practice.**— *Disinsecting of an aircraft on a through-flight should not be required to be repeated on behalf of any insect vectors of human disease, against which the insecticide used is effective, except when live insect vectors of human disease have been found on board the aircraft, or when the aircraft is proceeding directly from an infected area of an insect-borne disease to a receptive area.*

2.28 **Recommended Practice.**— *When a Contracting State requires treatment of the aircraft with an insecticide in the interest of agriculture or food conservation, a single treatment should be employed that also meets the requirements of public health.*

2.29 **Recommended Practice.**— *When disinsecting or other remedial measures are required by a Contracting State for animal and plant quarantine purposes, such State should devise means to integrate its procedures in this field with other clearance procedures whenever this will expedite the clearance of aircraft and the loads that they carry, in so far as this does not detract from the safety of the aircraft and the effectiveness of the measures.*

2.30 Contracting States shall ensure that their procedures for disinsecting or any other remedial measure are not injurious to the health of passengers and crew and cause the minimum of discomfort to them.

2.31 Contracting States shall ensure that any insecticide or any other substance used to meet the requirements of public health, agriculture or food conservation is not inflammable and does not have a deleterious effect on the structure of the aircraft or its operating equipment.

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H. Disinfection of Aircraft

2.32 Contracting States shall define the types of animals and animal products which, when imported by air, require that the aircraft be disinfected and shall normally exempt aircraft from disinfection when such animals or animal products are carried in approved containers. When aircraft disinfection is required, the following provision shall apply:

a) the application shall be limited solely to the container or to the compartment of the aircraft in which the traffic was carried;

b) the disinfection shall be carried out expeditiously;

c) inflammable chemical compounds or solutions likely to damage aircraft structure, by corrosion or other effects, shall not be employed.

I. Arrangements Concerning International General Aviation and Other Non-scheduled Flights

I. General

2.33 Contracting States shall publish their regulations concerning the advance notices and applications for permission referred to in 2.34 and 2.39, and communicate them to ICAO.

II. Advance Notification of Arrival

2.34 In the case of aircraft registered in other Contracting States, which are not engaged in scheduled international air services and which are making flights either in transit non-stop across the territory of a Contracting State or stopping in the territory of a Contracting State for non-traffic purposes, such Contracting State shall not require more advance notice of such flights than is necessary to meet the requirements of air traffic control and of the public authorities concerned.

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

2.35 Contracting States shall accept from the appropriate authority of any other Contracting State the information contained in a flight plan as adequate advance notification of the arrival of in-coming aircraft referred to in 2.34 above, provided that such information is received at least two hours in advance of arrival and that the landing occurs at a previously designated international airport. Responsibility for notification to authorized inspection officials, in the case of both arrivals and departures of registered aircraft of other Contracting States, shall rest with the appropriate authority of the State concerned.

Note.— Specifications for flight plans are set forth in Annex 2 — Rules of the Air.

2.36 Contracting States requiring advance notice of the intended landing of aircraft in their territory shall designate a single agency through which such notices may be routed.

2.37 **Recommended Practice.—** *Contracting States requiring advance notice as referred to in 2.34 and 2.36 or special permission as referred to in 2.38 should indicate the address and, where available, the telex number or cable address of the agency to which application for special permission or advance notice shall be routed.*

III. Special Permission for Operations

2.38 Any Contracting State which, for reasons of safety of flight, requires special permission in respect of flights referred to in 2.34 above, shall not require any other information than that contained in a flight plan when application for such permission is made. Such application shall not be required to be filed more than three working days in advance of the intended arrival of the aircraft in the territory of said Contracting State, or the intended non-stop transit flight across the territory of said State.

2.39 In the case of aircraft engaged in the carriage of passengers, cargo or mail for remuneration or hire on other than scheduled international air services, if a Contracting State requires its special permission for the operation of taking on or discharging passengers, cargo or mail, it shall not require that such special permission be applied for through diplomatic channels, and shall:

a) establish procedures whereby such application will be dealt with promptly;

b) make such permission effective for a specific length of time or number of flights wherever possible; and

c) impose no fees, dues or charges for the issue of such permission.

2.40 **Recommended Practice.—** *Contracting States should not require more than the following details in the applications referred to in 2.39:*

a) name of operator;

b) type of aircraft and registration marks;

c) date and time of arrival at, and departure from, the airport concerned;

d) place or places of embarkation or disembarkation abroad, as the case may be, of passengers and/or freight;

e) purpose of flight and number of passengers and/or nature and amount of freight;

f) name, address and business of charterer, if any.

Note.— It is the intent of this provision that applications in advance for special permission should be acted upon expeditiously on the basis of the above standard information. As an example to illustrate the intent of this provision, a State which requires applications in advance could provide that whenever applications contain all of the above standard information they need not reach the appropriate agency more than two full business days in advance of the intended landing of the aircraft in the territory of that State.

IV. Clearance and Sojourn of Aircraft

2.41 **Recommended Practice.—** *Where there are international general aviation operations at an international airport, Contracting States should arrange for an adequate level of inspection and clearance for those services.*

2.42 **Recommended Practice.—** *In cases where the number of border-crossing general aviation flights so warrant, Contracting States should make arrangements whereby one governmental agency is authorized to undertake, on behalf of all other government departments concerned, clearance of smaller aircraft and their loads at airports used only by occasional international flights.*

Note.— Some Contracting States have already authorized local police or other authorities at or near certain of their airfields to carry out all clearance aspects, thus enabling the State concerned to permit many of the smaller aircraft, coming directly from abroad, to land and depart from airports where normal clearance facilities do not exist, provided that no dutiable articles are unladen upon arrival or intended to be laden on departure.

2.43 An aircraft which is not engaged in scheduled international air services and which is making a flight to or through any designated international airport of a Contracting State and is admitted temporarily free of duty in accordance with Article 24 of the Convention shall be allowed to remain within that State, for a period to be established by that State, without security for customs duty on the aircraft being required.

CHAPTER 3. ENTRY AND DEPARTURE OF PERSONS AND THEIR BAGGAGE

A. General

3.1 Regulations and procedures applied to persons travelling by air shall be no less favourable than those applied to persons travelling by other means of transport.

3.2 Contracting States shall make provision whereby the procedures for clearance of persons travelling by air, including those normally applied for aviation security purposes, as well as those appropriate for narcotics control, will be applied and carried out in such a manner as to retain the advantage of speed inherent in air transport.

Note 1.— With respect to application of aviation security measures, attention is drawn to Annex 17 and to the ICAO Security Manual.

Note 2.— With respect to application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

3.3 No documents other than those provided for in this Chapter shall be required by Contracting States for the entry into and departure from their territories of visitors.

B. Entry Requirements and Procedures

I. Passenger Identity Documents

3.4 Contracting States shall not require from visitors travelling by air any other document of identity than a valid passport.

Note.— It is not the intent of the above provision to discourage Contracting States, who wish to be more liberal, from accepting official documents of identity such as expired passports, national registration cards, seafarers' identity documents, alien resident permits and crew member certificates in lieu of a valid passport.

3.4.1 **Recommended Practice.—** *Contracting States should endeavour, where practicable, to standardize the personal identification data included in their national passports (whether machine readable or not) to conform with the items and presentation recommended in ICAO Doc 9303* — A Passport with Machine Readable Capability.

3.5 Contracting States shall take all practicable measures to ensure that passports are issued as quickly as possible after receipt of the application.

3.5.1 **Recommended Practice.—** *Contracting States should issue machine readable passports in the layout set forth in ICAO Doc 9303.*

3.5.2 **Recommended Practice.—** *As a means of giving effect to 3.5 above, Contracting States should, if necessary, decentralize their facilities for the issue of passports and should waive any requirements to produce certificates of good conduct, documentary evidence of financial status and similar supporting documents, except in special circumstances.*

3.5.3 **Recommended Practice.—** *Contracting States should issue passports with an initial period of validity of at least five years, valid for an unlimited number of journeys and for all countries, except in special circumstances.*

3.5.4 **Recommended Practice.—** *Contracting States should institute simple procedures for the renewal or replacement of passports and grant the same period of validity for the new or renewed passport as for the initial issue.*

3.5.5 **Recommended Practice.—** *If any fee is charged for the issue or renewal of a passport, the amount of such fee should not exceed the cost of the operation.*

3.5.6 **Recommended Practice.—** *A Contracting State should not require separate passports for children under 16 years of age entering its territory when accompanied by a parent or legal guardian, provided that particulars of the child are recorded in the passport of the accompanying adult.*

3.5.7 **Recommended Practice.—** *Contracting States should refrain from issuing a joint passport to two spouses.*

3.5.8 **Recommended Practice.—** *Contracting States should endeavour within a reasonable period of time to issue a separate passport to children under the age of 16 years.*

3.6 In cases where a visitor holds a valid passport and no visa is required of him (*cf.* 3.7 below), Contracting States shall not require him to obtain any other identity document from their consulates or from operators prior to the commencement of his flight.

Note.— It is the intention of this provision that the visitors referred to should be admitted upon arrival without having to furnish any other document except, if required, a

Disembarkation Card (cf. 3.10 and 3.10.1 below) and, if required, a Certificate of Vaccination or Revaccination (cf. 3.11 below).

II. Visas

3.7 **Recommended Practice.—** *Contracting States should extend to the maximum number of countries the practice of abolishing, through bilateral or multilateral arrangements or through unilateral action, entrance visas for visitors.*

3.8 In cases where a Contracting State continues to require entrance visas from visitors, it shall adopt the practice of issuing such visas without charge through reciprocal or other acceptable arrangements.

3.8.1 **Recommended Practice.—** *In cases where Contracting States continue to require entry clearances or visas, these should be issued in machine readable form compatible with the layout specified in ICAO Doc 9303 even if the travel document in which they are placed is not established in machine readable format.*

3.8.2 Contracting States shall simplify the documentary requirements and other formalities for the issue of entrance visas for visitors and shall ensure that such visas are issued as quickly as possible after receipt of the application and shall not normally require the applicant to make a personal appearance at a consulate.

3.8.3 Entrance visas for visitors shall normally be made valid for at least twelve months from the date of issue regardless of the number of entries into the State concerned and with the understanding that the duration of each stay may be limited. However, the State concerned may require that the length of validity of the visa does not exceed the length of validity of the passport or other identity document in which such visa is inserted.

3.8.4 **Recommended Practice.—** *In exceptional circumstances, when a visitor, for reasons of* force majeure, *does not possess the required entry visa, Contracting States should authorize entry and enable the visitor to regularize his position.*

3.8.5 Contracting States shall not require visas for re-entry from their own nationals.

3.8.6 **Recommended Practice.—** *Contracting States should not require visas for re-entry from their resident aliens.*

3.8.7 **Recommended Practice.—** *Visas should in all cases include the following information given in the order shown:*

a) number of visa;

b) type of visa;

c) date of issue, showing day, month and year in that order;

d) date of expiry, showing day, month and year in that order;

e) number of entries permitted;

f) authorized duration of each stay.

3.8.8 **Recommended Practice.—** *Numerals 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 and the Gregorian calendar (with months being spelled out in full) should be used in furnishing the information listed in 3.8.7.*

3.8.9 **Recommended Practice.—** *When the text of the visa is in a national language other than English, French or Spanish, one of these three languages should also be used.*

III. Additional Documentation

3.9 **Recommended Practice.—** *Contracting States should not require either from visitors travelling by air, or from operators on their behalf, any information in writing supplementary to or repeating that already presented in their identity documents.*

3.10 A Contracting State which continues to require written supplementary information from visitors travelling by air, shall limit its requirements to the items and shall follow the format set forth in Appendix 5 — Embarkation/Disembarkation Card.

3.10.1 Contracting States, when requiring Embarkation/Disembarkation Cards, shall accept their completion by visitors and shall not require them to be completed or checked by the operator. Legible handwritten script shall be accepted on the cards, except where the form specifies block lettering.

3.10.2 Contracting States which require the presentation of Embarkation/Disembarkation Cards shall provide them to airline operators at no charge for distribution to passengers prior to embarkation or during the flight.

IV. Public Health Requirements

3.11 In cases where evidence of protection against yellow fever is required from persons travelling by air, Contracting States shall accept the International Certificate of Vaccination or Revaccination in the form set out by the World Health Organization in Appendix 2 of the International Health Regulations (1969).

3.12 **Recommended Practice.—** *Medical examination of persons arriving by air should normally be limited to those disembarking and coming within the incubation period of the* *disease concerned, as stated in the International Health Regulations (1969), from an area infected with one of the three quarantinable diseases (plague, cholera and yellow fever).*

V. Clearance Procedures

3.13 Except in special circumstances, Contracting States shall not require that identity documents be collected from passengers or crew before they arrive at the passport control points.

3.13.1 After individual presentation by passengers and crew of the identity documents, the public officials concerned shall, except in special individual cases, hand back such documents immediately after examination, rather than withholding them for purposes of obtaining additional control.

3.14 In giving effect to 3.2, Contracting States shall ensure that examination by clearance control officials is performed as expeditiously as possible.

3.14.1 **Recommended Practice.**— *Contracting States should adopt a multi-channel immigration inspection system at international airports where passenger traffic justifies its installation and where this may expedite clearance procedures.*

3.15 Each Contracting State shall make arrangements whereby the identity document of a visitor need be inspected by only one official at times of entry and departure.

Note.— This provision is intended to ensure inspection of the identity document of a visitor by only one official on behalf of both the Immigration and Police authorities. It is not intended to discourage Health and Customs officials from examining the identity document whenever this may facilitate health and customs clearance of the visitor.

3.16 Contracting States shall accept an oral declaration of baggage from passengers and crew.

3.17 Contracting States shall normally accomplish inbound passenger baggage inspection on a sampling or selective basis.

3.17.1 Contracting States shall adopt the dual-channel baggage clearance system at international airports where the volume of passenger traffic justifies its installation.

Note.— See Appendix 6 — Dual-Channel Clearance System as recommended by the Customs Co-operation Council.

3.18 **Recommended Practice.**— *Contracting States should make arrangements whereby a passenger and his baggage, on an international flight making two or more stops within the territory of the same State, should not be required to be cleared through governmental formalities at more than one airport of the State concerned. Similarly, the State concerned should, in so far as is possible, make arrangements whereby these formalities are effected at the passenger's airport of destination on that flight, except in special circumstances determined by the authorities concerned.*

3.19 Contracting States shall facilitate the return of mishandled baggage to passengers or crew concerned or to the operator's central tracing office and shall not hold operators liable for penalties, fines, customs duties and taxes, on the basis that the baggage was mishandled. Under the conditions laid down by the competent authorities, operators may be permitted to open such baggage to determine ownership.

Note.— The application of this provision should be subject to the relevant customs laws and regulations. The provision of storage facilities for unclaimed, unidentified and mishandled baggage is covered in 6.37.2.

3.20 Contracting States shall permit operators to clear mishandled baggage at an appropriate destination on behalf of passengers and crew, subject to completion of the appropriate documentation.

Note 1.— Appropriate documentation may include:

a) a list of contents and a written customs declaration, in lieu of clearance in person by the passenger or crew concerned; and

b) where required, a written authorization for the operator to act as representative of the passenger or crew in clearing such baggage.

Note 2.— Appropriate destination may refer to:

a) the final destination which has clearance facilities; or

b) where necessary, the first port of entry.

In each case it is the intent of this provision that the operator shall retain the responsibility for delivering the baggage to its final destination.

3.21 Subject to appropriate security measures, Contracting States shall facilitate the clearance of unidentified and unclaimed baggage and its return to the operator. Under the conditions laid down by the competent authorities, operators may be permitted to open such baggage so as to ascertain its owner.

VI. Crew and Other Operators' Personnel

3.22 Contracting States shall ensure that when inspection of crew members and their baggage is required on arrival or departure, such inspection shall be carried out as expeditiously as possible.

3.23 Contracting States shall provide facilities which will enable crew members of their airlines who are not required to be licensed to obtain without delay and without charge crew members' certificates containing the material set forth in Appendix 7 and valid for the crew member's term of employment.

3.24 In the case of an airline flight crew member who retains his licence in his possession when embarking and disembarking, remains at the airport where the aircraft has stopped or within the confines of cities adjacent thereto, and departs on the same aircraft or on his next regularly scheduled flight, each Contracting State shall accept such licence for temporary admission to the State and shall not require a passport or visa provided the licence contains the specifications set forth in 5.1.1 of Annex 1, plus: a) a certification that the holder may at all times re-enter the State of issuance of the licence upon production of the licence; b) a photograph of the holder; and c) place and date of birth of the holder.

Note.— It is the intent of this provision that a licence shall be recognized as a satisfactory identity document under the specific circumstances when it contains the above certification and the other items specified, even if the holder is not a national of the State of Registry of the aircraft on which he serves. It is not desired to discourage Contracting States from issuing such licences to resident alien flight crew members if they are willing to do so.

Specifications for licences are set forth in Chapter 5 of Annex 1 — Personnel Licensing.

3.24.1 Each Contracting State shall extend privileges of temporary admission similar to those provided under 3.24, and on the same conditions, to a flight crew member of an aircraft operated for remuneration or hire but not engaged in scheduled international air services, subject to the requirement that such flight crew member must depart on the aircraft on its first flight out of the territory of the State.

3.25 In the case of either an airline flight crew member whose licence does not meet the specifications of 3.24 or an airline crew member who is not required to be licensed, each Contracting State shall extend privileges of temporary admission similar to those provided under 3.24 and on the same conditions, provided the crew member concerned is in possession of a valid Crew Member Certificate (Appendix 7).

Note.— The implementation of 3.24 and 3.25 permits rapid and efficient disposition of flight personnel by airlines. The full benefit cannot be derived from these provisions while some States withhold acceptance of them.

3.25.1 **Recommended Practice.—** *Each Contracting State should extend privileges of temporary admission similar to those provided under 3.25 and on the same conditions, to a flight crew member of an aircraft operated for remuneration or hire but not engaged in scheduled international air services, when such flight crew member's licence does not meet the specifications of 3.24 and to a crew member who is not required to be licensed of an aircraft operated for remuneration or hire but not engaged in scheduled international air services, subject to the requirements that:*

a) the crew member concerned is in possession of a valid Crew Member Certificate (Appendix 7); and

b) the crew member concerned must depart on the aircraft on its first flight out of the territory of the State.

3.25.2 When it is necessary for an airline crew member, in the exercise of his duties, to travel to another State as a passenger by any means of transportation in order to join an aircraft, each State shall accept from that crew member, in lieu of a passport and visa for temporary admission and for the necessary freedom of movement within its territory to join such aircraft, a licence as specified in 3.24 or a Crew Member Certificate as specified in Appendix 7, together, where required, with a document from the crew member's employer certifying the purpose of the journey.

3.25.3 **Recommended Practice.—** *Each Contracting State should extend privileges of temporary admission similar to those provided under 3.25.2 and on the same conditions, to a crew member of an aircraft operated for remuneration or hire but not engaged in scheduled international air services.*

3.26 **Recommended Practice.—** *Contracting States should make arrangements to expedite the admission, for residence in their territories, of ground and flight personnel of foreign airlines operating to or through such territories, to the extent that such personnel are necessary to perform supervisory and technical duties directly connected with the operation of the international air services being performed by such airlines.*

3.27 Contracting States shall make arrangements to ensure entry without delay into their territories on a temporary basis of technical personnel of foreign airlines operating to or through such territories who are urgently required for the purpose of converting to an airworthy condition any aircraft which is, for technical reasons, unable to continue its journey. In the event of States requiring a guarantee of, for instance, the subsistence in, and return from, such State, this shall be negotiated without delaying the immediate admission of such personnel.

C. Departure Requirements and Procedures

3.28 Contracting States shall not require exit visas from their own nationals or residents wishing to tour abroad nor from visitors at the end of their stay.

3.29 **Recommended Practice.—** *Contracting States should, in conformity with their respective regulations, endeavour to reduce the documentation required to be* *produced by passengers departing from their territories to a valid passport or other acceptable form of identity document.*

Note.— It is not the intent of the above provision to discourage Contracting States, who wish to be more liberal, from accepting official documents of identity such as expired passports, national registration cards, seafarers' identity documents, alien resident permits, crew member certificates, etc. in lieu of a valid passport.

3.30 **Recommended Practice.—** *Contracting States should not require presentation of baggage of passengers departing from their territory except for aviation security measures, or in special circumstances.*

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

3.31 Contracting States shall not require inspection of baggage of passengers departing from their territory, except for aviation security measures, or in special circumstances.

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

3.32 Contracting States shall not require tax clearance certificates from visitors.

3.33 Contracting States shall not hold the operator responsible for any payment arising from the non-payment of taxes by any passenger.

D. Completion of Passenger and Crew Documents

3.34 **Recommended Practice.—** *The practice of entering names on passenger and crew documents should be to put the surname or surnames first. Where both paternal and maternal surnames are used, the paternal surname should be placed first. Where for married females both the husband's and the wife's paternal surnames are used, the husband's paternal surname should be placed first.*

E. Custody and Care of Passengers and Crew and Their Baggage

I. Passengers and Crew

A. General Provisions

3.35 The public authorities concerned shall, without unreasonable delay, accept passengers and crew for examination as to their admissibility into the State.

3.35.1 The operator shall be responsible for the custody and care of passengers and crew until they are accepted for such examination. The responsibility of the operator shall include the custody of passengers and crew between the aircraft and the terminal building and within the terminal building transit area, it being understood that the Contracting State may, if it so wishes, relieve the operator from all, or part of this responsibility.

3.35.2 **Recommended Practice.—** *After such acceptance, whether conditional or unconditional, the public authorities concerned should be responsible for the custody and care of passengers and crew until they are admitted for entry or found to be inadmissible and transferred back to the custody of the operator for transport away from the territory of the State.*

B. Particular Provisions

Inadmissible Persons

3.36 Each Contracting State shall ensure that a person found inadmissible is transferred back into the custody of the operator(s) who shall be responsible for prompt removal to:

— the point where the person commenced his journey; or

— to any other place where the person is admissible.

Note.— The public authorities shall without delay inform the operator(s) when a person is found inadmissible and consult the operator(s) regarding the possibilities of departure.

3.36.1 Contracting States shall accept for examination a person being returned from his point of disembarkation after having been found inadmissible if this person previously stayed in their territory before embarkation, other than in direct transit. Contracting States shall not return such a person to the country where he was earlier found to be inadmissible.

Note 1.— This provision is not intended to prevent public authorities from further examining a returned inadmissible person to determine his eventual acceptability in the State or make arrangements for his transfer, removal or deportation to a State of which he is a national or where he is otherwise acceptable. Where a person who has been found to be inadmissible has lost or destroyed his travel document, a Contracting State will accept instead a document attesting to the circumstances of embarkation and arrival issued by the public authorities of the Contracting State where the person was found to be inadmissible.

Note 2.— Nothing in this provision or in Note 1 is to be construed so as to allow the return of a person seeking asylum in the territory of a Contracting State, to a country where his life or freedom would be threatened on account of his race, religion, nationality, membership of a particular social group or political opinion.

3.36.2 The obligation of a carrier to transport any person away from the territory of a Contracting State shall terminate from the moment such person has been definitely admitted into that State.

3.36.3 When a person is found inadmissible and is returned to the operator for transport away from the territory of the State, the operator shall not be precluded from recovering from such person any transportation costs arising from his inadmissibility.

3.37 Operators shall take precautions at the point of embarkation to the end that passengers are in possession of any control documents prescribed by Contracting States.

3.37.1 Contracting States shall not fine operators in the event that passengers are found inadmissible unless there is evidence to suggest that the carrier was negligent in taking precautions to the end that the passengers complied with the documentary requirements for entry into the receiving State.

3.37.2 Contracting States and operators shall co-operate, where practicable, in establishing the validity and authenticity of passports and visas.

3.38 Each Contracting State shall ensure that the public authorities seize fraudulent, falsified or counterfeit travel documents of inadmissible persons. Such documents shall be removed from circulation and returned to the appropriate authorities when practicable. In place of a seized document, a covering letter shall be issued by the removing State and attached to it will be a photocopy of the forged travel documents (if available) as well as any important information. The covering letter and its attachments shall be handed over to the operator responsible for the removal of the inadmissible person. It will serve to give information to the authorities at the transit and/or the original point of embarkation.

Note.— A suggested format for the covering letter is set forth in Appendix 8.

Deportees

3.39 Each Contracting State shall ensure that operator(s) are informed when persons are obliged to travel because they have been formally ordered by the public authorities to be removed from that State.

Note.— Information to be provided as far as practicable by the public authorities at the time of reservation is:

— Name of person to be identified as deportee;

— Reason for deportation;

— Names of escorts/guards.

3.40 **Recommended Practice.—** *Each Contracting State should, whenever practicable, ensure that the public authorities ordering the deportation inform the public authorities of transit and destination countries of the planned transport.*

II. Baggage

3.41 In Contracting States where the operator has the obligation to the customs authorities for safeguarding baggage until it is cleared by customs, he shall be freed from this obligation and from liability for customs duties and taxes chargeable on such baggage when it is taken into charge by the customs authorities and is under their sole control.

CHAPTER 4. ENTRY AND DEPARTURE OF CARGO AND OTHER ARTICLES

A. General

4.1 Regulations and procedures applicable to goods carried by aircraft shall be no less favourable than those which would be applicable if the goods were carried by other means.

4.2 Contracting States shall make provisions whereby procedures for the clearance of goods carried by air and for the interchange of air cargo with surface transport, including those normally applied for aviation security purposes as well as those appropriate for narcotics control, will be applied and carried out in such a manner as to retain the advantage of speed inherent in air transport and to avoid delay.

Note 1.— With respect to application of aviation security measures, attention is drawn to Annex 17 and to the ICAO Security Manual.

Note 2.— With respect to application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

4.3 Contracting States shall examine with operators and organizations concerned with international trade all possible means of simplifying the clearance of goods carried inbound and outbound by air and shall introduce such means as soon as possible.

B. Electronic Data-processing Techniques

4.4 **Recommended Practice.—** *When introducing electronic data-processing techniques for air cargo facilitation, Contracting States should encourage international airline operators, handling companies, airports, customs and other authorities and/or cargo agents, to exchange data electronically to facilitate cargo processing in conformity with international message standards.*

4.5 Contracting States shall accept commercial documents required for the clearance of air cargo, when produced by electronic data-processing techniques, provided they are in legible and understandable form and that they contain the required information.

4.6 Contracting States shall examine, in close collaboration with international operators and others concerned with air cargo, the facilitation implications which may result from the introduction of electronic data-processing techniques.

4.6.1 **Recommended Practice.—** *When introducing electronic data-processing techniques for air cargo, Contracting States should limit the information required from operators to that relating to the latter's particular function concerned (e.g. operator, clearing agent, importer), as provided for in the pertinent provisions of this Annex.*

4.7 **Recommended Practice.—** *When the introduction, or modification, of electronic data-processing techniques for air cargo is planned Contracting States should endeavour to apply the following principles:*

a) affording all interested parties, from the outset, the opportunity for consultation;

b) evaluating existing procedures and eliminating those which are unnecessary;

c) determining those procedures which are to be computerized;

d) using United Nations (UN) standards to the maximum extent practicable. These include, but are not limited to, the UN Trade Data Elements Directory (TDED), Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT syntax rules) and UN Standard Messages (UNSMs); and

e) ensuring compatibility with the various electronic data-processing systems in existence.

4.8 When introducing electronic data-processing techniques for air cargo, Contracting States shall consider the principle of optionality regarding participation by operators and other interested parties.

4.8.1 **Recommended Practice.—** *Electronic data-processing systems for the clearance and facilitation of air cargo should cover its intermodal transfer.*

C. Clearance of Export Cargo

4.9 **Recommended Practice.—** *Contracting States should waive, as far as possible, presentation of individual documents pertaining to shipments of cargo including unaccompanied baggage to be exported by air.*

4.9.1 **Recommended Practice.—** *Contracting States, in giving effect to 4.9, should encourage, to the maximum extent* *practicable, alignment of documents required for the clearance of export cargo with the United Nations Layout Key for Trade Documents, to follow the format set forth in Appendix 9 — United Nations Layout Key for Trade Documents.*

4.10 A Contracting State which continues to require such documents for export clearance shall, for as many types of goods as possible, limit its requirements to a simple export declaration.

4.11 Contracting States shall make arrangements consistent with aviation security, as well as those appropriate for narcotics control, which permit operators to select and load cargo, including unaccompanied baggage, and stores on outbound aircraft up to the time of departure.

4.12 A Contracting State which continues to require export licences or permits for certain types of goods shall establish simple procedures whereby such licences or permits can be obtained or renewed rapidly.

4.13 Except for reasons of aviation security Contracting States shall not normally require physical examination of cargo, including unaccompanied baggage, to be exported by air.

Note.— This provision is not intended to prevent authorities from examining goods exported under certain conditions, e.g. under bond, licence or drawback, nor is it intended to preclude other essential examinations including any appropriate narcotics control measures.

4.14 In Contracting States where physical examination of export cargo cannot be waived completely, such examination shall be accomplished by applying the sampling or selective technique in a most liberal manner. The appropriate public authorities of the State concerned shall also, in consultation with, *inter alia*, operators and airport administrations, devise physical means for carrying out the inspection rapidly and without necessitating a separate ground handling of the bulk of the goods for purposes of examination.

4.15 Contracting States shall permit cargo, including unaccompanied baggage which is to be exported by air, to be presented for clearance purposes at any approved customs office. Transfer from the first office to the air customs office of the airport where the cargo, including unaccompanied baggage, is to be laden on the aircraft, shall be effected in accordance with the procedure laid down in the laws and regulations of the State concerned. Such procedure shall be as simple as possible, making due allowance for aviation security requirements, and any appropriate narcotics control measures.

4.16 Where goods are exported from a Contracting State, free of taxes or duties which would be payable in the absence of exportation, and that State requires evidence of the arrival abroad of such goods, it shall accept as such evidence a statement supplied by the shipper or consignee and certified by the customs authorities in the State of destination. In any event, the Contracting State shall not require a certified cargo manifest as such evidence of arrival at destination.

D. Clearance of Import Cargo

4.17 Contracting States shall endeavour to simplify documentary requirements for the clearance of import cargo and reduce to a minimum the variety of forms and the information to be shown thereon.

4.17.1 **Recommended Practice.—** *Contracting States, in giving effect to 4.17, should encourage to the maximum extent practicable, alignment of documents required for the clearance of import cargo with the United Nations Layout Key for Trade Documents, to follow the format set forth in Appendix 9 — United Nations Layout Key for Trade Documents.*

4.18 The commercial invoice, which includes the information required by the importing country for the clearance of goods, shall constitute the basic document for the accomplishment of customs or other governmental formalities.

4.19 **Recommended Practice.—** *Where a Contracting State requires two or more of the following documents :*

— *commercial invoice,*

— *certificate of origin,*

— *certificate of value.*

it should accept either separate documents or a combined form incorporating the information contained on the separate documents, at the trader's option.

4.20 Contracting States which continue to require the air waybill to be presented for inspection in connexion with the clearance of cargo shall not require the consignor and/or operator to place special information for customs or other governmental purposes on the air waybill.

Note.— It is the intention of this provision, inter alia, *that the provisions of 4.9.1 and 4.17.1 should also apply to the air waybill.*

4.21 Contracting States shall not require consular formalities or consular charges or fees in connexion with documents for the clearance of air cargo.

4.22 A Contracting State which continues to require import licences or permits for certain types of goods shall establish simple procedures whereby such licences or permits can be obtained and renewed rapidly.

4.23 **Recommended Practice.—** *Each Contracting State should make arrangements whereby imported air cargo, including private gift packages and trade samples, not exceeding a certain value or weight specified by that State, will be exempt, as far as possible, from governmental clearance documents and facilitate their prompt clearance and release to the consignee or his agent. Such value or weight limitation should be set at a level as high as possible.*

4.23.1 **Recommended Practice.—** *Contracting States should exempt those shipments referred to in 4.23, as far as possible, from import duties and other taxes and charges.*

4.24 Contracting States shall make arrangements for the use of a simplified form of customs documentation and facilitate prompt clearance and release in respect of that imported cargo, including private gift packages and trade samples, which exceeds the limits set in accordance with 4.23 and shall establish higher limits of value or weight up to which such simplified documentation will apply.

4.25 **Recommended Practice.—** *Contracting States should make arrangements whereby the maximum number of consignments not falling under 4.23 and 4.24 above can be released promptly after arrival upon presentation of a provisional entry document and an adequate guarantee for payment of duties and other taxes and charges, subject to complete fulfilment of customs and other requirements within a time limit specified by that State.*

4.26 **Recommended Practice.—** *Procedures should be developed for the submission of pre-import information to customs prior to arrival of cargo in order to facilitate the processing of entries.*

4.27 Contracting States shall, subject to compliance with any national prohibitions or restrictions and any required aviation security or appropriate narcotics control measures, make arrangements whereby special air cargo consignments, e.g. disaster relief shipments, perishable goods (livestock, plants, foodstuffs, etc.) can be released and/or cleared immediately upon arrival.

4.28 **Recommended Practice.—** *Where the nature of a consignment calls for different clearance agencies, e.g. customs and veterinary or phytosanitary controls, Contracting States should endeavour to delegate authority for clearance to one of the agencies or, where not feasible, take all necessary steps to ensure that clearance is carried out simultaneously and with a minimum of delay.*

4.29 Contracting States, in co-operation with operators, airport authorities and other agencies concerned with the handling, clearance and forwarding of goods, shall take the necessary steps to reduce to a minimum the dwell-time of air cargo in airport cargo terminals.

4.30 Contracting States shall accomplish their physical examination of cargo imported by air on a sampling or selective basis. The appropriate public authorities of the State concerned shall also, in consultation with, *inter alia*, operators and airport administrations, devise physical means for carrying out such examination rapidly.

4.31 Each Contracting State shall allow cargo, including unaccompanied baggage, which has been unladen from an aircraft at an international airport to be transferred to any authorized customs office within the State for customs entry and clearance. The customs regulations of the State concerned relating to such transfer shall be as simple as possible.

E. Containers, Pallets and their Loads

4.32 Contracting States shall, subject to compliance with their respective regulations, permit the temporary importation of containers, pallets and associated equipment — whether owned by airlines, consignors/consignees, or third parties — without payment of customs duties and other taxes and charges and shall facilitate the use of this equipment in air traffic.

Note.— A Contracting State may reserve the right not to grant these concessions in the case of containers, pallets and associated equipment which have been the subject of purchase, hire-purchase, lease or a contract of a similar nature, concluded by a person (natural or legal) resident or established in its territory.

4.32.1 **Recommended Practice.—** *Contracting States should provide in their regulations, referred to in 4.32, for the acceptance of a simple declaration from the operator to the effect that the containers, pallets and associated equipment temporarily imported will be re-exported within the time limit set by the State concerned.*

4.33 Containers, pallets and associated equipment entering the territory of a Contracting State under the provisions of 4.32 shall be permitted to leave the limits of an international airport for import clearance of their loads and/or for export lading under simplified control procedures and with a minimum of documentation as specified by the State concerned.

4.34 **Recommended Practice.—** *Contracting States should, where practicable and desirable, make suitable arrangements for the clearance and/or examination of containers/pallets and their loads at off-airport locations.*

4.35 Contracting States shall permit containers, pallets and associated equipment temporarily imported, to be re-exported to any other State and through any of its approved customs offices.

4.36 Contracting States shall permit the temporary importation of component parts of containers and pallets without payment of customs duties and other taxes and charges when these parts are needed for the repair of containers and pallets already admitted under the terms of 4.32.

4.37 **Recommended Practice.**— *Contracting States should permit the loan between airlines of temporarily imported containers, pallets, and associated equipment, without payment of customs duties and other taxes and charges, when these are used only on international routes.*

F. Limitation of Operators' Responsibilities

4.38 Where a Contracting State has requirements for documents such as the commercial invoice, declaration forms, import licence and the like, it shall not make it the obligation of the operator to ensure that these documentary requirements are met, nor shall the operator be held responsible, fined or penalized for inaccuracies or omissions of facts shown on such documents, unless he is, or is acting for, the importer or exporter.

4.39 In Contracting States where the operator has the obligation to the customs authorities for safeguarding cargo, unaccompanied baggage, mail and stores until they are cleared by customs, he shall be freed from this obligation and from liability for customs duties and taxes chargeable on such items when they are taken into charge by the customs authorities and are under their sole control.

4.40 Contracting States shall absolve operators from liability for customs duties, taxes and other charges at such time as goods are transferred, with the approval of the authorities, into the possession of a third party, having on file with the customs authorities adequate security or guarantee.

4.41 Contracting States shall not impede the movement of air cargo solely in order to collect statistics. Any necessary documents shall be provided by the declarant as required by the authorities.

G. Aircraft Equipment, Stores and Parts

4.42 Stores imported into the territory of a Contracting State by an airline of another Contracting State for use in connexion with the establishment or maintenance of an international service operated by that airline shall be admitted free of customs duties and other taxes or charges subject to compliance with the regulations of the Contracting State concerned. Such regulations shall not unreasonably interfere with the necessary use by the airline concerned of such stores.

4.43 **Recommended Practice.**— *In the case where aircraft engaged in international flights stop at two or more international airports within the territory of a Contracting State without intermediate landing in the territory of another State and without embarking and disembarking any domestic passengers, Contracting States should permit the sale and use of commissary supplies on board aircraft without payment of customs duties or other taxes.*

4.44 **Recommended Practice.**— *Ground equipment and security equipment imported into the territory of a Contracting State by an airline of another Contracting State for use within the limits of an international airport in connexion with the establishment or maintenance of an international service operated by that airline should be admitted free of customs duties and, as far as possible, other taxes and charges, subject to compliance with the regulations of the Contracting State concerned. Such regulations should not unreasonably interfere with the necessary use by the airline concerned of such ground equipment and security equipment.*

Note.— It is the intent of this provision that items such as the following should be admissible under the above provision, and it is not desired to discourage a Contracting State from allowing once-admitted items to be used by another foreign airline or at a location other than an international airport:

a) Repair, maintenance and servicing equipment:

- *all repair and maintenance material for airframes, engines and instruments;*
- *specialized aircraft repair kits;*
- *starter batteries and carts;*
- *maintenance platforms and steps;*
- *test equipment for aircraft, aircraft engines, and aircraft instruments;*
- *aircraft engine heaters and coolers;*
- *ground radio equipment.*

b) Passenger-handling equipment:

- *passenger-loading steps;*
- *specialized passenger-weighing devices;*
- *specialized catering equipment.*

c) Cargo-loading equipment:

- *vehicles for moving or loading of baggage, cargo, equipment or supplies;*
- *specialized cargo-loading devices;*
- *specialized cargo-weighing devices.*

d) Component parts for incorporation into ground equipment including the items listed above.

e) Security equipment:

— weapon-detecting devices;

— explosives-detecting devices;

— intrusion-detecting devices.

f) Component parts for incorporation into security equipment.

4.45 **Recommended Practice.—** *Instructional material and training aids imported by an airline of another Contracting State into the territory of a Contracting State for use in connexion with the technical training of ground and flight personnel required to establish and maintain an international service operated by that airline should be admitted free of customs duties and other taxes and charges, subject to compliance with the regulations of the Contracting State concerned.*

Note.— It is the intent of this provision that items solely identified with aviation and aeronautical education and training such as the following should be admissible under the above provisions:

— flight simulators;

— link-trainers;

— mock-ups;

— cutaway engines and parts;

— charts showing the functioning of various technical systems.

4.46 **Recommended Practice.—** *Contracting States should, wherever possible, arrange for duty-free admittance of airline and operators' documents and should arrange for their expeditious clearance.*

4.47 Contracting States shall establish procedures for airlines and/or operators of other Contracting States allowing the prompt entry into or departure from their territories of aircraft equipment, spare parts, ground, training and security equipment, whether or not they are free of customs duties and other taxes and charges, under the provisions of this Annex or any other arrangements. Contracting States shall grant prompt clearance for the importation and exportation of such goods upon completion of simplified documentary procedures by the airlines or operators concerned. These arrangements shall not extend to goods intended for general sale, food, beverages and tobacco.

4.47.1 **Recommended Practice.—** *A Contracting State should whenever possible permit an airline or operator of another Contracting State to present on a separate page of the Cargo Manifest a list of the aircraft equipment, spare parts, ground, training and security equipment being imported or exported. This should be endorsed as follows:*

Note.— We certify that the goods listed on this page of the Manifest are not for sale and are for the sole use of (insert name of airline or operator) in connexion with the establishment or maintenance of an international air service.

4.48 Contracting States shall dispense with the requirements for advance production of documents such as entry or exit permits, and the like, when aircraft equipment, spare parts, stores, ground, training and security equipment are urgently required by an airline or operator of another Contracting State in order to maintain service, provided the airline accepts full responsibility in writing to produce these documents within a reasonable time after the items have been admitted or exported, and provided that the Contracting State concerned is satisfied that the documents will in fact be produced.

4.49 Contracting States shall allow the loan of aircraft equipment and spare parts and security equipment and spare parts between airlines, when these are used in connexion with the establishment or maintenance of scheduled international air services, without payment of customs duties or other taxes or charges subject only to control measures which may provide that repayment of the loan is normally to be accomplished by means of the return of articles that are qualitatively and technically similar and of the same origin, and in any event that no profit-making transaction is involved.

H. Cargo and Other Articles Not Entering the Country of Intended Destination

4.50 When cargo, unaccompanied baggage or stores are not unladen at their intended destination, due to error, emergency or inaccessible stowage, the public authorities at the place of intended unlading shall, subject to the operator proving to them that there has been no gross negligence or carelessness on his part, accept a declaration from him that the articles in question have not been unladen and the reasons therefor, and shall not require the operator to prepare new documentation, nor impose penalties, fines, customs duties and taxes on the operator.

4.51 When goods are consigned to a destination within a Contracting State and have not yet been released for home consumption in that State but subsequently are required to be returned to the point of origin or to be redirected to another destination, the Contracting State shall allow reforwarding without requiring import, export or transit licences if no contravention of the laws and regulations in force is involved.

Note.— This provision is not intended to prevent Contracting States from requiring import, export or transit licences in case of particular consignments which are subject to special restrictions.

4.52 When, because of error or emergency, or being stowed so as to be inaccessible upon arrival, cargo, unaccompanied baggage or stores are not unladen at their intended destination but are unladen at another international airport, the Contracting State where the unlading takes place shall facilitate their being reforwarded to their intended destination and, if satisfied that there has been no gross negligence or carelessness by the operator, shall not impose penalties, fines, customs duties and taxes on the operator nor any requirements in connexion with such reforwarding other than the following:

a) that they be reported to the public authorities concerned;

b) that until reforwarded, they remain under the supervision of the public authorities concerned at the point of unlading or at any other place prescribed by the State;

c) that a notation that they were carried to the wrong destination be made either on the manifest or General Declaration (see also 2.4) delivered in connexion with the unlading;

d) that they be reforwarded without delay;

e) that they be subject to the laws and regulations of the State relating to public health and animal and plant quarantine;

f) that, if reforwarded by air, they be entered either on the appropriate manifest or General Declaration (see also 2.4) upon reforwarding;

g) that, if reforwarded by air, a declaration of transshipment and/or verification be made in respect of them at the airport from which they leave the State.

I. Unaccompanied Baggage

4.53 Unaccompanied baggage carried by air shall be cleared under the procedure applicable to accompanied baggage or under another simplified customs procedure distinct from that normally applicable to other cargo.

Note.— It is the intent of this provision, inter alia, *that:*

a) unaccompanied baggage, to the extent possible, be as free from declaration forms as accompanied baggage; however, clearance documents provided by airlines shall be completed by the passenger prior to shipment;

b) the same customs concessions be granted as for accompanied baggage, subject to compliance with the regulations of the Contracting State concerned; and

c) arrangements be made for the clearance of unaccompanied baggage in the passenger customs hall where selected accompanied baggage is cleared when necessary.

4.53.1 Contracting States shall make provision so that unaccompanied baggage may be cleared upon request of a person acting as an authorized representative for the owner.

J. Animal and Plant Shipments

4.54 Contracting States which in certain circumstances require sanitary certificates or related documents in respect of particular animal and plant shipments shall publish the details of their requirements in this connexion.

K. Mail Documents and Procedures

4.55 Contracting States shall carry out the handling, forwarding and clearance of mail and shall comply with the documentary procedures as prescribed in the Acts in force of the Universal Postal Union.

CHAPTER 5. TRAFFIC PASSING THROUGH THE TERRITORY OF A CONTRACTING STATE

A. Traffic Arriving and Departing on the Same Through-flight

5.1 Each Contracting State shall make provision by means of direct transit areas, direct transit arrangements, or otherwise, whereby crew, passengers, baggage, cargo, stores and mail continuing their journey on the same through-flight may remain temporarily within the State without undergoing any examination except for reasons of aviation security, narcotics control or in special circumstances.

Note 1.— With respect to application of aviation security measures, attention is drawn to Annex 17 and the ICAO Security Manual.

Note 2.— With respect to application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

5.2 Contracting States shall not require any documents or visas in respect of traffic continuing its journey on the same through-flight, except in special circumstances determined by the public authorities concerned.

Note.— It is the intent of this provision, inter alia, *that Contracting States shall neither a) temporarily deprive passengers of their passports nor b) require the operator to do so.*

B. Traffic Being Transferred to Another Flight at the Same Airport

5.3 Each Contracting State shall make arrangements so that disembarking passengers and their baggage being transferred from one flight or operator to another at the same airport will be treated in a manner similar to that set forth in Section A above. Operators shall undertake to sort out transferring passengers and their baggage in order that such passengers and baggage may be allowed to proceed as rapidly as possible to their connecting flights.

5.4 Contracting States shall not require any documents or visas in respect of traffic being transferred to another flight at the same airport, except in special circumstances determined by the public authorities concerned.

5.4.1 With respect to passengers passing through the territory of a Contracting State who are to leave that State within two days from the day of their arrival and who cannot stay at the international airport of arrival until their next flight for lack of facilities or on account of other circumstances, each Contracting State shall permit them to remain within its territory without requiring them to obtain visas prior to their arrival, except in special circumstances determined by the public authorities concerned.

Note.— It is the intent of this provision that each Contracting State may:

a) issue to such passengers, upon arrival, some form indicating they have permission to enter, such as a laissez-passer *or a stopover visa;*

b) designate some specific area or place in the city where the international airport is located, or a neighbouring city, as the sphere of activities of such passengers;

c) take any other necessary administrative measures relating to the stay of such passengers in its territory; and

it is also understood that any Contracting State may, if it wishes to do so, extend to passengers passing through its territory more facilities than are provided in the above provision and in a), b) and c) of this Note.

5.5 Each Contracting State shall make arrangements for the direct trans-shipment of mishandled baggage, unaccompanied baggage, unladen cargo and stores, from one flight or operator to another at the same airport, without examination, except for reasons of aviation security or in special circumstances. In cases when direct trans-shipment cannot be effected, Contracting States shall ensure that arrangements are made for the temporary custody of such goods under secure supervision at an appropriate location. Operators shall undertake to process mishandled baggage, unaccompanied baggage, trans-shipment cargo and stores as rapidly as possible.

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

5.6 Each Contracting State shall make arrangements to allow operators, under supervision of the public authorities concerned, to disassemble trans-shipment cargo, including shipments in containers and pallets, so that they may sort and reassemble shipments for onward carriage without examination, except for reasons of aviation security or in special circumstances, and subject only to simple documentation where required.

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

5.7 Unladen airmail being trans-shipped from one flight or operator to another at the same airport shall be effected in accordance with the Acts in force of the Universal Postal Union.

C. Traffic Being Transferred to Another Airport

5.8 **Recommended Practice.—** *Each Contracting State should make provision, by means of direct transit arrangements or otherwise, whereby traffic which passes directly through the State and, in the course of such passage, transfers from one international airport to another international airport, may proceed without undergoing examination, except for aviation security measures or in special circumstances.*

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

5.9 **Recommended Practice.—** *With respect to the traffic referred to in 5.8, Contracting States should not require any documents or visas for passengers and their baggage, and if documents are required for cargo, unaccompanied baggage and stores, documents as simplified as possible should be used.*

D. Cargo Traffic Being Transferred Between Air and Surface Transport

5.10 Contracting States shall make arrangements whereby formalities for the interchange of air cargo with surface transport are applied in such a manner as to retain the speed advantage of air transport and to avoid delay.

E. Free Airports and Free Zones

5.11 **Recommended Practice.—** *Contracting States should establish free airports.*

5.12 **Recommended Practice.—** *In connexion with international airports, Contracting States should establish and either develop and operate themselves, or permit other parties to develop and operate, free zones and/or warehousing facilities and should publish detailed regulations as to the types of operations which may or may not be performed therein.*

5.13 In all cases where free zone facilities and/or warehousing facilities are not provided in connexion with an international airport but have been provided elsewhere in the same general vicinity, Contracting States shall make arrangements so that air transport can utilize these facilities on the same basis as other means of transport.

5.14 Contracting States shall ensure that the provision of free airports, free zones and/or warehousing facilities presents no additional risks as regards aviation security and narcotics control.

CHAPTER 6. INTERNATIONAL AIRPORTS — FACILITIES AND SERVICES FOR TRAFFIC

A. General

6.1 Contracting States shall take all necessary steps to secure the co-operation of operators and airport administrations in ensuring that satisfactory facilities and services are provided for rapid handling and clearance of passengers, crew, baggage, cargo and mail at their international airports. Such facilities and services shall be flexible and capable of expansion to meet anticipated growth in traffic volume, or increased security measures during higher threat situations, while permitting appropriate narcotics control measures.

*Note 1.— With respect to the application of aviation security measures, attention is drawn to the relevant specification in Annex 17, Chapter 2.**

Note 2.— With respect to the application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

6.1.1 Contracting States shall take the necessary steps to ensure that facilities and services are adapted to the needs of elderly and disabled persons.

6.2 Contracting States shall take all necessary steps to encourage consultations between the airport administration on the one hand and operators, control authorities and appropriate bodies representing other airport users on the other at the earliest stage in the planning of new or substantially modified terminal buildings at their international airports.

6.3 Contracting States shall take all necessary steps to secure the co-operation of operators and airport administrations in ensuring that the facilities and services at their international airports are designed in such a way as to provide the best possible airport traffic flow arrangements.

6.3.1 **Recommended Practice.—** *Contracting States whose international airports experience traffic peaking problems should, in accordance with appropriate procedures for co-ordination of schedules at airports, indicate to the appropriate airlines operating scheduled and non-scheduled flights, well in advance of the recognized traffic seasons, any restrictions that may apply in order to match the traffic and the airport capacity.*

6.4 **Recommended Practice.—** *Where a passenger service charge is levied at an international airport and its collection from passengers gives rise to facilitation problems, this charge should be levied on the airlines where practicable, following consultations and advance notice.*

6.5 **Recommended Practice.—** *Whenever possible, the use of credit cards should be acceptable as a means of payment for services rendered at international airports.*

6.6 **Recommended Practice.—** *It is recommended that the airlines, in agreement with, and subject to reasonable limitations which may be imposed by the airport authorities, be offered the choice of providing their own services for ground handling operations, or the option of having such operations performed entirely, or in part, by an organization controlled by another airline authorized by the airport authority, or by the airport operator, or by a servicing agent approved by the airport authority.*

B. Airport Traffic Flow Arrangements

I. Common Provisions

6.7 Contracting States shall ensure that particular attention is given to the need for adequate facilities to be available at all times at international airports and that appropriate measures are adopted to permit embarkation and disembarkation of passengers without delay.

6.8 **Recommended Practice.—** *The arrangements in 6.3 should be by the most direct route with no crossing between passenger and baggage lines nor between different circuits. To the extent that the route is not self-evident, appropriate sign-posting should be used.*

6.9 **Recommended Practice.—** *International signs to facilitate passengers using airports, reproduced in the document developed for that purpose by ICAO, should be introduced at the earliest practicable opportunity.*

6.9.1 **Recommended Practice.—** *Notices and leaflets should be prominently displayed at international airports, warning travellers of the serious consequences of illegal*

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* The specification reads as follows:

2.2.1 Recommendation.— Each Contracting State should whenever possible arrange for the security measures and procedures to cause a minimum of interference with, or delay to the activities of, international civil aviation.

narcotics trafficking and of the penal measures to which persons convicted of narcotics law offences may be liable.

6.10 **Recommended Practice.**— *Arrangements should be made so that, when necessary, passengers and crew can proceed under shelter between the air terminal buildings and the aircraft, and vice versa.*

6.11 **Recommended Practice.**— *Contracting States should ensure that lifting systems or any other appropriate device are made available in order to facilitate the movement of elderly and disabled passengers between the aircraft and the terminal on both arrival and departure as required where telescopic passageways are not used.*

6.12 **Recommended Practice.**— *Particular attention should be given to passenger routes involving long distances to be covered on foot and the possibility should be studied of facilitating travel over these routes by mechanical systems.*

6.13 **Recommended Practice.**— *Flight information boards, or displays, supplemented, where necessary, by a clearly audible public address system should be provided so that passengers and the public can be fully informed of arrivals, departures and cancellations of flights, and particularly of any last minute changes in arrival or departure times or changes in gate numbers.*

6.13.1 **Recommended Practice.**— *In giving effect to 6.13, flight information boards or displays should, as far as possible, be in the standard layout recommended in ICAO Doc 9249* — Dynamic Flight-related Public Information Displays.

6.13.2 **Recommended Practice.**— *Measures should be taken to ensure that the hearing and vision impaired are able to obtain flight information.*

II. Parking and Servicing Arrangements

6.14 **Recommended Practice.**— *Adequate measures should be taken to ensure convenient parking and servicing of aircraft of all types and categories — regular, non-scheduled and general aviation aircraft — in order to expedite clearance and operations on the apron and to reduce aircraft ground stop time. It is desirable in particular:*

a) to make arrangements for optimum allocation of aircraft parking spaces as close as possible to the terminal building for rapid loading and unloading;

b) to provide adequate parking spaces for aircraft when neither loading nor unloading, away from the terminal building so as to avoid obstruction to the flow of traffic on the apron, and make adequate arrangements for their optimum use;

c) to equip the parking spaces with the necessary means for rapid performance of all aircraft servicing operations;

d) to give particular importance to measures for assistance to aircraft during embarkation and disembarkation operations;

e) to provide facilities for fuelling of aircraft during hours established by the public authorities;

f) to provide transportation between remote parking positions and the terminal building when distance and safety so require as a result of optimum use of the parking area available;

g) to provide, when necessary, parking space for international flights where inspection of aircraft, passengers, crew and baggage can be performed.

III. Outbound Passengers, Crew and Baggage

6.15 **Recommended Practice.**— *Easy and speedy access to the terminal should be provided for passengers, crew and their baggage arriving at the airport by surface transport.*

6.15.1 **Recommended Practice.**— *For elderly and disabled persons being set down or picked up at a terminal building, reserved points should be located as close as possible to main entrances. These should be clearly marked with appropriate signs. Access routes to the check-in desk area should be barrier-free.*

6.16 **Recommended Practice.**— *Contracting States should ensure that rapid and reliable city/airport ground transportation is available.*

6.16.1 **Recommended Practice.**— *Where access to public services is limited, every effort should be made to provide accessible and reasonably priced ground transportation services, by adapting current and planned public transit systems, or by providing special transport services for the mobility impaired.*

6.17 **Recommended Practice.**— *Easy and frequent transportation should be available between airport terminal buildings as well as between designated remote parking facilities and airport terminal buildings.*

6.18 **Recommended Practice.**— *International airports should have available appropriate automobile parking facilities for short- and long-term parking.*

6.18.1 **Recommended Practice.**— *Adequate parking facilities should be provided for wheelchair users and appropriate measures taken to facilitate their movement between parking areas and the terminal buildings.*

6.19 **Recommended Practice.**— *Consideration should be given to the provision of baggage check-in facilities as close as possible to arrival points of surface transport.*

6.20 **Recommended Practice.**— *Contracting States should study the possibility of allowing the provision of off-airport check-in facilities, with due regard to the necessary security precautions.*

6.21 **Recommended Practice.**— *In order to facilitate aircraft departure, Contracting States, in examining passengers as a security measure, or for purposes of narcotics control as appropriate, should, to the extent feasible, utilize specialized equipment in conducting such examinations so as to reduce materially the number of persons to be searched by other means.*

Note 1.— The use of radiological techniques for screening passengers should be avoided.

Note 2.— Privacy should be assured when a thorough physical search is to be carried out. If special rooms are not available, portable screens may be used for this purpose.

6.22 **Recommended Practice.**— *In order to facilitate aircraft departure, Contracting States, in examining baggage of passengers departing from their territory as a security measure, or for narcotics control purposes as appropriate, should, to the extent feasible, utilize specialized equipment in conducting such examinations so as to reduce materially the amount of baggage to be searched by other means.*

6.23 **Recommended Practice.**— *An individual and continuous "trickle" method of processing and loading of passengers, crew and baggage should be adopted — in lieu of the group ("package") system — whenever this will speed up their clearance.*

6.24 **Recommended Practice.**— *Particular attention should be paid to the use of sorting, conveyance and loading devices for baggage. Provision should be made as far as possible for:*

a) mechanized systems capable of transferring and loading large quantities of baggage within a minimum amount of time, consistent with the volume of traffic;

b) an area where it would be possible to hold baggage containers and to rearrange their contents;

c) mechanical means of handling and storing empty baggage containers, consistent with the volume of traffic.

6.25 **Recommended Practice.**— *The premises where crew members have to report for operational purposes should be readily accessible and, if possible, next to one another.*

IV. Inbound Passengers, Crew and Baggage

6.26 Contracting States shall make arrangements for a sufficient number of control channels so that clearance of inbound passengers and crew may be obtained with the least possible delay. Additional channel(s) shall be available if possible to which complicated cases may be directed without delaying the main flow of passengers.

6.27 **Recommended Practice.**— *Particular attention should be given to points where passenger delays are frequently found to occur.*

6.28 **Recommended Practice.**— *Contracting States should establish as a goal, as far as is practicable, the clearance within forty-five (45) minutes of disembarkation from the aircraft of all passengers requiring not more than the normal inspection at major international airports, regardless of aircraft size and scheduled arrival time.*

6.29 To obviate any delay to passengers, the necessary steps shall be taken to ensure that baggage arrives on time in the baggage claim area.

6.29.1 **Recommended Practice.**— *Arrangements should be made for rapid unloading of baggage, including containerized baggage, from the aircraft and its swift movement to the baggage claim area. To this end, mechanical unloading and conveyance systems should be used where the volume of traffic warrants and a sufficient number of handling staff should be available at all times.*

6.30 **Recommended Practice.**— *Adequate space should be provided in the baggage claim area permitting ready identification and speedy withdrawal by each passenger of his checked baggage.*

6.31 **Recommended Practice.**— *Where the volume of baggage so warrants, mechanized baggage dispensing systems should be provided in baggage-claim areas so as to move the baggage towards passengers, thus facilitating pick-up of baggage.*

6.31.1 The authorities responsible for international airports shall ensure that passengers can obtain assistance in the carriage of baggage to enable them to transfer baggage from baggage claim areas to points as close as possible to areas where surface transportation from the airport or between airport terminals is provided.

V. Transit and Transfer of Passengers and Crew

6.32 **Recommended Practice.**— *Contracting States should, whenever possible, permit passengers to remain on board the aircraft and authorize embarkation and disembarkation during refuelling, subject to the necessary safety measures.*

6.32.1 **Recommended Practice.**— *It is recommended in particular, that technical and regulatory provisions should be adopted to ensure that telescopic passageways to and from aircraft can be kept in use during refuelling of aircraft.*

6.33 **Recommended Practice.**— *Contracting States should ensure that physical facilities at airports are provided, where the volume and nature of the traffic so require, whereby crew and passengers in direct transit on the same aircraft, or transferring to other flights, may remain temporarily without being subject to inspection formalities, except for aviation security measures, or in special circumstances.*

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

6.34 **Recommended Practice.**— *Provisions should be made for airline handling counters in the transit area for the purpose of processing passengers transferring from one aircraft to another and not going through clearance controls.*

6.35 **Recommended Practice.**— *Direct transfer from one aircraft to another of passengers, particularly elderly and disabled passengers, should be authorized, where necessary and possible, whenever this is warranted by deadlines in making connecting flights or by other circumstances.*

6.36 **Recommended Practice.**— *Arrangements should be made whereby crew members in brief transit can communicate from a point near the aircraft's loading position, located either on the apron or in a locale near the apron, via television, telautograph or telephone with the various governmental agencies (e.g. air traffic control, MET Office) without the need to report to them in person.*

VI. Miscellaneous Facilities and Services in Passenger Terminal Buildings

6.37 **Recommended Practice.**— *Facilities provided for the use of transit passengers should contain all necessary arrangements for their convenience.*

6.37.1 **Recommended Practice.**— *Storage facilities should be provided for baggage left by their owners at international airports for later pick-up.*

6.37.2 International airports shall be equipped with functional storage facilities where unclaimed, unidentified and mishandled baggage will be kept available for clearance for a minimum of five days. Airline personnel shall have access to the baggage at least throughout the hours of airport operation.

6.38 **Recommended Practice.**— *To the extent that the non-travelling public are admitted to terminal buildings, appropriate arrangements should be made so that they do not interfere with the flow of inbound and outbound traffic.*

6.38.1 **Recommended Practice.**— *Provisions should be made to locate facilities for group/tour operators in public or uncontrolled areas in the arrival and/or departure areas in order to minimize congestion in the terminal buildings.*

6.39 **Recommended Practice.**— *When duty-free goods are offered for sale in terminal buildings, whether to outbound passengers only or to both outbound and inbound passengers, provisions should be made for convenient locations of the stores and adequate customer space so as to avoid congestion and interference with the main streams of outbound and inbound passenger traffic.*

VII. Cargo and Mail Handling and Clearance Facilities

6.40 **Recommended Practice.**— *Contracting States should make arrangements whereby all-cargo aircraft and their loads can be entered and cleared at the cargo terminal area.*

6.41 **Recommended Practice.**— *Easy and speedy access should be provided to airport cargo terminals, taking into account the space requirements of extra-large trucks on access roads and in front of terminals for manoeuvring into position.*

6.42 **Recommended Practice.**— *Each cargo terminal should be provided with delivery/receiving positions adaptable to truck-bed heights.*

6.43 **Recommended Practice.**— *Use should be made, where justified, of mechanized and automated facilities for loading and unloading, conveyance and storage of cargo.*

6.44 **Recommended Practice.**— *Adequate space should be available in cargo terminals for storage and handling of air cargo, including building up and breaking down of pallet and container loads, located next to the customs area and easily accessible to authorized persons and vehicles from both the apron and the landside road. Such arrangements should take into account aviation security and appropriate narcotics control measures.*

6.45 **Recommended Practice.**— *Adequate space and facilities should be provided at international airports, or at convenient off-airport locations, for the temporary storage of empty containers.*

6.46 **Recommended Practice.**— *Cargo terminals should be equipped with storage facilities as appropriate for special cargo (e.g. valuable goods, perishable shipments, human remains, radioactive and other dangerous goods, as well as live animals). Those areas of cargo terminals in which cargo and mail are stored overnight or for extended periods prior to shipment by air should be protected against access by unauthorized persons.*

6.47 **Recommended Practice.**— *Parking spaces should be available at cargo terminals for handling equipment when not in use, located so as to avoid interference with the flow of inbound and outbound cargo.*

6.48 **Recommended Practice.**— *Where high-capacity aircraft with mixed passenger and cargo loads are positioned next to the passenger terminal, all necessary facilities should be provided for swift loading/unloading and conveyance between the aircraft and the cargo terminal(s) of large volumes of air cargo. To this end flow routes should be designed so as to avoid interference with those for passengers and baggage.*

6.49 **Recommended Practice.**— *Facilities should be provided, where necessary, for the direct removal of bulky or heavy consignments by approved transport, from the airport to the premises of the importer, agent or freight forwarder, such removal being subject to customs approval and any conditions attached to that approval.*

6.50 **Recommended Practice.**— *Sufficiently large and convenient areas should be provided at international airports, where, under customs supervision, trans-shipment cargo can be broken down, sorted and reassembled for immediate or later onward transmission. Such arrangements should take into account aviation security and appropriate narcotics control measures.*

6.51 **Recommended Practice.**— *At airports whose cargo handling capacity is insufficient and whose expansion is limited or unfeasible, off-airport bonded warehouses should be allowed, and the procedures for moving cargo between them and the airport should be minimal in order to accelerate clearance and reduce congestion in airport warehouses.*

6.52 **Recommended Practice.**— *Where the volume of air mail so warrants and where it will expedite the onward transmission of the mail, in the opinion of the postal authorities, adequate space and facilities should be provided at international airports for the reworking, sorting and onward transmission of air mail. Such arrangements should take into account aviation security and appropriate narcotics control measures.*

C. Facilities Required for Implementation of Public Health, Emergency Medical Relief, and Animal and Plant Quarantine Measures

6.53 Contracting States, in co-operation with airport authorities, shall ensure the maintenance of public health, including human, animal and plant quarantine at international airports.

6.54 **Recommended Practice.**— *Contracting States should provide, at or near all their major international airports, facilities and services for vaccination or revaccination, and for the delivery of the corresponding certificates.*

6.55 **Recommended Practice.**— *International airports should have available adequate facilities for administration of public health and animal and plant quarantine measures applicable to aircraft, crew, passengers, baggage, cargo, mail and stores.*

6.56 **Recommended Practice.**— *Contracting States should provide arrangements whereby passengers and crew in transit can remain in premises free from any danger of infection and insect vectors of diseases and, when necessary, facilities should be provided for the transfer of passengers and crew to another terminal or airport nearby without exposure to any health hazard. Similar arrangements and facilities should also be made available in respect of animals.*

6.57 **Recommended Practice.**— *Contracting States, in co-operation with airport authorities and aircraft operators, should take all steps to ensure that the procurement, preparation, handling, storage and service of food and water supplies intended for consumption both at airports and on board aircraft are hygienically carried out in accordance with the pertinent regulations, recommendations and standards of the World Health Organization and the pertinent recommendations of the Food and Agriculture Organization of the United Nations.*

6.58 **Recommended Practice.**— *Contracting States, in co-operation with airport authorities and aircraft operators, should ensure that an effective system is instituted for the safe removal and safe disposal of excrement, refuse, waste water, waste, unused and condemned food and other matter dangerous to the health of persons, animals or plants in accordance with the pertinent regulations and recommendations of the World Health Organization and the recommendations of the Food and Agriculture Organization of the United Nations.*

6.59 **Recommended Practice.**— *There should be maintained at international airports an organized, immediately responsive staff with facilities for first aid attendance on site and appropriate arrangements should be available for expeditious referral of the occasional more serious case to pre-arranged competent medical attention.*

D. Facilities Required for Clearance Controls and Operation of Control Services

6.60 **Recommended Practice.**— *Space and facilities for the authorities in charge of clearance controls should, as far as possible, be provided at public expense.*

6.61 If the space and facilities referred to in 6.60 are not provided at public expense, Contracting States shall ensure that such space and facilities are provided on terms not less favourable than those which apply to the operators of other means of transportation entering the State and requiring space and facilities on a comparable scale.

6.62 Contracting States shall provide sufficient services of the public authorities concerned without charge to operators during working hours established by those authorities.

Note.— Where traffic, volume and available space and facilities warrant, Contracting States may wish to provide clearance controls for passengers and their baggage at more than one location.

6.62.1 Contracting States shall provide sufficient services of the public authorities concerned in such a way as to respond to real needs and thus to the flow of traffic during working hours established by those authorities.

Note 1.— Paragraphs 6.62 and 6.62.1 should be applied in accordance with Article 82 of the International Health Regulations (1969), Third Annotated Edition (1983) which provides that no charge shall be made by a health authority for any medical examination provided for in the International Health Regulations (IHR) or for any vaccination of a person on arrival and any certificate thereof. The IHR specify that it is not permissible to exact or receive payment for medical examination carried out at any time of the day or night. Article 24 provides that health measures shall be initiated forthwith and completed without delay.

Note 2.— Under Annex 15 — Aeronautical Information Services, *States are obligated to publish the types and hours of clearance services (customs, immigration, health) at their international airports.*

6.63 Outside of the working hours established to cover any periods of substantial workload at international airports referred to in 6.62 and 6.62.1 Contracting States shall provide services of such authorities on terms not less favourable to operators of aircraft than those which apply to operators of other means of transportation entering the State.

6.64 **Recommended Practice.—** *Contracting States should make arrangements whereby one State will permit another State to station representatives of the public authorities concerned in its territory to examine aircraft, passengers, crew, baggage, cargo and documentation for customs, immigration, public health and animal and plant quarantine purposes, prior to departure for the other State concerned, when such action will facilitate clearance upon arrival in that State.*

E. Monetary Exchange Facilities

6.65 Contracting States shall make arrangements to display at their international airports their regulations governing the exchange of funds of other States against national funds.

6.66 Contracting States which maintain exchange controls with respect to funds of other States shall make arrangements:

a) to publish the current legal rates of exchange for such funds;

b) to display or otherwise make available at their international airports such rates as may be of principal interest at the respective airports.

6.67 Contracting States which do not maintain exchange controls with respect to some or all funds of other States shall make arrangements to display information to that effect at their international airports.

6.68 **Recommended Practice.—** *With respect to those funds of other States for which no controlled exchange rates have been established by the Contracting State concerned, it should make such arrangements as may be feasible to make information available at its international airports as to the prevailing open market rates.*

6.69 Contracting States shall provide, at such times as to meet the needs of the travelling public, adequate facilities at international airports for the legal exchange of funds of other States through governmental agencies or shall authorize private agencies to do so. These facilities shall be available to arriving and departing passengers.

Note.— In giving effect to this provision, the use of vending machines at international airports, enabling a departing passenger to obtain foreign currency, at any time of the day or night, has proved to be of valuable assistance and should be considered as a possibility by Contracting States.

6.70 **Recommended Practice.—** *Contracting States restricting the import or export of funds of other States should provide for the issuance to travellers of certificates showing the amounts of such funds in their possession upon entering the State and should permit such travellers, upon surrender of such certificates prior to leaving the State, to take such funds with them. Inscription on the passport or other official document for travel may serve the same purpose.*

6.71 **Recommended Practice.—** *Contracting States which prohibit or limit the amount of importation of their own currency should provide reasonable facilities for travellers from abroad, who declare an amount of such currency in excess of that permitted by the current regulations, to deposit such amount at the international airport of entry and, upon departure, to reclaim it at the same point or at any other point designated by the public authorities concerned.*

CHAPTER 7. LANDING ELSEWHERE THAN AT INTERNATIONAL AIRPORTS

A. General

7.1 Each Contracting State shall take steps to ensure that all possible assistance is rendered by its public authorities to an aircraft which, for reasons beyond the control of the pilot-in-command, has landed elsewhere than at one of its international airports and, to this end, shall keep control formalities and procedures, in such cases, to a minimum.

7.2 The pilot-in-command or the next senior crew member available shall cause the landing to be reported as soon as practicable to the public authorities concerned.

B. Short Stopover

7.3 If it is apparent that the aircraft can resume its flight within a relatively short time of arrival, the following procedure shall apply:

7.3.1 Control measures shall be limited to those that ensure that the aircraft departs with the same load that was on board at the time of arrival. In case the load or part thereof cannot, for operational or other reasons, continue on that flight, the public authorities shall expedite clearance formalities and co-operate in speedy onward transportation for that load to its destination.

7.3.2 The public authorities shall designate, if necessary, an adequate area under their general supervision where passengers and crew can move about during their stopover.

7.3.3 The pilot-in-command shall not be required to apply to more than one government agency for take-off permission (other than for any necessary air traffic control clearance).

C. No Resumption of Flight

7.4 If it is apparent that the aircraft will be substantially delayed or is unable to continue its flight, the following provisions shall apply:

7.4.1 The pilot-in-command, while awaiting the instructions of the public authorities concerned or if he or his crew is unable to get in touch with them, shall be entitled to take such emergency measures as he deems necessary for the health and safety of passengers and crew and for avoiding or minimizing loss or destruction to the aircraft itself and its load.

7.4.2 Passengers and crew shall be permitted to secure suitable accommodation pending completion of the necessary formalities if such formalities cannot be promptly carried out.

7.4.3 Cargo, stores and unaccompanied baggage, if required to be removed from the aircraft for safety reasons, shall be deposited in a nearby area and remain there pending completion of the necessary formalities.

7.4.4 Mail shall be disposed of as is required pursuant to the Acts in force of the Universal Postal Union.

CHAPTER 8. OTHER FACILITATION PROVISIONS

A. Bonds and Exemption from Requisition or Seizure

8.1 **Recommended Practice.**— *If a Contracting State requires bonds of an operator to cover his liabilities under the customs, immigration, public health, animal and plant quarantine, or similar laws of the State, it should permit the use of a single comprehensive bond whenever possible.*

8.2 **Recommended Practice.**— *The aircraft, ground equipment, security equipment, spare parts and technical supplies of an airline located in a Contracting State (other than the Contracting State in which such airline is established) for use in the operation of an international air service serving such Contracting State, should be exempt from the laws of such Contracting State authorizing the requisition or seizure of aircraft, equipment, parts or supplies for public use, without prejudice to the right of seizure for breaches of the laws of the Contracting State concerned.*

B. Facilitation of Search, Rescue, Accident Investigation and Salvage

8.3 Subject to any conditions imposed by Annex 12 — *Search and Rescue* and Annex 13 — *Aircraft Accident Investigation*, Contracting States shall make arrangements to ensure entry without delay into their territories on a temporary basis of qualified personnel required for search, rescue, accident investigation, repair or salvage in connexion with a lost or damaged aircraft.

8.4 Each Contracting State shall facilitate the temporary entry into its territory of all aircraft, tools, spare parts and equipment required in the search, rescue, accident investigation, repair or salvage of the damaged aircraft of another State. These items shall be temporarily admitted free from customs duties and other taxes or charges and the application of regulations of any nature restricting the importation of goods.

Nqte.— It is understood that this provision does not preclude the application of public health and animal and plant quarantine measures, if required.

8.5 Each Contracting State shall facilitate the removal from its territory of both the damaged and any assisting aircraft, together with tools, spare parts and equipment which may have been brought in for search, rescue, accident investigation, repair or salvage purposes.

8.6 Damaged aircraft or parts thereof, and any stores or cargo contained therein, together with any aircraft, tools, spare parts or equipment brought in for temporary use in search, rescue, accident investigation, repair or salvage, which are not removed from the territory of the Contracting State within a length of time to be specified by that State, shall be subject to the requirements of the applicable laws of the State concerned.

8.7 If, in connexion with an aircraft accident investigation, it becomes necessary to send a part, or parts, of a damaged aircraft to another Contracting State for technical examination or testing, each Contracting State concerned shall ensure that the movement of such part, or parts, is effected without delay. The Contracting States concerned shall likewise facilitate the return of such part, or parts, to the State instituting the accident investigation should the latter State require them in order to complete the investigation.

C. Relief Flights Following Natural and Man-made Disasters Which Seriously Endanger Human Health or the Environment, and Similar Emergency Situations Where United Nations (UN) Assistance is Required

8.8 Contracting States shall facilitate the entry into, departure from and transit through their territories of aircraft engaged in relief flights performed by or on behalf of international organizations recognized by the UN or by or on behalf of States themselves and shall take all possible measures to ensure their safe operation. Such relief flights are those undertaken in response to natural and man-made disasters which seriously endanger human health or the environment, as well as similar emergency situations where UN assistance is required. Such flights shall be commenced after obtaining agreement with the recipient State as quickly as possible.

8.9 Contracting States shall ensure that personnel and articles arriving on relief flights referred to in 8.8 are cleared without delay.

Note.— With respect to the application of measures to ensure the safe operation of relief flights attention is drawn to Annex 11 — Air Traffic Services *(paragraphs 2.15 and 2.16), the* Manual concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations *(Doc 9554) and the* Manual concerning Interception of Civil Aircraft *(Doc 9433).*

D. Marine Pollution and Safety Emergency Operations

8.10 In cases of emergency, Contracting States shall facilitate the entry, transit and departure of aircraft engaged in the combatting or prevention of marine pollution, or other operations necessary to ensure maritime safety, safety of the population or protection of the marine environment.

8.11 In cases of emergency, Contracting States shall, to the greatest extent possible, facilitate the entry, transit and departure of persons, cargo, material and equipment required to deal with the marine pollution and safety operations described in 8.10.

E. Implementation of International Health Regulations and Related Provisions

8.12 Contracting States shall comply with the pertinent provisions of the current edition of the International Health Regulations (1969) of the World Health Organization and any amendments thereto.

8.13 **Recommended Practice.**— *In cases where epidemiological conditions permit and it will result in reducing or eliminating the number of sanitary measures required, Contracting States should, pursuant to Article 85, paragraphs 1 and 1 d) of the International Health Regulations, Third Annotated Edition (1983), combine their territories or make agreements for the purpose of sanitary control.*

8.14 Contracting States shall take all possible measures to have vaccinators use the International Certificates of Vaccination or Revaccination form, in order to assure uniform acceptance.

8.15 **Recommended Practice.**— *Each Contracting State should make arrangements to enable all airlines and agencies concerned to make available to passengers, sufficiently in advance of departure, information concerning the vaccination requirements of the countries of destination, as well as vaccination or revaccination certificate forms conforming to the International Health Regulations (1969).*

8.16 Operators shall ensure compliance with any requirement of a Contracting State whereby illness, other than suspected airsickness, on an aircraft is to be reported promptly by radio to health authorities in the Contracting State for which the aircraft is destined, in order to facilitate provision for the presence of any special medical personnel and equipment necessary for medical assistance and health procedures on arrival.

F. Establishment of National Facilitation Programmes

8.17 Each Contracting State shall establish a national air transport facilitation programme based on the facilitation requirements of the Chicago Convention and Annex 9.

8.18 Each Contracting State shall ensure that the objective of its national air transport facilitation programme shall be to adopt all practicable measures to facilitate the movement of aircraft, crews, passengers, cargo, mail and stores, by removing unnecessary obstacles and delays.

8.19 **Recommended Practice.**— *Each Contracting State should establish a National Air Transport Facilitation Committee, and Airport Facilitation Committees as required, or similar co-ordinating bodies, for the purpose of co-ordinating facilitation activities between departments, agencies, and other organizations of the State concerned with, or responsible for, various aspects of international civil aviation as well as with airport and aircraft operators.*

8.20 **Recommended Practice.**— *In establishing and operating National and Airport Facilitation Committees, States should use the guidance material outlined in Appendix 10.*

APPENDIX 1. GENERAL DECLARATION

GENERAL DECLARATION

(Outward/Inward)

Operator . . . .

Marks of Nationality and Registration* . . . . Flight No. . . . . Date . . . .

Departure from. . . . . Arrival at. . . . .
(Place)　　　　(Place)

FLIGHT ROUTING

("Place" Column always to list origin, every en-route stop and destination)

PLACE	TOTAL NUMBER OF CREW*	NUMBER OF PASSENGERS ON THIS STAGE**
		Departure Place: Embarking. . . . . Through on same flight. . . . . *Arrival Place:* Disembarking . . . . Through on same flight. . . . .

*Declaration of Health**	For official use only
Persons on board with illnesses other than airsickness or the effects of accidents (including persons with symptoms or signs of illness such as rash, fever, chills, diarrhoea) as well as those cases of illness disembarked during the flight. . . . . Any other conditions on board which may lead to the spread of disease. . . . . Details of each disinsecting or sanitary treatment (place, date, time, method) during the flight. If no disinsecting has been carried out during the flight give details of most recent disinsecting . . . . Signed, if required ______________________ Crew member concerned	

I declare that all statements and particulars contained in this General Declaration, and in any supplementary forms required to be presented with this General Declaration are complete, exact and true to the best of my knowledge and that all through passengers will continue/have continued on the flight.

SIGNATURE ______________________
Authorized Agent or Pilot-in-Command

297 mm (or 11 3/4 inches)

Size of document to be 210 mm x 297 mm (or 8 1/4 x 11 3/4 inches).
* To be completed only when required by the State.
** Not to be completed when passenger manifests are presented and to be completed only when required by the State.

210 mm (or 8 1/4 inches)

APPENDIX 2. PASSENGER MANIFEST

PASSENGER MANIFEST

Operator ....

Marks of Nationality and Registration* .... Flight No. .... Date ....

Point of embarkation .... Point of disembarkation ....
(Place) (Place)

Surname and Initials	For use by operator only	For official use only
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* To be completed only when required by the State.

APPENDIX 3. CARGO MANIFEST

CARGO MANIFEST

Operator ....

Marks of Nationality and Registration* .... Flight No. .... Date ....

Point of lading .... (Place) Point of unlading .... (Place)

Air Waybill Number	Number of packages	Nature of goods*	For use by operator only	For official use only
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297 mm (or 11 3/4 inches)

Size of document to be 210 mm x 297 mm (or 8 1/4 x 11 3/4 inches).
* To be completed only when required by the State.

210 mm (or 8 1/4 inches)

APPENDIX 4. CERTIFICATE OF RESIDUAL DISINSECTION

GOVERNMENT OF ....

CERTIFICATE OF RESIDUAL DISINSECTION

Interior surfaces, including cargo space, of this aircraft .... were treated with permethrin on ....
(aircraft registration) (date)
in accordance with the World Health Organization recommendations (WHO Weekly Epidemiological Record No. 7, 1985, p. 47; No. 12, 1985, p. 90; No. 45, 1985, pp. 345-346; and No. 44, 1987, pp. 335-336) and any amendments thereto.

The treatment must be renewed if cleaning or other operations remove a significant amount of the permethrin residue, and in any case within 8 weeks of the above date.

Expiry Date: ....

Signed: ....

Designation: ....

Date: ....

APPENDIX 5. EMBARKATION/DISEMBARKATION CARD*

INTERNATIONAL
EMBARKATION/DISEMBARKATION CARD

1. (Please print) (Mr.) (Mrs.) (Miss) . . . .
(Surname)

. . . .
(Maiden name)

. . . .
(Given names)

2. Date of birth. . . . .
(Day) (Month) (Year)

3. Place of birth . . . .

4. Nationality. . . . .

5. Passport Number . . . .

6. Occupation . . . .

7. Permanent address . . . .

8. For arriving passengers: port of embarkation / For passengers leaving: port of disembarkation . . . .

(FOR OFFICIAL USE ONLY)

148 mm (or 5 7/8 inches)

105 mm (or 4 1/8 inches)

* *Layout:* Card to be printed vertically with its layout and print size, as illustrated above, back of the card to be left blank.

Colour: White.

Languages: Text to be printed in one or more of the four working languages of ICAO (English, French, Russian, Spanish) and possibly in the language of the operator.

Completion: Card to be completed: a) on board aircraft when required from arriving passengers; b) prior to clearing with public authorities concerned at airport, when required from departing passengers.

Carbon copies: Carbon-copy version of card to be furnished when it is required in duplicate by the State concerned.

APPENDIX 6. RECOMMENDATION OF THE CUSTOMS CO-OPERATION COUNCIL

For a Simplified Customs Control, Based on the Dual-Channel System, of Passengers Arriving by Air (8 June 1971)

"THE CUSTOMS CO-OPERATION COUNCIL,

Having Regard to Recommendation No. B-3 of the Seventh Session of the Facilitation Division of the International Civil Aviation Organization, as adopted by the Council of that Organization in December 1968, relating to the establishment at international airports of dual-channel systems for speedy clearance of inbound baggage;

Having Regard to Recommendation No. 11 adopted by the Second Intermediate Session of the European Civil Aviation Conference in July 1969 on the dual-channel or red/green system;

Desiring to contribute to the efforts to improve the flow of passenger traffic at international airports;

Considering that this aim can be achieved by introducing a simplified procedure, based on the dual-channel system, for the Customs control of passengers and their baggage;

Considering that such a system can be adopted without reducing the effectiveness of the control and that it enables Customs authorities to deal efficiently with an increasing number of passengers without a corresponding increase in the number of Customs staff;

Considering that harmonization of the features of this system, as between the various countries, is essential to its smooth operation;

Recommends that Members introduce, at their major international airports, in close co-operation with the airport operators and other agencies concerned, the dual-channel system outlined below for the clearance inwards of passengers and their baggage:

1) The system shall allow the passengers to choose between two types of channels:

   a) one (green channel) for passengers having with them no goods or only goods which can be admitted free of import duties and taxes and which are not subject to import prohibitions or restrictions; and

   b) the other (red channel) for other passengers.

2) Each channel shall be clearly and distinctively marked so that the choice between them can easily be understood by passengers. The basic distinctive marking shall be:

   a) for the channel referred to under 1) a), green, in the shape of a regular octagon, and the words "NOTHING TO DECLARE" ("RIEN À DÉCLARER");

   b) for the channel referred to under 1) b), red, in the shape of a square, and the words "GOODS TO DECLARE" ("MARCHANDISES À DÉCLARER").

   In addition, the channels should be identified by an inscription including the words "CUSTOMS" ("DOUANE").

3) The texts referred to in paragraph 2) shall be in English and/or French and in any other language or languages deemed useful for the airport concerned.

4) Passengers must be sufficiently well informed to choose between the channels. For this purpose it is important:

   a) that passengers be informed about the functioning of the system and about the descriptions and quantities of goods they may have with them when using the green channel. This may be done by means of posters or panels at the airport or by means of leaflets available to the public at the airport or distributed through tourist agencies, airlines and other interested bodies.

   b) that the route to the channels be clearly signposted.

5) The channels shall be located beyond the baggage delivery area so that passengers have all their baggage with them when choosing their channel. Moreover, the channels shall be so arranged that the passenger flow from that area to the exits from the airport is as direct as possible.

6) The distance between the baggage delivery area and the entrances to the channels shall be sufficient to allow passengers to decide which channel to choose and to move into that channel without causing congestion.

7) In the green channel passengers shall not be subject to any Customs formalities but the Customs may make spot checks; in the red channel passengers shall accomplish the formalities required by the Customs;

Points out that the dual-channel system is not necessarily incompatible with the application of other controls, for example, exchange control, unless the relevant regulations require full control of the passengers and their baggage;

Requests Members who accept this Recommendation to notify to the Secretary General:

a) their acceptance and the date from which they will apply the Recommendation;

b) the names of the airports where the dual-channel system is applied.

The Secretary General will transmit this information to the Customs Administrations of Members, to the Secretary General of the International Civil Aviation Organization (ICAO) and to the Director General of the International Air Transport Association (IATA)."

APPENDIX 7. CREW MEMBER CERTIFICATE

. . . .
(Issuing State)

CREW MEMBER CERTIFICATE

Number . . . .

The . . . . certifies that
(Competent authority of issuing State)

Affix photograph of holder of Certificate

(Mr.)
(Mrs.)
(Miss) . . . .
(Surname)

. . . .
(Maiden name)

. . . .
(Given names)

Residing at . . . .

Born on . . . .
(Date)

At . . . .
(Place of Birth)

is a national of. . . . ., is registered in
(State of Nationality)

. . . . as a person following the occupation of
(Issuing State)

an airline crew member, and is presently employed by . . . .
(Airline)

. . . . .as a . . . .
(Description of duties)

Signature of holder . . . .

The holder may, at all times, re-enter . . . .
(Issuing State)
upon production of this certificate.

(Affix stamp or seal of competent authority)

Valid for use in connexion with service for the crew member's term of employment

. . . .
(Issuing State)

Issued at . . . ., on . . . . . .
(Date)

. . . .
(Signature of issuing officer)

148 mm (or 5 7/8 inches)

105 mm (or 4 1/8 inches)

APPENDIX 8. SUGGESTED FORMAT FOR LETTER REFERRED TO IN 3.38

From: Immigration or appropriate authority: (Name)
Airport: (Name)
State: (Name)
Telephone:
Telex:
Facsimile:

To: Immigration or
appropriate authority: (Name)
Airport: (Name)
State: (Name)

Enclosed herewith is a photocopy of a fraudulent/falsified/counterfeit passport/identity card.
Document number:
State in whose name this document was issued:

The above-mentioned document was used by a person claiming to be:

Surname:

Given name(s):

Date of birth:

Place of birth:

Nationality:

Residence:

Photograph if available

This person arrived on (date) at (name of) Airport on flight (flight number) from (City and State).

The holder was refused entry to (name of State) and the incoming carrier has been instructed to remove the passenger from the territory of this State on flight (flight number) departing at (time) and (date) from (name of airport).

The above-mentioned document will be required as evidence in the holder's prosecution and has been impounded. As this document is the property of the State in whose name it was issued, it will be returned, following prosecution, to the appropriate authorities.

According to Annex 9 of the Convention on International Civil Aviation, the last State in which a passenger previously stayed and most recently travelled from, is invited to accept him for re-examination when he has been refused admission to another State.

Date:

Name and signature of Official
Title
Name of immigration or appropriate authority

(Warning: This is NOT an Identification Document)

APPENDIX 9. UNITED NATIONS LAYOUT KEY FOR TRADE DOCUMENTS

Shipper (Exporter)	Date: Reference No. etc.
Consignee	Other address (e.g. buyer. If other than consignee)
Notify or delivery address	Statements as to countries
Statements as to transportation	Terms of delivery and payment

Marks and numbers; number and kind of package; description of goods — Statistical No. — Net quantity — Value

Gross weight — Measurement

Free disposal

Place and date of issue; signature

297 mm (or 11 3/4 inches)

210 mm (or 8 1/4 inches)

ANNEX 9

15/11/90

APPENDIX 10. GUIDELINES FOR THE ESTABLISHMENT AND OPERATION OF NATIONAL AIR TRANSPORT AND AIRPORT FACILITATION COMMITTEES

The following guidelines outline suggested terms of reference, membership and methods of operation of National Air Transport and Airport Facilitation Committees. States may find it useful to have both a National Air Transport Facilitation Committee and one or more Airport Facilitation Committees, bearing in mind the need to solve local problems in the simplest possible manner at the local level with more complex, legislative, policy and interdepartmental problems being considered by the higher body. However, in cases where there is only one international airport, the National Air Transport Facilitation Committee may serve as an Airport Facilitation Committee or vice versa.

I. National Air Transport Facilitation Committees

Terms of Reference

Where a National Air Transport Facilitation Committee (or a similar co-ordinating body) is formed, its functions should broadly be as follows:

a) to implement the National Facilitation Programme;

b) to review questions of policy in relation to clearance formalities applied to international air transport services;

c) to consider recommendations made by Airport Facilitation Committees established at international airports; and, in turn, refer matters to Airport Facilitation Committees for attention;

d) to make recommendations to the departments, competent authorities and other organizations concerned with the National Facilitation Programme;

e) to keep the departments, competent authorities, and other organizations concerned, informed of significant developments in the field of international civil aviation in so far as they affect operations into and out of the Contracting State.

Membership

National Air Transport Facilitation Committees should be composed of senior officials representing the main interests concerned with facilitation, including the following, as required: civil aviation authorities; government clearance agencies (immigration, customs, consular, passport and visa, public health, agriculture, security and narcotics control); other government agencies concerned with facilitation (such as postal services, tourism and trade departments); airport authorities; and operators, including forwarders and express carriers.

Operation

a) As a general rule, National Air Transport Facilitation Committees should meet at least twice a year. It is desirable that the site of meetings be rotated among the premises of the different government agencies concerned.

b) Whenever possible, periodic inspection tours of international airports within the national territories and abroad should be arranged for members of the Committee.

c) Representatives of the board(s) of airline representatives should be encouraged to attend meetings and to submit their co-ordinated approach to current facilitation problems, together with proposed solutions.

d) Whenever appropriate, National Air Transport Facilitation Committees should consider the establishment of sub-committees to study particular facilitation problems (e.g. cargo or baggage). Such sub-committees should have a balanced representation similar to that of the Committee.

e) Whenever possible, on the occasion of visits to States by facilitation experts of the ICAO Secretariat, arrangements should be made for them to participate in meetings of the National Air Transport Facilitation Committees.

f) States should inform ICAO of the work of their Facilitation Committees, so that this information can be distributed to other States.

II. Airport Facilitation Committees

Terms of Reference

Where Airport Facilitation Committees are formed for particular international airports, their functions should be broadly as follows:

a) to implement the National Facilitation Programme at the airport level;

b) to examine problems arising in connexion with the clearance of aircraft, passengers, baggage, cargo, mail and stores and to effect, if possible, immediate solutions to the problems which may arise at the international airport concerned;

c) to make recommendations, as appropriate, to the Regional Office of the department, ministry, or authority concerned, or to the National Facilitation Committee for the implementation of proposals which cannot be effected by the Airport Committee;

d) to inform the National Facilitation Committee of action taken and recommendations made by forwarding copies of the minutes of all Committee meetings.

Membership

Airport Facilitation Committees should be composed of representatives of the main interests concerned with facilitation at the airport(s), including the following, as required: civil aviation authorities; the authority responsible for the airport; government clearance agencies (immigration, customs, consular, passport and visa, public health, agriculture, security and narcotics control); other government agencies concerned with facilitation at the airport (such as postal services, tourism and trade departments); and operators using the airport(s), including representatives of forwarders and express carriers.

Operation

Airport Facilitation Committees should meet regularly and whenever necessary for the purpose of reviewing the FAL situation and finding solutions to local problems.

ATTACHMENT. GUIDANCE MATERIAL

Note.— This guidance material does not form part of the Annex proper but provides supplementary information concerning methods and procedures for implementing its provisions and facilitation in general.

Guidance Material relating to Chapter 3 — Entry and Departure of Persons and Their Baggage

Airline operators, airport administrations and public services of Contracting States should maintain, and expand where possible, continuing programmes to inform passengers on a timely basis of entry requirements and procedures, particularly with respect to public health and immigration requirements, customs exemptions, prohibitions and restrictions on imports, agricultural quarantine regulations and rates of duty on articles most commonly purchased abroad by tourists and other returning travellers.

Note.— Source: Recommendation B-3 of FAL/8.

Contracting States should encourage their immigration authorities to exchange information through the appropriate channels on practices relating to document abuse by passengers and/or travel agents. For that purpose they should direct their airlines to supply the said information to their immigration authorities.

Whenever a travel agent's right to sell air transportation on behalf of an airline is withdrawn by that airline for abuses in the observance of immigration requirements, the airline taking such action should inform the public authorities concerned, as well as all other airlines that may be affected by similar abuses by that agent, so that they may take appropriate action.

Note.— Source: Recommendation B-7 of FAL/10.

Carriers should systematically publish the last check-in time in timetables for use by the public, at least for each international flight;

this last check-in time should be confirmed in writing to the passenger at the time he makes his reservations or purchases his ticket; and

the operators and airport administrations should endeavour to determine, for one and the same airport, a single time for each flight category, for the time intervening between the last check-in time and the time of departure.

Note.— Source: Recommendation B-15 of FAL/6.

Operators should make every effort to inform their passengers of any delays in departure times, prior to check-in.

Note.— Source: Recommendation B-8 of FAL/9.

Considering that great importance should be attached to research by airlines into rapid operational procedures in their ground services in general;

considering that time can be saved by reducing to the minimum the amount of baggage to be checked in and placed in the hold; and

considering the progress made by certain airlines in simplifying and accelerating ground operations on high-frequency short-range flights;

airlines should endeavour to enlarge the maximum dimensions now imposed on hand baggage and consequently investigate new designs for aeroplane cabins; and

on high-frequency short-range flights, the arrangements indicated above should be made in such a way that the majority of passengers need not check any of their baggage, and measures should also be adopted to accelerate the pertinent procedures for those passengers that continue to check their baggage.

Note.— Source: Recommendation B-14 of FAL/6.

Contracting States should make arrangements for passengers, arriving at an international airport of entry and continuing their voyage on a connecting flight of the domestic network, to allow the checked baggage of such transferring passengers to be cleared at the customs airport of final destination, whenever such clearance may be carried out by the competent authorities at the time of arrival of the passengers.

Note 1.— Source: Recommendation B-4 of FAL/7.

Note 2.— See also 3.18 of the Annex.

States which are prepared to accept the arrangements for checked baggage to be cleared through customs at the airport of final destination should arrange for the insertion into the FAL Section of Aeronautical Information Publications of the list of airports in their territories at which this measure can be implemented.

Note 1.— Source: Recommendation B-4 of FAL/8.

Note 2.— See also 3.18 of the Annex.

Airline operators and their agents, together with airport handling organizations and airport operators, should take all necessary steps to reduce substantially the incidence of baggage mishandling through training of, and supervision over, all personnel involved, better co-ordination between personnel processing passengers and those handling their baggage and improvements in the labelling of baggage.

Wherever existing procedures delay the reforwarding of mishandled baggage to its owner, Contracting States should establish an Airport Committee comprising representatives of the public authorities, airport operator and the airlines with a view to adopting procedures which will lead to the speedy disposal of mishandled baggage, if such terms of reference are not already given to the existing Airport Facilitation Committees.

Note 1.— Source: Recommendation B-2 of FAL/9.

Note 2.— In the light of Council action subsequent to FAL/9 (i.e. with respect to Recommendation B-12 of FAL/10 as noted below), any procedures adopted for handling such baggage must be fully consistent with security requirements.

Note 3.— The Council, in approving this recommendation, noted that additional airport consultative committees need not be established where adequate machinery is available.

To assist in dealing with congestion problems caused by high volumes of courier traffic at certain airports, States, airport authorities, airline operators and courier companies should, where required and possible, make special arrangements for processing courier baggage.

Such arrangements must be fully consistent with security requirements and could include:

a) advance notification by couriers when they will be presenting a large number of bags;

b) a more advanced deadline for check-in by such couriers;

c) a distinctive baggage tag for courier baggage to facilitate handling at destination and transfer points; and

d) identification of check-in facilities to be used by couriers.

Note.— Source: Recommendation B-12 of FAL/10 as amended by Council to include a reference to security requirements.

Guidance Material relating to Chapter 4 — Entry and Departure of Cargo and Other Articles

Contracting States, air carriers and shippers' organizations should encourage the development and use of containers for transport of agricultural products by air that are designed to assure the maximum degree of facilitation in the conduct of necessary animal and plant quarantine inspections.

Note.— Source: Recommendation B-12 of FAL/7.

Contracting States, in order to realize the benefits of uniform customs treatment of containerized cargo, should give careful consideration to adoption of the Customs Convention on the International Transit of Goods (ITI Convention), adopted by the Customs Co-operation Council on 7 June 1971.

Note.— Source: Recommendation B-6 of FAL/8.

Contracting States should take all practical measures to impress upon shippers, forwarding agents and international operators the need for ensuring that the processing and movement of documents relating to the contents of containers and pallets are closely co-ordinated with the movement of the respective containers and pallets. To this end, steps should be taken to ascertain that documents relating to the contents are completed by the time of packing the container or pallet and that these documents are readily available at the point of clearance of all or part of the contents.

Note.— Source: Recommendation B-14 of FAL/7.

Guidance Material relating to Chapter 6 — International Airports — Facilities and Services for Traffic

Contracting States should undertake, on a priority basis, comprehensive planning for expansion of international airport facilities;

they should recognize fully the need to experiment with new passenger- and cargo-handling techniques to reduce ground time for the aircraft and time spent in the terminal area by passengers and cargo and that, where possible, the results of such experiments should be communicated to ICAO for circulation to other Contracting States;

they should give particular attention to the design and layout of international air terminal buildings to assure sufficient space for the handling and clearance of passengers and baggage. In the planning process, consideration must be given to traffic levels at average busy hours;

they should emphasize in their planning swift passenger, baggage and cargo flow through the terminal area by careful interrelationship of access roads, parking facilities, passenger ticketing and service areas, arrival and departure lounges, and aircraft aprons and gate positions; and

they should plan expanded air cargo facilities, using automated systems as widely as possible, capable of handling substantial increases in cargo.

Note 1.— Source: Recommendation B-20 of FAL/7.

Note 2.— In the light of Council action subsequent to FAL/7, States should also take into account the aspect of security and appropriate narcotics control measures — see also 6.1 of the Annex.

Contracting States should make adequate provision in planning expansion of airport facilities for the smooth and efficient handling of intermodal van containers;

the objective of this planning should be to reduce to a minimum the time spent by such containers within the airport area;

to this end Contracting States should encourage the development and use of facilities for the loading, unloading and storing of containers and for the conduct of necessary inspections away from the airport; and

Contracting States should seek to provide effective procedures for removal of containers from the apron area and transfer to rail or highway carriers.

Note 1.— Source: Recommendation B-11 of FAL/7.

Note 2.— In the light of Council action subsequent to FAL/7, States should also take into account the aspect of security and appropriate narcotics control measures — see also 6.1 of the Annex.

Airport administrations, in co-operation with operators, should provide, at international airports where the volume of traffic warrants, facilities for the proper care and handling of elderly and disabled passengers and of small children; such facilities might include, for example, wheelchairs, baby trolleys, a special room where these passengers can rest, etc.

Note 1.— Source: Recommendation B-17 of FAL/7.

Note 2.— See also 6.1.1 of the Annex.

States, in co-operation with airport authorities and other bodies as necessary, should make every effort to provide accessible airport ground transportation services to facilitate, to the extent possible, the use of taxi services and private transport and to ensure that parking areas and access routes to terminal buildings are suitably designed and identified;

new airport buildings should be designed to ensure obstacle-free movement for disabled persons and the removal of physical barriers in existing buildings should be undertaken when any general improvements are made;

the provision of services and facilities at airports should be evaluated to ensure that they are both accessible and adapted to disabled users including the sensory-impaired;

airport authorities, in co-operation with airlines, should make it possible, where practical, for wheelchair users to use their own wheelchairs to move to and from the aircraft door; and

airport authorities, in co-operation with airlines, should establish and co-ordinate training programmes to ensure the availability of personnel sensitive to the needs of the elderly and disabled and familiar with means of communicating with the sensory-impaired.

Note 1.— Source: Recommendation B-6 of FAL/10.

Note 2.— See also 6.1.1 of the Annex.

Contracting States, in giving effect to 6.2 of Annex 9 in their respective territories, should ensure that postal authorities are included amongst those to be consulted at the earliest stage in the planning of new or substantially modified terminal facilities at their international airports.

Note.— Source: Recommendation B-6 of FAL/9.

Whereas charges are collected in various States for facilities provided for passengers at airports and this practice is becoming more general and the method of collecting these charges should involve as little inconvenience as possible for the passenger and not cause any delay in the traffic flow;

save in exceptional circumstances the charge should normally be collected only from departing passengers;

the system adopted for collection should not impose any extra formality on the passenger at the time of his departure but should enable him to pay the amount of the charge when he completes one of the formalities required for his journey (i.e. at the time he purchases his ticket, makes his reservation or checks in);

the charge should be payable in reasonably acceptable foreign currency as well as in the national currency and by all the usual means of payment (e.g. travellers' cheques, banknotes or coins);

the passenger should be given a receipt as proof that he has paid the charge;

all suitable measures should be taken to inform the passenger in advance of the existence of this charge (e.g. mention in the airline's timetables, when the ticket is purchased, when the reservation is made, etc.); and

representatives of the airport authority and elected representatives of the appropriate operator's committee at each airport where the charge is being imposed should engage in consultation with a view to developing the simplest possible method of collection within the terms of this recommendation.

Note 1.— Source: Recommendation B-8 of FAL/6.

Note 2.— These guidelines are for use where service charges are levied on the passengers and not the airlines. See also 6.4 of the Annex.

With regard to existing procedures, Contracting States, airport authorities and airlines should co-operate in introducing better methods of informing passengers of the existence of passenger service charges; and

also with regard to existing procedures, Contracting States, airport authorities and airlines should co-operate in developing methods whereby passengers may pay the charge while purchasing tickets or visiting airline offices for reconfirmation. Where this cannot be achieved, co-operation should be directed towards developing simplified procedures for payment of these charges at every check-in point.

Note 1.— Source: Recommendation B-7 of FAL/7.

Note 2.— These guidelines are for use where service charges are levied on the passengers and not the airlines. See also 6.4 of the Annex.

As a means of relieving congestion at international airports, Contracting States should encourage the authorities concerned to:

a) expedite check-in procedures through simplification;

b) provide adequate staff and facilities, etc.; and

c) consider the advisability of using city terminals, including check-in facilities where possible.

Note 1.— Source: Recommendation B-5 of FAL/7.

Note 2.— See also 6.28 of the Annex.

Facilities should be made available to provide incoming passengers with information of interest to tourists and on room reservations at as many hotels as possible;

States and airport administrations should devote the closest attention to the provision of these services with a view to supplementing the efforts already made by air carriers and travel agencies; and

arrangements should be made, to the maximum extent possible, to enable passengers on departure to book a room in the country of their destination.

Note.— Source: Recommendation B-16 of FAL/7.

With regard to departures on high-frequency short- and medium-range flights, operators and airport authorities at busy air terminals should give consideration to:

a) the elimination of routine baggage weighing;

b) the establishment of a simple baggage reception system in lieu of the present system.

Note.— Source: Recommendation B-6 of FAL/7.

Guidance Material relating to Chapter 8 — Other Facilitation Provisions

In order to ensure that security measures deemed essential to prevent unlawful interference with civil aviation are carried out as expeditiously as possible and in such a manner as to cause the minimum inconvenience or delay to international civil aviation, there should be close co-ordination, adapted to circumstances, between facilitation and security programmes and, to this end, certain members of Facilitation Committees should also be members of Security Committees.

Note 1.— Source: Recommendation B-12 of FAL/8.

Note 2.— See also 8.20 and Appendix 10.

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D

— END —

SUPPLEMENT TO

ANNEX 9 — FACILITATION

(Ninth Edition)

1. This revised and enlarged version of the Supplement to Annex 9 includes differences notified by Contracting States up to 28 February 1994 and replaces the edition dated July 1991.

2. The Supplement should be inserted at the end of Annex 9, Ninth Edition. Additional differences and revised comments received from Contracting States will be issued at intervals as amendments.

28/2/94

SUPPLEMENT TO ANNEX 9 — NINTH EDITION

(revised and enlarged version)

FACILITATION

Differences between the national regulations and practices of Contracting States and the corresponding International Standards and Recommended Practices contained in Annex 9, as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

FEBRUARY 1994

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS

No.	*Date*	*Entered by*

No.	*Date*	*Entered by*

AMENDMENTS TO ANNEX 9 ADOPTED OR APPROVED BY THE COUNCIL

No.	*Date of adoption or approval*	*Date applicable*

No.	*Date of adoption or approval*	*Date applicable*

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards and Recommended Practices of Annex 9, Ninth Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
Algeria	25/9/90	1-2	28/2/94
Angola	12/12/91	1	28/2/94
Argentina	12/8/92	1	28/2/94
Australia	28/8/92	1-4	28/2/94
Austria	16/1/91	1	28/2/94
Belgium	10/8/92	1-2	28/2/94
Bolivia	26/7/90	1-2	28/2/94
Botswana	1/2/92	1-2	28/2/94
Brazil	10/1/91	1-2	28/2/94
Burkina Faso	26/1/93	1	28/2/94
Burundi	17/12/91	1	28/2/94
Canada	8/10/93	1-4	28/2/94
Chile	1/8/91	1-2	28/2/94
Cuba	31/8/92	1-5	28/2/94
Cyprus	9/12/91	1	28/2/94
Czech Republic	26/1/94	1-2	28/2/94
Denmark	12/12/90	1-2	28/2/94
Ecuador	4/9/92	1	28/2/94
Egypt	26/7/93	1	28/2/94
Ethiopia	12/8/92	1	28/2/94
Fiji	16/10/92	1-2	28/2/94
Finland	28/11/90	1	28/2/94
France	12/7/91	1-2	28/2/94
Germany	21/7/92	1-3	28/2/94
Ghana	11/2/91	1	28/2/94
Greece	12/10/90	1-2	28/2/94
India	21/7/92	1-3	28/2/94
Indonesia	30/3/92	1-2	28/2/94
Iran, Islamic Republic of	22/12/92	1-2	28/2/94
Ireland	18/2/91	1	28/2/94
Israel	13/9/92	1	28/2/94
Japan	31/10/90	1-4	28/2/94
Kuwait	16/6/93	1	28/2/94
Malawi	28/1/92	1	28/2/94
Mauritius	24/1/92	1	28/2/94
Mexico	8/1/91	1	28/2/94
Monaco	19/8/92	1	28/2/94
Netherlands, Kingdom of the	26/10/90	1-2	28/2/94
New Zealand	28/8/92	1	28/2/94
Norway	16/1/91	1-2	28/2/94
Panama	28/8/92	1-2	28/2/94

State	Date of notification	Pages in Supplement	Date of publication
Portugal	3/9/92	1-2	28/2/94
Russian Federation	3/12/90	1-2	28/2/94
Rwanda	24/7/92	1	28/2/94
Saudi Arabia	17/9/90	1-2	28/2/94
Seychelles	23/12/91	1-3	28/2/94
Singapore	14/12/90	1	28/2/94
Slovakia	6/1/94	1-2	28/2/94
Spain	8/11/90	1-2	28/2/94
Swaziland	28/1/93	1-2	28/2/94
Sweden	4/12/92	1	28/2/94
Switzerland	1/10/90	1	28/2/94
Thailand	3/9/93	1-3	28/2/94
Uganda	19/8/92	1-2	28/2/94
United Kingdom	7/12/93	1-6	28/2/94
Hong Kong	16/7/92	7-8	28/2/94
United Republic of Tanzania	18/3/92	1-2	28/2/94
United States	24/10/90	1-3	28/2/94
Vanuatu	20/4/90	1	28/2/94
Zambia	31/12/92	1-2	28/2/94

2. Contracting States which have notified ICAO that no differences exist

State	Date of notification
Benin	8/7/92
El Salvador	24/4/90
Lesotho	7/9/92
Malaysia	5/12/90
Pakistan	26/7/92
Tunisia	29/6/91
United Arab Emirates	10/8/92

3. **Contracting States from which no information has been received**

Afghanistan
Albania
Antigua and Barbuda
Armenia
Azerbaijan
Bahamas
Bahrain
Bangladesh
Barbados
Belarus
Belize
Bhutan
Bosnia and Herzegovina
Brunei Darussalam
Bulgaria
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Colombia
Comoros
Congo
Cook Islands
Costa Rica
Côte d'Ivoire
Croatia
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Equatorial Guinea
Eritrea
Estonia
Gabon
Gambia
Georgia
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
Iceland
Iraq
Italy
Jamaica
Jordan
Kazakhstan
Kenya
Kiribati
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Liberia
Libyan Arab Jamahiriya
Lithuania
Luxembourg
Madagascar
Maldives
Mali
Malta
Marshall Islands
Mauritania
Micronesia, Federated States of
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nauru
Nepal
Nicaragua
Niger
Nigeria
Oman
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Qatar
Republic of Korea
Republic of Moldova
Romania
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Senegal
Sierra Leone
Slovenia
Solomon Islands
Somalia
South Africa
Sri Lanka
Sudan
Suriname
Syrian Arab Republic
Tajikistan
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Turkey
Turkmenistan
Ukraine
Uruguay
Uzbekistan
Venezuela
Viet Nam
Yemen
Zaire
Zimbabwe

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4. Paragraphs with respect to which differences have been notified

Paragraph	*Differences notified by*
Definitions	Argentina
	Cuba
2.1	Australia
2.3	United Republic of Tanzania
	United States
2.4	Argentina
	Australia
	Bolivia
	Botswana
	Brazil
	Chile
	Cuba
	Cyprus
	Egypt
	Greece
	Hong Kong (United Kingdom)
	India
	Indonesia
	Israel
	Japan
	Malawi
	Panama
	Portugal
	Russian Federation
	Rwanda
	Seychelles
	Swaziland
	Thailand
	Uganda
	United Kingdom
	United Republic of Tanzania
	United States
	Zambia
2.4.1	Argentina
	Cuba
	Egypt
	Greece
	Japan
	United States
2.4.2	Botswana
	India
	Indonesia
	Thailand
2.4.3	Australia
	Cuba
2.4.4	Australia
	Botswana
	Chile
	Cyprus
	India
	Japan
	Uganda
	United States
2.5	Botswana
	Egypt
	Fiji
	Greece
	Hong Kong (United Kingdom)
	India
	Indonesia
	Israel
	Japan
	Mauritius
	Russian Federation
	Thailand
	Uganda
	United States
	Vanuatu
2.6	Australia
	Botswana
	Burkina Faso
	Burundi
	Cuba
	Egypt
	Ethiopia
	Greece
	India
	Indonesia
	Iran, Islamic Republic of
	Japan
	Mexico
	Panama
	Rwanda
	Saudi Arabia
	Slovakia
	Swaziland
	Thailand
	Uganda
	Vanuatu
	Zambia
2.6.1	Botswana
	India
	Malawi
	Thailand
2.7	Algeria
	Botswana

Paragraph	*Differences notified by*
	Chile
	Cyprus
	Greece
	Israel
	Japan
	Malawi
	Netherlands, Kingdom of the
	Portugal
	Russian Federation
	Rwanda
	Seychelles
	Thailand
	Uganda
	United Kingdom
	United Republic of Tanzania
	United States
	Zambia
2.8	Belgium
	Burundi
	Canada
	Denmark
	Fiji
	Germany
	Hong Kong (United Kingdom)
	Indonesia
	Ireland
	Japan
	Netherlands, Kingdom of the
	Portugal
	Rwanda
	Spain
	Uganda
	United Kingdom
	United Republic of Tanzania
	United States
	Vanuatu
2.8.1	Algeria
	Argentina
	Belgium
	Burkina Faso
	Canada
	Cyprus
	Denmark
	Egypt
	France
	Germany
	Greece
	Hong Kong (United Kingdom)
	India
	Ireland
	Japan

Paragraph	*Differences notified by*
	Malawi
	Mauritius
	Monaco
	Netherlands, Kingdom of the
	Russian Federation
	Seychelles
	Slovakia
	Spain
	Thailand
	United Kingdom
	United Republic of Tanzania
	United States
2.8.2	Japan
2.10	Australia
	Denmark
	Fiji
	United Kingdom
	United Republic of Tanzania
	United States
2.11	Saudi Arabia
2.12	Angola
	Brazil
	Egypt
	Hong Kong (United Kingdom)
	Indonesia
	Japan
	Panama
	Rwanda
	Thailand
	Zambia
2.13	Fiji
	Thailand
2.14	Indonesia
	Thailand
2.15	Angola
	Brazil
	Egypt
	Indonesia
	Japan
	Rwanda
	Thailand
	Zambia
2.16	Fiji
	Thailand
2.17	Saudi Arabia
	Spain
	Switzerland
2.18	Australia
	Burkina Faso
	Thailand
	Zambia

Paragraph	*Differences notified by*
2.19	Egypt
	Indonesia
	Thailand
2.20	Bolivia
	Iran, Islamic Republic of
2.21	United States
2.22	Botswana
	Greece
2.23	Australia
	Cuba
	Fiji
	India
	New Zealand
	Saudi Arabia
	Seychelles
	Vanuatu
2.24	Australia
	Cuba
	Seychelles
2.25	Seychelles
2.26	Seychelles
2.27	Cuba
	Seychelles
2.28	Cuba
	Seychelles
2.29	Cuba
	Seychelles
2.30	Seychelles
2.31	Iran, Islamic Republic of
	Seychelles
2.32	Australia
	Seychelles
2.33	Seychelles
2.34	Bolivia
	Burundi
	Egypt
	India
	Indonesia
	Iran, Islamic Republic of
	Japan
	Malawi
	Mauritius
	Panama
	Russian Federation
	Saudi Arabia
	Seychelles
	Thailand
2.35	Bolivia
	Brazil
	Burundi
	Chile
	Egypt
	Fiji
	Germany
	India
	Mauritius
	Russian Federation
	Saudi Arabia
	Seychelles
	Thailand
	United States
	Vanuatu
2.36	Egypt
	Indonesia
	Iran, Islamic Republic of
	Russian Federation
	Seychelles
2.37	Seychelles
2.38	Algeria
	Angola
	Czech Republic
	Ethiopia
	India
	Japan
	Malawi
	Mauritius
	Panama
	Russian Federation
	Seychelles
	Thailand
	Zambia
2.39	Fiji
	Malawi
	Russian Federation
	Seychelles
	Swaziland
	Thailand
2.40	Algeria
	Australia
	Austria
	Canada
	Czech Republic
	Hong Kong (United Kingdom)
	Malawi
	Russian Federation
	Rwanda
	Seychelles
	Slovakia
	United Republic of Tanzania
	United States
	Zambia

Paragraph	Differences notified by
2.41	Australia
	Saudi Arabia
2.42	Brazil
	Burkina Faso
	Czech Republic
	Greece
	Japan
	Russian Federation
	Slovakia
	United States
3.3	Burundi
	India
	Japan
	United Republic of Tanzania
	United States
3.4	Cuba
	France
	Indonesia
	Japan
	Monaco
3.4.1	Cuba
3.5	Cuba
	Swaziland
	United Republic of Tanzania
3.5.1	Argentina
	Belgium
	Burundi
	Chile
	Kuwait
	Portugal
	United Republic of Tanzania
3.5.2	Cuba
	Panama
	Swaziland
3.5.3	Bolivia
	Burkina Faso
	Burundi
	Chile
	Cuba
	Ethiopia
	Iran, Islamic Republic of
	Japan
	Swaziland
3.5.4	Bolivia
	Cuba
	Iran, Islamic Republic of
	Japan
3.5.5	Hong Kong (United Kingdom)
	Iran, Islamic Republic of
3.5.6	Czech Republic
	Denmark
	Iran, Islamic Republic of
3.5.7	Cuba
3.5.8	Cuba
	France
	Hong Kong (United Kingdom)
	Monaco
3.6	Cuba
	Panama
	Saudi Arabia
3.7	Chile
	Hong Kong (United Kingdom)
	Iran, Islamic Republic of
	Israel
	Russian Federation
	Saudi Arabia
	Swaziland
	Uganda
	United Republic of Tanzania
	United States
3.8	Algeria
	Austria
	Burundi
	Canada
	Ethiopia
	France
	Germany
	Hong Kong (United Kingdom)
	India
	Israel
	Monaco
	Netherlands, Kingdom of the
	Norway
	Panama
	Portugal
	Rwanda
	Switzerland
	United Kingdom
	United Republic of Tanzania
	Zambia
3.8.1	Burkina Faso
	Cuba
	Denmark
	Hong Kong (United Kingdom)
	Thailand
	United Kingdom
3.8.2	Algeria
	Canada

Paragraph	Differences notified by
	Cuba
	Cyprus
	Denmark
	Indonesia
	Netherlands, Kingdom of the
	United Kingdom
3.8.3	Algeria
	Angola
	Austria
	Bolivia
	Brazil
	Burkina Faso
	Burundi
	Canada
	Chile
	Cuba
	Cyprus
	Czech Republic
	Denmark
	Ethiopia
	Fiji
	Germany
	Greece
	Hong Kong (United Kingdom)
	India
	Iran, Islamic Republic of
	Israel
	Japan
	Mauritius
	Netherlands, Kingdom of the
	Norway
	Panama
	Slovakia
	Swaziland
	Switzerland
	Thailand
	Uganda
	United Kingdom
	United Republic of Tanzania
	United States
	Zambia
3.8.4	Australia
	Chile
	Cuba
	Greece
	Hong Kong (United Kingdom)
	Japan
	United Kingdom
	United States
3.8.5	Australia
	Cuba
	Hong Kong (United Kingdom)
3.8.6	Algeria
	Angola
	Australia
	Botswana
	Burkina Faso
	Chile
	Czech Republic
	Denmark
	India
	Japan
	Mauritius
	New Zealand
	Panama
	Slovakia
	Thailand
	United Kingdom
3.8.7	Cuba
	Germany
	Japan
	Thailand
	United Kingdom
	Zambia
3.8.8	Australia
3.8.9	Mauritius
	Slovakia
3.9	Angola
	Australia
	Bolivia
	Botswana
	Brazil
	Chile
	Cuba
	Denmark
	Finland
	Greece
	Hong Kong (United Kingdom)
	Israel
	Mauritius
	New Zealand
	Norway
	Panama
	Portugal
	Rwanda
	Saudi Arabia
	Seychelles
	Sweden

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Paragraph	Differences notified by
	Thailand
	United Kingdom
	Vanuatu
3.10	Angola
	Australia
	Botswana
	Brazil
	Burkina Faso
	Cyprus
	Ethiopia
	Fiji
	Finland
	Germany
	Greece
	Hong Kong (United Kingdom)
	India
	Indonesia
	Israel
	Japan
	Mauritius
	Norway
	Panama
	Portugal
	Saudi Arabia
	Seychelles
	Singapore
	Sweden
	Uganda
	United Kingdom
	United Republic of Tanzania
	Vanuatu
	Zambia
3.10.1	Cuba
	Germany
	Norway
	Seychelles
	United States
3.10.2	Argentina
	Germany
	Japan
	Seychelles
	United Kingdom
	United States
	Zambia
3.11	Cuba
	Iran, Islamic Republic of
3.12	Australia
	Cuba
	Egypt
	India
3.13	Cuba
3.13.1	Greece
3.15	Botswana
	Greece
3.16	Australia
	Botswana
	Fiji
	Ghana
	India
	Indonesia
	Iran, Islamic Republic of
	New Zealand
	Russian Federation
	Seychelles
	Swaziland
	Thailand
	United Kingdom
	United States
	Zambia
3.17	Bolivia
	Burundi
	Ethiopia
	Panama
	Seychelles
	Swaziland
3.17.1	Australia
	Bolivia
	Canada
	Ethiopia
	Hong Kong (United Kingdom)
	Japan
	Malawi
	Seychelles
	Swaziland
	Uganda
	United Republic of Tanzania
	United States
3.18	Netherlands, Kingdom of the
	United Kingdom
	Vanuatu
3.19	Canada
3.20	Algeria
	Vanuatu
3.22	Indonesia
3.23	Algeria
	Australia
	Cuba
	United Kingdom
	Zambia
3.24	Cuba
	Czech Republic
	Fiji

Paragraph	*Differences notified by*
	Greece
	Iran, Islamic Republic of
	Netherlands, Kingdom of the
	Norway
	Russian Federation
	Saudi Arabia
	Slovakia
	Thailand
	United Kingdom
	United States
3.24.1	Algeria
	Czech Republic
	Germany
	India
	Netherlands, Kingdom of the
	Russian Federation
	Slovakia
	Thailand
	United Kingdom
	United States
3.25	Australia
	Czech Republic
	Fiji
	Netherlands, Kingdom of the
	Russian Federation
	Slovakia
	Thailand
	United Kingdom
	United States
3.25.1	Algeria
	Australia
	Czech Republic
	Germany
	India
	Netherlands, Kingdom of the
	Russian Federation
	Slovakia
	Thailand
	United Kingdom
	United States
3.25.2	Cyprus
	Czech Republic
	Denmark
	Ethiopia
	Fiji
	Germany
	Greece
	Hong Kong (United Kingdom)
	Japan
	Netherlands, Kingdom of the
	New Zealand

Paragraph	*Differences notified by*
	Russian Federation
	Slovakia
	Thailand
	United Kingdom
	United States
	Zambia
3.25.3	Algeria
	Czech Republic
	Denmark
	Germany
	Hong Kong (United Kingdom)
	India
	Japan
	Netherlands, Kingdom of the
	New Zealand
	Russian Federation
	Slovakia
	Thailand
	United Kingdom
	United States
3.26	Cuba
3.27	Cuba
3.28	Bolivia
	Cuba
	Ethiopia
	Indonesia
	Russian Federation
	Thailand
3.29	Algeria
	Australia
	Bolivia
	Hong Kong (United Kingdom)
	Israel
	Slovakia
3.30	Algeria
	Burkina Faso
	Czech Republic
	India
	Iran, Islamic Republic of
	Rwanda
	Slovakia
	United Republic of Tanzania
3.31	Burundi
	Ethiopia
	Ghana
	India
	Iran, Islamic Republic of
	Thailand
	United Republic of Tanzania
3.32	Bolivia
	Thailand

Paragraph	*Differences notified by*
3.33	Greece
	India
	Iran, Islamic Republic of
3.35.2	Austria
	Japan
	United Kingdom
3.36	Austria
	Canada
	Hong Kong (United Kingdom)
	Japan
	Panama
	United Kingdom
3.36.1	Canada
	Hong Kong (United Kingdom)
	Japan
3.36.2	Canada
	Japan
	United Kingdom
3.36.3	Canada
3.37	Angola
	Canada
	Germany
3.37.1	Australia
	Austria
	Botswana
	Brazil
	Canada
	Denmark
	Germany
	Hong Kong (United Kingdom)
	New Zealand
	Saudi Arabia
	United Kingdom
3.37.2	Germany
3.38	Japan
3.39	Algeria
	Denmark
	United Kingdom
3.40	Algeria
	Belgium
	Japan
	Kuwait
	Netherlands, Kingdom of the
	United Kingdom
3.41	Switzerland
4.4	Indonesia
	Swaziland
4.5	Fiji
	Swaziland

Paragraph	*Differences notified by*
4.6	Chile
	Fiji
	Swaziland
4.6.1	Swaziland
4.7	Indonesia
	Swaziland
4.8	Fiji
	Swaziland
4.8.1	Australia
	Chile
	Swaziland
4.9	Algeria
	Argentina
	Belgium
	Burkina Faso
	Canada
	Denmark
	Ecuador
	Finland
	France
	Germany
	India
	Indonesia
	Iran, Islamic Republic of
	Ireland
	Monaco
	Netherlands, Kingdom of the
	Norway
	Portugal
	Saudi Arabia
	Seychelles
	Spain
	Swaziland
	Sweden
	Switzerland
	Uganda
	United Kingdom
	United Republic of Tanzania
4.9.1	Chile
	Ecuador
	Seychelles
	Swaziland
4.10	Burundi
	Canada
	Fiji
	Swaziland
	United Republic of Tanzania
4.11	Argentina
4.12	Argentina
	Panama

Paragraph	Differences notified by
4.13	Algeria
	Bolivia
	Ethiopia
	Greece
	India
	Iran, Islamic Republic of
	Japan
	Spain
	Swaziland
	Thailand
	Uganda
	United Republic of Tanzania
4.14	Canada
	Greece
4.15	Algeria
	Argentina
	Bolivia
	Iran, Islamic Republic of
	Thailand
	Vanuatu
4.17	Australia
	Bolivia
	Rwanda
4.17.1	Australia
	Chile
	Ecuador
4.18	Canada
	Greece
	Panama
	United Kingdom
4.19	Australia
	Belgium
	Bolivia
	Denmark
	Finland
	Germany
	Greece
	Ireland
	Netherlands, Kingdom of the
	Norway
	Panama
	Portugal
	Spain
	Sweden
	Uganda
	United Kingdom
	United Republic of Tanzania
4.20	Fiji
4.21	Iran, Islamic Republic of
	Panama
	Saudi Arabia

Paragraph	Differences notified by
4.22	Bolivia
	Panama
4.23	Bolivia
	Botswana
	Brazil
	Canada
	Czech Republic
	Finland
	Greece
	India
	Iran, Islamic Republic of
	Norway
	Panama
	Slovakia
	Sweden
	United Republic of Tanzania
4.23.1	Australia
	Bolivia
	Botswana
	Canada
	Chile
	Cyprus
	Czech Republic
	Finland
	India
	Mauritius
	Norway
	Slovakia
	Sweden
4.24	Bolivia
	Botswana
	Ethiopia
	Finland
	Iran, Islamic Republic of
	Norway
	Panama
	Sweden
4.25	Bolivia
	India
	Iran, Islamic Republic of
4.26	Iran, Islamic Republic of
4.27	India
4.28	Bolivia
	Czech Republic
	Panama
	Slovakia
4.30	Bolivia
	Burundi
	Ethiopia
	Greece
	Panama

Paragraph	*Differences notified by*
4.31	New Zealand
4.32	Saudi Arabia
4.32.1	Slovakia
	Spain
4.33	Panama
4.34	Algeria
	Panama
4.37	Algeria
4.38	Algeria
	Australia
4.39	Australia
4.40	Israel
	New Zealand
4.42	Australia
	Burkina Faso
	Iran, Islamic Republic of
4.43	Australia
	Burkina Faso
4.44	Algeria
	Australia
	Belgium
	Burkina Faso
	Canada
	Cyprus
	Denmark
	France
	Germany
	India
	Iran, Islamic Republic of
	Ireland
	Japan
	Monaco
	Netherlands, Kingdom of the
	New Zealand
	Saudi Arabia
	Spain
	Thailand
	United Kingdom
	United States
4.45	Australia
	Belgium
	Denmark
	France
	Germany
	Greece
	India
	Ireland
	Japan
	Monaco
	Netherlands, Kingdom of the
	New Zealand

Paragraph	*Differences notified by*
	Spain
	Thailand
	United Kingdom
	United States
4.46	Australia
	Canada
	Cyprus
	India
	Japan
	Panama
	Thailand
4.47	Canada
	Japan
4.47.1	Japan
4.48	Japan
	United Republic of Tanzania
4.49	Iran, Islamic Republic of
	New Zealand
	United States
4.50	Iran, Islamic Republic of
	United States
4.51	India
	Japan
4.52	United States
4.53	Algeria
	Australia
	Belgium
	Botswana
	Cyprus
	Denmark
	Ethiopia
	Fiji
	France
	Germany
	Ireland
	Israel
	Japan
	Monaco
	Netherlands, Kingdom of the
	New Zealand
	Portugal
	Seychelles
	Spain
	Uganda
	United Kingdom
4.53.1	Algeria
4.54	Ecuador
5.1	Germany
	United States
5.2	Botswana
	Denmark

Paragraph	Differences notified by
	France
	Germany
	India
	Switzerland
	United States
5.3	United States
5.4	Australia
	Belgium
	Botswana
	Denmark
	France
	Germany
	India
	Ireland
	Netherlands, Kingdom of the
	Portugal
	Seychelles
	Spain
	Switzerland
	United Kingdom
	United States
5.4.1	Austria
	Canada
	Chile
	Denmark
	Finland
	France
	Germany
	Hong Kong (United Kingdom)
	New Zealand
	Norway
	Panama
	Russian Federation
	Sweden
	Thailand
	Uganda
	United Kingdom
	United States
5.5	Belgium
	Denmark
	France
	Germany
	Ireland
	Monaco
	Netherlands, Kingdom of the
	Portugal
	Spain
	United Kingdom
5.8	Botswana
	Canada
	Denmark
	France
	Germany
	Ireland
	Japan
	Netherlands, Kingdom of the
	Saudi Arabia
	Spain

Paragraph	Differences notified by
	United Kingdom
	United States
5.9	Botswana
	Germany
	Japan
	United Kingdom
	United States
5.11	Australia
	Chile
	Czech Republic
	Greece
	Hong Kong (United Kingdom)
	Netherlands, Kingdom of the
	Russian Federation
	Saudi Arabia
	Seychelles
	Slovakia
	United Republic of Tanzania
	Zambia
5.12	Australia
	Canada
	Czech Republic
	Greece
	Hong Kong (United Kingdom)
	Panama
	Russian Federation
	Rwanda
	Saudi Arabia
	Seychelles
	Slovakia
	Zambia
5.13	Czech Republic
	Indonesia
	Russian Federation
	Seychelles
	Slovakia
6.3.1	United States
6.4	Chile
	United Republic of Tanzania
6.5	Belgium
	Chile
	Denmark
	Egypt
	France
	Germany
	Ireland
	Monaco
	Netherlands, Kingdom of the
	Portugal
	Spain
	United Kingdom
6.6	Bolivia
	Cuba
	Hong Kong (United Kingdom)
6.10	Burundi
	Saudi Arabia
	Seychelles

Paragraph	*Differences notified by*
6.22	Panama
6.26	Zambia
6.27	Cuba
6.28	Belgium
	Cuba
	Denmark
	France
	Germany
	Ireland
	Monaco
	Netherlands, Kingdom of the
	Portugal
	Spain
	United Kingdom
	Zambia
6.31.1	Germany
6.32	Cuba
6.33	Cuba
	Seychelles
	United States
6.35	Cuba
	Seychelles
6.37.1	Bolivia
	Chile
	Mauritius
6.37.2	Belgium
6.39	Belgium
	Denmark
	France
	Germany
	Ireland
	Netherlands, Kingdom of the
	Portugal
	Spain
	United Kingdom
6.40	Bolivia
6.41	Bolivia
6.42	Bolivia
6.43	Bolivia
6.44	Bolivia
6.45	Bolivia
6.46	Bolivia
	Chile
6.47	Bolivia
6.48	Bolivia
6.49	Bolivia
6.50	Australia
	Bolivia
6.51	Australia
	Bolivia
	Denmark
	France
	Germany
	Ireland
	Japan
	Netherlands, Kingdom of the
	Portugal
	Spain
	United Kingdom

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Paragraph	*Differences notified by*
6.52	Bolivia
6.53	Cuba
	Malawi
6.54	Burundi
	Cuba
	Mauritius
6.55	Australia
	Cuba
6.56	Cuba
6.57	Cuba
6.58	Cuba
6.59	Cuba
	Panama
	Seychelles
6.60	United Kingdom
6.62	Cuba
	Egypt
	Singapore
	United Kingdom
6.62.1	Cuba
	Thailand
6.63	United Kingdom
6.64	Bolivia
	Cuba
	Czech Republic
	Greece
	Russian Federation
	Saudi Arabia
	United Kingdom
6.69	Canada
6.71	Czech Republic
	Mauritius
	Slovakia
7.3.3	Saudi Arabia
8.1	Canada
	United States
8.4	Canada
	Greece
8.5	Greece
8.6	Greece
8.7	Canada
8.12	Australia
	Cuba
	India
	Saudi Arabia
8.13	Australia
	Cuba
8.14	Cuba
8.15	Cuba
	Saudi Arabia
8.16	Brazil
	Cuba
8.19	Belgium
	Chile
	Denmark
	Germany
	United Kingdom
	United Republic of Tanzania

CHAPTER 2

2.7* The Cargo Manifest is required in accordance with the format set forth in Appendix 3.

2.8.1* The nature of the goods must be indicated in the cargo manifest.

2.38 As a general rule, special permission is required in addition to the flight plan for the flights mentioned in 2.34.

2.40* In the case of non-scheduled transport flights with commercial stops, unless there are reciprocal arrangements, a request for permission must be addressed to the Directorate General of Civil Aviation and Meteorology fifteen days before the commencement of the planned flight or flights. This application must contain, in addition to the information in 2.40, the name of the aircraft owner (where applicable).

CHAPTER 3

3.8 As a general rule, a tax is levied when an entrance visa is issued.

3.8.2 The visa applicant must appear in person.

3.8.3 Aside from nationals of States with which Algeria has signed an agreement for the mutual elimination of visas, entrance visas for temporary visitors are valid for one or more entries and for a period of three months from the date of use.

3.8.6* As a general rule, an "exit and re-entry" visa is required from resident aliens.

3.20 Customs clearance of unaccompanied baggage may be effected by the operator if he is empowered to effect forwarding operations (see also 4.53.1 below).

3.23 The Crew Members' Certificates presented in Appendix 7 are not issued.

3.24.1 The flight crew members of an aircraft operated for remuneration or hire but not engaged in scheduled international air services do not have the same privileges as those outlined in 3.24.

3.25.1* The flight crew members of an aircraft operated for remuneration or hire but not engaged in scheduled international air services do not have the same privileges as those outlined in 3.24.

3.25.3* This provision not applied as a general rule. Such crew members as are given temporary permission must possess a valid passsport and, where applicable, a visa.

3.29* Applied as a general rule.

3.30* Passenger baggage is inspected by customs service on a random sample basis.

3.39 The Algerian Public Authorities will ensure, whenever it is deemed possible, that operators are informed when passengers are obliged to travel due to a deportation order.

3.40* The Algerian Public Authorities ordering the deportation order will, whenever it is deemed feasible, inform the public authorities of destination countries of the planned transport.

* Recommended Practice

CHAPTER 4

4.9*	A cargo report declaration is required.
4.13	Inspection is carried out by the customs on a random sample basis.
4.15	Cargo, including unaccompanied baggage which is to be exported by air, is presented for clearance purposes at the customs office of the embarkation airport.
4.34*	Parts and elements of containers must be intended for domestic use. They must be cleared through customs on payment of the fees and taxes prescribed in the customs tariffs.
4.37*	The customs administration cannot allow the loan between airlines operating in Algeria of containers and other associated equipment. This is due to the fact that an open account manages and covers the equipment (containers) specific to each airline.
4.38	From the point of view of customs legislation, the operator is responsible for omissions or inaccuracies of fact on documents.
4.44*	Customs legislation provides that goods intended for use in the manufacture, modification or repair of aircraft are admitted free of duties and taxes. Other equipment is admitted under the temporary admission system.
4.53	Baggage, whether accompanied or unaccompanied, shall be grouped together when presented for clearance to enable the customs service to determine the tolerance (freedom from duties and taxes) and taxation thresholds under a simplified procedure.
4.53.1	Customs clearance of unaccompanied baggage may be effected by: the owner, a forwarding agent or customs broker, or the operator empowered to effect forwarding operations.

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* Recommended Practice

CHAPTER 2

2.12 One of the copies of the General Declaration shall be delivered by the operator to each DNAC, ENANA and DNEFA for departure clearance from every stop in Angolan Territory.

2.15 One of the copies of the General Declaration shall be delivered by the operator to each DNAC, ENANA and DNEFA for arrival clearance at every stop in Angolan Territory.

2.38 The authority of the international airport where the aircraft will land, as first stop when entering Angolan Territory, must be notified at least 72 hours before the arrival of the aircraft.

CHAPTER 3

3.8.3 The tourist visa is valid for one entry for 120 days from the date of issue.

3.8.6* Exit visas are required for national and permanent resident aliens in Angola as well as for temporary visitors, such as technical personnel, teachers and other classes of professionals who work under a labour agreement or in the service of the Angolan Government. The exit visa is not required for tourists if they leave the country within the period of stay allotted to them.

3.9* The passport number is required on the Embarkation/Disembarkation Card to be filled out by the passenger before embarking or disembarking.

3.10 The passport number is required on the Embarkation/Disembarkation Card to be filled out by the passenger before embarking or disembarking.

3.37 Operators are liable to be fined if they carry alien passengers whose documents are not in order and aliens who enter Angolan Territory illegally.

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* Recommended Practice

CHAPTER 1

Definitions

Pilot-in-command. The Argentine Administration will continue to use the term "comandante de la aeronave".

Unaccompanied baggage. Baggage may be personally conveyed by the passenger or handed over by him before or after the passenger's exit or entrance.

Cargo. Any property carried on an aircraft other than mail and stores.

Free zone. An area that may exceptionally be subject to control measures.

CHAPTER 2

2.4 Presentation of the General Declaration is required.

2.4.1 Presentation of the General Declaration is required on arrival and at departure.

2.8.1* Information on the nature of the goods is required in the cargo manifest.

CHAPTER 3

3.5.1* It is not feasible at present to issue machine readable passports (MRPs).

3.10.2 Airline operators, and not Contracting States, are charged with the responsibility for the provision of Embarkation/Disembarkation cards.

CHAPTER 4

4.9* Unaccompanied baggage is not considered the same as cargo.

4.11 Unaccompanied baggage is not considered the same as cargo.

4.12 Unaccompanied baggage is not considered the same as cargo.

4.15 Unaccompanied baggage is not considered the same as cargo.

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* Recommended Practice

CHAPTER 2

2.1 Except when permitted under special authority, Australian quarantine requirements prohibit the bringing into Australia by air, not only of animals and certain animal products intended for importation, but also of animals on aircraft transiting Australia for some other destination.

2.4 General Declarations are required (see also 2.4.3).

2.4.3 The General Declaration is not required by the Australian Quarantine and Inspection Service. The aircraft is required to make the health declaration by radio message before arrival.

2.4.4 Customs in Australia use the Declaration as a reporting and clearance document. As such it is required to be signed. Stamping merely identifies the authority.

2.6 Unacceptable. Australia considers that the current wording (as per 8th Edition) is more appropriate, i.e. "Contracting States shall not require the presentation of a passenger manifest."

2.10 Aircraft arriving at and departing from the same airport without proceeding to another airport in Australia, and aircraft of countries in respect of which bilateral agreements between those countries and Australia provide for duty-free consumption of stores on flights within Australia, are not required to present a written declaration of stores remaining on board. All other aircraft are required to present such a declaration.

2.18* Documents are required to be furnished in English.

2.23 Aircraft cabins should be treated by disinsecting at top-of-descent, or residually disinsected in accordance with a Compliance Agreement between the airline and the Australian Quarantine and Inspection Service.

2.24* Aircraft cabins should be treated by disinsecting at top-of-descent, or residually disinsected in accordance with a Compliance Agreement between the airline and the Australian Quarantine and Inspection Service.

2.32 If considered necessary by the health authorities, all or any part of the aircraft and the contents may be treated by disinfection after the aircraft lands at its first airport of call in Australia.

2.40* Operators of high-capacity aircraft (more than 38 passenger seats or 4 200 kg payload) who wish to conduct programmes of charters involving more than two flights in a calendar year are required to submit copies of company operations (or instructors) manual, route manual, flight manual and aircraft operations manual.

2.41* Under Australian law, all aircraft arriving in or departing from Australian territory must use a designated airport as their first point of arrival or last point of departure, as the case may be.

CHAPTER 3

3.8.4* Unacceptable.

a) Clarification of the intention of the proposed clause and the use of the term "force majeure" is required for further consideration.

b) The Australian Migration Act and Regulations provide for certain categories of persons, in certain circumstances, to apply for a border visa.

3.8.5 While Australia conforms to this Standard, it should be noted that in circumstances where Australian nationals hold another citizenship and elect to travel on other than their Australian passport, they will be required to provide proof of Australian citizenship on arrival, so as to establish their right of re-entry. Travellers in these circumstances may choose to have a re-entry visa issued in their non-Australian passport to simplify clearance formalities on arrival in Australia and to ensure uplift by carriers for travel to Australia.

* Recommended Practice

3.8.6* Australia requires non-citizen residents to be in possession of a valid re-entry visa.

3.8.8* Australian visas do not indicate the month in full.

3.9* Australia requires Embarkation and Disembarkation Cards.

3.10 The content and format of Australian Embarkation/Disembarkation Cards differ from Appendix 5 of Annex 9.

3.12* Australian health authorities reserve the right to examine medically any person arriving by air who is subject to the Australian Quarantine Act 1908.

3.16 A questionnaire is to be completed by passengers. A written declaration on Australian Customs Form 5 (Aircraft) is required in respect of goods in the possession of crew members.

3.17.1 The general principle and purpose of the dual-channel baggage clearance system are incorporated in Australia's modified one-stop system. The basic difference is that in checking all passengers for immigration purposes at a single point, the opportunity is taken to re-direct a small proportion of those passengers who, by their baggage statement, have been identified as "free-run" (or green) channel.

3.23 Unacceptable. Australia is unable to issue crew member certificates to other than Australian citizens.

3.25 Flight crew travelling to Australia as passengers aboard aircraft and not listed as crew members are required to be in possession on arrival, in addition to a pilot's licence as specified in 3.23 of Annex 9, or crew member certificate, a visa or a letter from their employers providing certification of the purpose of their journey (in lieu of visa).

3.25.1* Flight crew travelling to Australia as passengers aboard aircraft and not listed as crew members are required to be in possession on arrival, in addition to a pilot's licence as specified in 3.23 of Annex 9, or crew member certificate, a visa or a letter from their employers providing certification of the purpose of their journey (in lieu of visa).

3.29* Australia requires Embarkation and Disembarkation Cards.

3.37.1 Proof of negligence is not an element of defence in Australian Immigration law when a carrier brings an undocumented person to Australia. In practice, however, prosecution or service of an infringement notice is not initiated if the carrier was not negligent.

CHAPTER 4

4.8.1* Customs is wherever possible aligning its import and export document requirements with the United Nations Layout Key for Trade Documents. In some instances, circumstances at this time do not permit the adoption of the United Nations format.

4.17 The Australian customs authorities accept the commercial invoice together with the air waybill as basic documents for customs formalities. In certain circumstances a customs entry may also be required.

4.17.1* Customs is wherever possible aligning its import and export document requirements with the United Nations Layout Key for Trade Documents. In some instances, circumstances at this time do not permit the adoption of the United Nations format.

4.19* The inclusion of a "Value for Customs Purposes" on the air waybill will greatly assist the clearance of goods falling within 4.22 and 4.23 of Annex 9.

4.23.1* Australian law does not provide for complete exemption of goods in these categories from customs duties and sales tax.

4.38 In the case of the importation of any animal into Australia by air, it will be the operator's responsibility to be in possession of the appropriate import permit or a copy of it.

* Recommended Practice

4.39 The Australian authorities are unable to relieve airlines of their responsibilities in respect of goods brought to Australia on their aircraft, that being a matter between the airlines and the owner of the goods. However, these authorities would accept liability for any loss or damage sustained by any goods subject to the control of the customs where such loss or damage was due to the neglect or wilful act of a customs officer.

In regard to customs duty payable on the goods, an airline would be released from all liability to pay such duty while the goods were in the custody of the customs authorities or after receipt into the custody, possession or control of another person in pursuance of a permission given by the customs authorities.

4.42 Acceptable, subject to the following conditions:

1) The stores are consumed on the aircraft in the operation of an international air service. Stores, if landed for use in Australia, would lose their identity as stores and be treated as goods imported.

2) The country in which the aircraft is registered grants reciprocal concessions on stores to Australian aircraft operating in that country.

4.43* Countries which implement this paragraph of Annex 9 will receive reciprocal concessions on stores consumed in Australia.

4.44* Certain items in this category are subject to sales tax. In so far as customs duties are concerned, Australia will implement this paragraph, whenever possible, subject only to its international trade agreements and other obligations arising out of the Australian Government's policy to protect existing Australian industries.

4.45* Australian law does not provide for complete exemption from customs duties and sales tax on instructional material and training aids.

4.46* Australia is not able to comply fully with the provisions of this paragraph in respect of the duty-free admission of airline documents.

4.53 Unaccompanied baggage arriving by air is treated as cargo for purposes of inward report of aircraft, but may be cleared under procedures other than formal entry. Personal and household effects which qualify for concessions when accompanied may not necessarily enjoy the same treatment when unaccompanied. Other goods are liable to normal customs duties.

CHAPTER 5

5.4 Transfer traffic is treated as incoming and outgoing traffic; as such, normal documentation is required except in the case of transfer and through-flight passengers when they remain in transit areas.

5.11* No free airports or free zones have been established in Australia. Warehousing facilities are available elsewhere in the same general vicinity.

5.12* No free airports or free zones have been established in Australia. Warehousing facilities are available elsewhere in the same general vicinity.

CHAPTER 6

6.50* Warehousing facilities are provided in the same general vicinity as the international airports.

6.51* Warehousing facilities are provided in the same general vicinity as the international airports.

6.55* Australia is not bound by International Health Regulations.

CHAPTER 8

8.12 Australia is not bound by International Health Regulations.

8.13* Australia is not bound by International Health Regulations.

* Recommended Practice

AUSTRIA

CHAPTER 2

2.40* Detailed provisions concerning contents of applications and advance filing periods are published in AIP Austria, Section FAL.

CHAPTER 3

3.8 Charges are imposed for the issuance of entrance visas.

3.8.3 The issuance of visas at entry clearance points is limited to exceptional cases, the validity of such visas being restricted in the light of the reason of travel.

3.35.2* The public authorities concerned are not responsible for the custody of persons found inadmissible. The public authorities will bear the cost of custody only if a valid application requesting asylum has been submitted and the applicant has not found other means of protection.

3.36 The public authorities concerned are not responsible for the custody of persons found inadmissible. The public authorities will bear the cost of custody only if a valid application requesting asylum has been submitted and the applicant has not found other means of protection.

3.37.1 In the case of passengers who do not possess the required entry documents, the operator concerned must furnish evidence that the required documentary controls have been complied with.

CHAPTER 5

5.4.1 Permission to enter Austrian territory can only be issued if the passenger referred to in this paragraph holds a passport complying with the relevant regulations.

BELGIUM

CHAPTER 2

2.8 The interpretation given in the Note to paragraph 2.8 cannot be accepted at present. The customs and excise administration cannot offer operators a choice of the various options suggested.

2.8.1* This Recommended Practice cannot be accepted. Whether or not the cargo manifest is used, Community customs legislation requires an indication of the gross weight and the nature of the goods on the documents presented at customs.

CHAPTER 3

3.5.1* The production of machine readable passports is not envisaged in the foreseeable future.

3.40* Recommended Practice 3.40 will not always be applied in so far as it stipulates that public authorities in the destination country be informed in cases of deportation (repatriation). This is a Recommended Practice which will be applied only in very exceptional cases.

* Recommended Practice

CHAPTER 4

4.9* This Recommended Practice cannot be accepted by Member States of the EEC, as unaccompanied baggage is shipped as cargo and, as such, is covered by an air waybill.

4.19* This Recommended Practice is not applicable. The commercial invoice and the certificate of origin are required to be separate documents.

4.44* Not all the equipment referred to in this Recommended Practice is admitted duty-free.

4.45* Not all the equipment referred to in this Recommended Practice is admitted duty-free.

4.53 Notes (b) and (c) cannot be accepted. In fact, unaccompanied baggage, treated like cargo, is physically transferred to the areas provided for goods, which are different from those reserved for passengers' baggage.

CHAPTER 5

5.4 A document showing first, the identity of the packages and of the aircraft and second, the nature, gross weight and place of lading of the goods may be required by customs as a concise declaration of the goods.

5.5 The proposed change is unacceptable. Community customs legislation provides that goods introduced into customs territory are subject to customs surveillance and may be checked by customs authorities.

CHAPTER 6

6.5* This Recommended Practice is not acceptable. Community customs legislation provides that payment of duties and taxes may be made either in cash or by guaranteed and certified bank cheque. The use of credit cards as a means of payment is not provided for.

6.28* This Recommended Practice is not acceptable. While, in practice, customs clearance is carried out as rapidly as possible and, in most cases, within the limit provided by this measure, it is not possible for customs administrations to accept such a constraint.

6.37.2 The customs administration is not in a position to apply this Standard fully.

6.39* This Recommended Practice cannot be accepted. The activities of duty-free shops are tolerated because they are based on the notion that the goods offered for sale are for export. The new definition is incompatible with this principle.

CHAPTER 8

8.19* Belgium no longer has a facilitation committee. However, ongoing co-ordination of facilitation matters is established among the various ministries, institutions and other bodies as well as with operators and airport and aircraft users.

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* Recommended Practice

CHAPTER 2

2.4 A General Declaration is required (simplified format).

2.20 The fees are payable at the Consulate which has jurisdiction over the last point of departure before entering the national territory.

2.34 Advance notification by the aeronautical authorities of the country of origin of the aircraft is required for issuance of the particular authorization.

2.35 Notification of the arrival of the aircraft must be at least 48 hours in advance.

CHAPTER 3

3.5.3* The initial period of validity of passports is one year.

3.5.4* Passports may be renewed at the end of the first year of issue and in each case the period of renewed validity is one year.

3.8.3 Entry visas for temporary visitors are valid initially for 30 days and may be renewed twice (total 90 days).

3.9* A simple Embarkation/Disembarkation Card is required in original form only for the Immigration authorities.

3.17 All baggage is inspected.

3.17.1 There is no dual channel system.

3.28 Visas are required except for holders of official passports. Bolivian nationals and foreign residents leaving the territory of Bolivia are required to obtain a permit from the Ministry of the Interior (Immigration), and all minors whether foreign residents or nationals, must submit an exit certificate, issued by the National Directorate of Minors (DIRME).

3.29* Visas are required except for holders of official passports. Bolivian nationals and foreign residents leaving the territory of Bolivia are required to obtain a permit from the Ministry of the Interior (Immigration), and all minors whether foreign residents or nationals, must submit an exit certificate, issued by the National Directorate of Minors (DIRME).

3.32 Tax clearance certificates are required of temporary visitors who stay in Bolivia for gainful purposes.

CHAPTER 4

4.13 Examination of goods and unaccompanied baggage is not required but such shipments are inspected by the trained dogs of the narcotics law enforcement authorities.

4.15 Goods and unaccompanied baggage which are being exported are only cleared in the local customs office. At present, the clearing of merchandise and unaccompanied baggage not exceeding U.S.$300.00 in value is being done at the customs offices of La Paz and Santa Cruz Airports.

* Recommended Practice

4.17 For duty-free imports, a Certificate of Value of the goods is required to be attached to the original purchase bills.

4.19* For duty-free imports, a Certificate of Value of the goods is required to be attached to the original purchase bills.

4.22 Import licences or permits are still required for certain articles.

4.23* Goods of a value not exceeding U.S.$300.00 only require the air waybill and the commercial invoice as clearance documents. The customs will make out an official import certificate for clearing the goods.

4.23.1* Only goods of small value under U.S.$300.00 are exempt from payment of import duties.

4.24 Goods of a value not exceeding U.S.$300.00 only require the air waybill and the commercial invoice as clearance documents. The customs will make out an official import certificate for clearing the goods.

4.25* Applicable in exceptional cases only.

4.28* Veterinary and phytosanitary controls are only required in the absence of the relevant health documents.

4.30 All imported goods are required to be examined, but this can be done by sampling if the goods are identical.

CHAPTER 6

6.6* When an airline wishes to provide its own services for ground handling operations or to have such operations performed entirely, or in part, by another airline, it must have the express approval of the airport administration (AASÁNA).

6.37.1* There is not sufficient space available at the passenger terminal for storage of baggage.

6.40* to 6.52* These Recommended Practices will be taken into account in the plans for new cargo terminals and/or extension of existing cargo terminals.

6.64* Not justified at the present time.

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* Recommended Practice

CHAPTER 2

2.4 A General Declaration is required.

2.4.2 A Passenger Manifest is required in respect of inbound and outbound passengers.

2.4.4 The General Declaration must be presented to both Immigration and Customs authorities.

2.5 The names of the crew members must be given under the heading "Total Number of Crew" or by annex.

2.6 A list of names of inbound and outbound passengers is required. This list can be in the form of an annex to the General Declaration.

2.6.1* A list of names of inbound and outbound passengers is required. This list can be in the form of an annex to the General Declaration.

2.7* A cargo manifest is required.

2.22 Contravention of any of the regulations may lead to prosecution.

CHAPTER 3

3.8.6* Re-entry visas are not required from resident aliens provided they are in possession of a valid residents permit.

3.9* Arrival/Departure Forms differing from Appendix 5 and including passport particulars must be completed by passengers.

3.10 Arrival/Departure Forms differing from Appendix 5 and including passport particulars must be completed by passengers. The Arrival Form requires the following information:

1) Name
2) Other Names
3) Date of Birth
4) Country of Issue
5) Passport Number
6) Flight Number
7) Amount of money brought into Botswana
8) Country of Birth
9) Nationality of Passport Holder
10) Address in Botswana
11) Purpose of Entry
12) Permanent Home Address
13) Length of Intended Stay in Botswana
14) Whether the passport holder has ever been refused entry to Botswana
15) Declaration and Signature

The Departure Form also has 15 requirements. Requirements 1-7 (inclusive) are the same as in the Arrival Form. The others are as follows:

* Recommended Practice

8) Are you leaving Botswana for
   a) less than 6 months
   b) between 6 months to 1 year
   c) more than one year
9) Country of Birth
10) Nationality of Passport Holder
11) Address in Botswana
12) Permanent Home Address
13) Length of Stay in Botswana
14) Approximate amount of money spent in Botswana
15) Declaration and Signature

3.15 Documents of passengers may, under certain circumstances, be inspected by more than one official.

3.16 The customs authorities would determine the manner in which the declaration of goods by passengers and crew should be made.

3.37.1 Certain penalties may be imposed for failure to remove a prohibited person.

CHAPTER 4

4.23* All goods must be declared for customs purposes on the prescribed form except those goods which, in the opinion of the Director of Customs, are of no commercial value.

4.23.1* All goods must be declared for customs purposes on the prescribed form except those goods which, in the opinion of the Director of Customs, are of no commercial value.

4.24 All goods must be declared for customs purposes on the prescribed form except those goods which, in the opinion of the Director of Customs, are of no commercial value.

4.53 Unaccompanied baggage is not allowed the same concessions as accompanied baggage.

CHAPTER 5

5.2 The Arrival/Departure Form is required from all inbound and outbound passengers except Botswana passport holders.

5.4 The Arrival/Departure Form is required from all inbound and outbound passengers except Botswana passport holders.

5.8* The Arrival/Departure Form is required from all inbound and outbound passengers except Botswana passport holders.

5.9* The Arrival/Departure Form is required from all inbound and outbound passengers except Botswana passport holders.

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* Recommended Practice

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CHAPTER 2

2.4 Although there is no requirement for the presentation of the General Declaration, the operator has to provide the number of crew members and passengers disembarking and in transit (on arrival) and the route of the onward journey, the number of crew members and passengers embarking and in transit (on departure). This information has to be submitted to the Federal Police and Sanitary Inspection Unit. In addition the pilot-in-command has to report any sickness observed during flight and details of procedure followed concerning the sickness, conditions on board as affected by the sickness in question and the process of disinfection the aircraft has undergone when travelling through States affected by infectious/contagious disease.

2.12 At the outbound dispatch the operator shall provide the Federal Police and the Sanitary Inspection Unit, in writing, at intermediate stop airports, in addition to the name of the airline, the flight number or registration of aircraft, also the route, number of crew members and passengers embarking and in transit.

2.15 Upon arrival of aircraft at international airports, the operator has to provide, in writing to the Federal Police and Sanitary Inspection Unit, the name of the airline, flight number or registration number of the aircraft, details of inbound route, number of crew members and passengers disembarking and in transit. Also, the pilot-in-command has to inform the Sanitary Inspection Unit of all details of medical/sanitary events of concern that occur on board the aircraft.

2.35 The arrival of the aircraft shall be notified at least 24 hours in advance to the administration of the international airport at which it will land upon entering Brazilian airspace.

2.42* The participation of more than one government department is required for clearance of small aircraft and their loads.

CHAPTER 3

3.8.3 The validity of any visa is 90 days as of the date of issuance, subject to one renewal by the Consular authorities on payment of the appropriate fee. Foreign holders of tourist visas who leave Brazilian territory may return without a new visa provided the return falls within the period of validity of their stay in Brazil as prescribed in the visa.

3.9* The control of embarkation and disembarkation will be performed through an entry and departure form which will be completed and delivered, in duplicate copies, to the Federal Police by the passengers and crew members.

3.10 The authorities require full completion of entry and departure forms, which differ from the model contained in Appendix 5 of Annex 9.

3.37.1 Operators may be fined if they transport into Brazil any foreigners whose documents are not in order.

CHAPTER 4

4.23* Customs clearance of imported goods are processed by declaration regardless of the established value or weight. The air waybill corresponds in all respects to a commercial invoice and the carrier must provide to the Federal Revenue Authorities at the unloading point, within 48 hours following the arrival of the aircraft, a cargo bill of lading which must follow the format approved by the Secretary of Federal Revenue.

CHAPTER 8

8.16 The pilot-in-command has to report any sickness observed during flight and details of procedure followed concerning sickness, conditions on board as affected by the sickness in question and the process of disinfection the aircraft has undergone when travelling through States affected by infectious/contagious disease.

* Recommended Practice

CHAPTER 2

2.6 The Passenger Manifest is required.

2.8.1* The nature of the goods must be indicated.

2.18* The documents must be in French.

2.42* The undertaking of the owner to export his/her aircraft at the end of the time period is required.

CHAPTER 3

3.5.3* The period of validity of the passport is 3 years.

3.8.1* Machine Readable Passports are not issued.

3.8.3 Visas are valid for 3 months.

3.8.6* Foreigners obliged to have visas must be in possession of a visa for re-entry.

3.10 The Embarkation/Disembarkation Card contains the following additional information:

— address in the country of disembarkation;
— reason for the journey;
— duration of the journey;
— number, date and place of issue of the passport;
— duration of the period of validity of the visa; and
— passenger's signature.

3.30* Presentation of baggage may be required.

CHAPTER 4

4.9* Presentation of individual documents is required.

4.42 Payment of taxes for services rendered may be required.

4.43* Payment of taxes for services rendered may be required.

4.44* Payment of taxes for services rendered may be required.

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* Recommended Practice

CHAPTER 2

2.6 A list of passengers' names including their place of boarding and place of destination is required for an aircraft which is admitted to air traffic in Burundi.

2.8 A manifest of detailed bills of lading is required for a cargo aircraft which is admitted to air traffic in Burundi.

2.34 The minimum periods required for advance notification of arrival are established as 2 days for transit non-stop flights, 8 days for flights stopping for non-traffic purposes, and 15 days for flights stopping for traffic purposes.

2.35 The minimum periods required for advance notification of arrival are established as 2 days for transit non-stop flights, 8 days for flights stopping for non-traffic purposes, and 15 days for flights stopping for traffic purposes.

CHAPTER 3

3.3 A foreign currency declaration is required on arrival.

3.5.1* Burundi does not issue machine readable passports.

3.5.3* Burundi issues regular passports with a period of validity of four years, and one year for service passports.

3.8 There is no charge for the issue of diplomatic or courtesy visas. The issue of an entrance visa is subject to a charge of US$20 or its equivalent in Burundi francs.

3.8.3 Entrance visas for visitors have a period of validity of not more than three months.

3.17 Inbound passengers' baggage is inspected on a systematic basis.

3.31 Outbound passengers' baggage is inspected by the airport security and customs departments.

CHAPTER 4

4.10 An export licence is required for customs clearance of export cargo.

4.30 Goods imported by air are inspected on a systematic basis when they are cleared through customs.

CHAPTER 6

6.10* Passengers and crew are not under shelter when proceeding between the air terminal and the aircraft.

6.54* Vaccinations, revaccinations and the delivery of the corresponding certificates are carried out at the health service in the city.

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* Recommended Practice

28/2/94

CHAPTER 2

2.8 Canadian customs' regulations require that all air carriers report cargo either on an IATA standard format air waybill or on the official national customs cargo control deocument.

2.8.1* This Recommended Practice suggests that States not require the completion of information concerning the nature of goods listed on the Cargo Manifest. The description of the nature of goods provided on this document is essential information which cannot be dispensed with.

2.40*, Note In order to arrange for the clearance of charters involving the arrival of a large number of passengers at small airports or at remote locations in Canada, customs officials require more than two days notice. (The notification period varies between 48 hours and 15 days depending on the country of origin for reporting to the National Transportation Agency. In addition, the requirements pertaining to advance notice for a Canadian originating flight vary between two working days and 45 calendar days.)

CHAPTER 3

3.8 Fees are normally payable by nationals of all countries, except those countries where no visitor visa is required, for processing the issuance of approved Canadian visitor's visas. No charge is levied for refused visas as no further processing is required.

3.8.2 Canada reserves the right to require visitor visa applicants to appear at a Canadian consulate before a visitor's visa will be issued.

3.8.3 Some travellers may be issued single entry visas valid for less than one year.

3.17.1 The system of optional channels which may be established in Canada will be different in certain respects from the one recommended in Appendix 6 to Annex 9. Nevertheless, the general principle and the ultimate purpose are the same.

3.19 If mishandled baggage includes baggage which was delivered to the owner and not reported to customs by the air carrier, national legislation in Canada provides for the assessment of penalties in such cases.

3.36 In Canada, the responsibility of carriers goes further than is implied in the Standards and Note. Section 88(1) of the Immigration Act requires, *inter alia*, that the airline shall have the custody and care of the person in question until such time as it is possible to place him on board the aircraft on which he is deemed to travel.

3.36.1 Section 52(2) of the Immigration Act requires, *inter alia*, that where a person is ordered removed from Canada, the person shall be removed to:

(a) the country from which that person came to Canada;
(b) the country in which that person last permanently resided before he came to Canada;
(c) the country of which that person is a national or citizen; or
(d) the country of that person's birth.

In some cases, it may be necessary to return a person found inadmissible to Canada to a country where the person was earlier found inadmissible.

* Recommended Practice

3.36.2 In Canada, the responsibility of carriers goes further than is implied in the Standards. Section 85(1) of the Immigration Act requires, *inter alia*, that where a person is ordered removed from Canada after his admission, the carrier which brought that person to Canada shall convey him or cause him to be conveyed from Canada, at the expense of the Canadian government when required to do so.

3.36.3 Unless there is an agreement respecting return fares between the operator and the person being conveyed, Section 88(2) of the Immigration Act prohibits the operator from recovering transportation costs from any person who is ordered removed from Canada, rejected from Canada or is allowed or required to leave Canada.

3.37 The obligation of the carrier goes further than is implied in the Standards. Section 89(1) of the Immigration Act requires transportation companies, *inter alia*, to ensure that passengers requiring travel documents are presented to an immigration officer at the Canadian port of entry in possession of required documents.

3.37.1 A fine can only be levied where a transportation company has been convicted of an offence in court. However, no person (company) can be found guilty of an offence if the person can establish that they exercised due diligence to prevent its commission.

Subject to the terms of any Memorandum of Understanding between a transportation company and the Immigration Department, a transportation company may be assessed an administration fee for bringing improperly documented passengers to Canada. The fee is assessed in order to recover a small portion of the costs required to process inadmissible passengers with no documents or improper documents. The fee can be reduced to zero if the transportation company meets certain performance standards to reduce the arrival of improperly documented passengers.

CHAPTER 4

4.9* When goods are being exported from Canada, the exporting carrier is required to present to customs a single copy of the air waybill for each shipment laden on board the aircraft. This document is to be supported by individual export declarations, export permits, etc. as required by national legislation. In the case of goods exported temporarily, there is a need in some instances for additional documentation other than a simple export declaration.

4.10 When goods are being exported from Canada, the exporting carrier is required to present to customs a single copy of the air waybill for each shipment laden on board the aircraft. This document is to be supported by individual export declarations, export permits, etc. as required by national legislation. In the case of goods exported temporarily, there is a need in some instances for additional documentation other than a simple export declaration.

4.14 The physical examination of goods referred to in this section cannot normally be carried out on a selective technique basis. Goods exported temporarily or those which are exported after having been temporarily imported must normally be examined on an individual basis.

4.18 When the value of commercial shipments does not exceed $500.00 a commercial invoice is acceptable. In all other instances properly completed customs invoices are required.

4.23* Gifts, not being advertising matter, tobacco or alcoholic beverages, may be admitted duty free and tax exempt under the provisions of the Customs Tariff and Excise Tax Act provided they are sent by persons abroad to residents of Canada when the value does not exceed twenty-five dollars in any one case. Travellers' samples of negligible value may be admitted without payment of customs charges when imported by residents or non-residents to solicit orders for similar goods to be supplied from abroad. Commercial samples may be temporarily imported free of duties and taxes provided they meet the requirements of national legislation. However, such samples must be documented on an ATA Carnet or on the appropriate national customs document.

* Recommended Practice

4.23.1* Imports of commercial samples referred to in 4.23, while exempt from customs duties and excise taxes, may be subject to the filing of security when imported on a temporary basis. Commercial samples remaining in Canada on a permanent basis are subject to the regular provisions of the Customs Tariff Act and the Excise Tax Act. However, samples of negligible value are, under national legislation, free of duties and taxes and other charges.

4.44* Machinery and equipment imported into Canada for use exclusively in servicing aircraft registered in a foreign country while at international airports in Canada are duty free provided the foreign country in which the aircraft is registered grants a similar privilege to aircraft registered in Canada. Sales tax is payable on the value of the equipment.

4.46* National legislation provides for the duty and tax free importation of airline documents referred to in this section provided that reciprocal privileges are extended to Canada.

4.47 National legislation does not allow urgently required goods to be imported or exported from Canada completely free of all documentation. However, Canadian Customs entry and release procedures do provide in the case of goods imported systems whereby goods can be entered with a minimum of documentation so long as fully completed entry documents are provided and any duties and taxes payable are paid within a prescribed period of time.

CHAPTER 5

5.4.1 Under Canadian Immigration Legislation, every person who intends to come to Canada or to transit through Canada shall be in possession of a valid visa, unless exempted by the Immigration Act or regulations.

5.8* The Canadian Immigration Act requires that any person requesting admission to Canada shall first appear before an immigration officer at a port of entry for examination as to whether he may be allowed to enter Canada. Passengers in transit from an international airport to another international airport must satisfy these requirements.

5.12* Canadian legislation does not provide for the establishment of free airports or free zones, but a warehouse procedure may be utilized as an alternative system. Under this procedure, imported goods may be stored in a customs bonded warehouse for subsequent re-exportation without payment of duties and taxes.

CHAPTER 6

6.69 Wherever possible, the Canadian Department of Transport will make accommodation available for authorized private agencies to provide monetary exchange facilities, but the Department will not itself provide such services.

CHAPTER 8

8.1* It was concluded after careful study that it is not practical to have a single bond cover an operator's liabilities for all government requirements.

8.4 There is provision in national legislation for the temporary importation of goods for a search or rescue operation. However, there is no provision which would allow duty or tax free entry of the articles mentioned for the accident investigation, repair or salvage aspects. The goods in this case would be subject to the provisions of the Customs Tariff and Excise Tax Acts.

8.7 The outward movement of the parts would pose no problem. However, on re-importation the parts would be subject to the regular provisions of the Customs Tariff and Excise Tax Acts if they are foreign goods.

* Recommended Practice

CHAPTER 2

2.4	The presentation of a General Declaration containing a list of crew members is required.
2.4.4	An international police stamp is required for the purpose of outbound or inbound clearance.
2.7*	The presentation of a cargo manifest following the ICAO format is required.
2.35	The information contained in the flight plan alone is not accepted. The pilot-in-command or the owner of the aircraft (or his legal agent) must report their entry into the country to the Directorate General of Civil Aviation at least 24 hours beforehand.

CHAPTER 3

3.5.1*	The implementation of this provision in the near future is being studied.
3.5.3*	This provision is complied with. Passports are now valid for 10 years.
3.7*	This Recommended Practice is complied with on a reciprocal basis.
3.8.3	As a general rule, tourists do not require a visa to enter the country. They may continue in that capacity for 90 days from the date of issue of their visas after which their visas may be renewed for another 90 days. This system operates on a basis of reciprocity.
3.8.4*	In special cases of force majeure, international police can even permit the entry of transit passengers who do not possess suitable documentation.
3.8.6*	Resident aliens, with the exception of officials or diplomats and those who have permanent resident status, are required to have a re-entry visa granted by the administrative authorities so that they do not lose their resident status. On their return, they should enter as holders of the permit that they held before.
3.9*	An Embarkation/Disembarkation Card, as well as a tourist card, are required.

CHAPTER 4

4.6	Not yet applicable to Chile.
4.8.1*	This provision is not applied.
4.9.1*	The United Nations Layout Key is not used.
4.17.1*	The United Nations Layout Key is not used. Very similar forms, however, are used depending on customs requirements.
4.23.1*	Trade samples are not subject to customs duties in Chile, provided that a certificate of non-use has been previously issued. Gifts are subject to full duties, but their clearance is expedited.

* Recommended Practice

CHAPTER 5

5.4.1 This Standard is complied with. The International Police Authorities stamp the tourist cards of transit passengers with a 24-hour permit. This period may be extended by the competent authorities.

5.11* In Chile there are no free airports as such, but the purposes of such airports are served in specially designated areas.

CHAPTER 6

6.4* The airline simply functions as collector of the boarding fee for the Directorate General of Civil Aviation, using stamps of a particular value.

6.5* The credit card system is not yet implemented.

6.37.1* Such facilities are not available in Chile.

6.46* There are no cargo terminals with storage facilities for special cargo.

CHAPTER 8

8.19* There is an Air Transport National Facilitation Commission in Chile which meets ICAO requirements. There are also Airport Committees governed by Basic and Operational Regulations established by the Directorate General of Civil Aviation.

* Recommended Practice

CHAPTER 1

Infected area. The Ministry of Public Health complies with the requirements relating to international notification (PAHO/WHO) concerning the existence on national territory of areas infected by transmissible diseases. Currently, our country has no etiological agents, vectors or hosts of the diseases referred to in the International Health Regulations, or of others which are the subject of epidemiological surveillance by WHO such as malaria, dengue fever, filariasis, trypanosomiasis, leishmaniasis, hemorrhagic fevers, etc.

Disinsecting. In this respect the Ministry of Public Health has regulations similar to those contained in the Annex (operation in which measures are taken to kill the insect vectors of human diseases in aircraft and containers, International Health Regulations).

Direct transit area. This area, in addition to affording accommodation to passengers, should serve to prevent the propagation of transmissible diseases, through epidemiological monitoring and the adoption of immediate health measures while passengers remain therein.

CHAPTER 2

2.4 The health authorities of the Ministry of Public Health of the Republic of Cuba shall continue to require the presentation of the General Declaration at airports serving international traffic, but not that of the Passenger Manifest.

2.4.1 The Ministry of Public Health of the Republic of Cuba shall continue to require that the General Declaration be signed in the health section by the purser or other crew member designated by the pilot-in-command.

2.4.3 The final part of this provision is not clear where it reads: "When the General Declaration itself has been signed by a non-crew member."

2.6 The Minister of Public Health of the Republic of Cuba shall not normally require the presentation of a Passenger Manifest. This document shall be required only in situations of epidemiological emergency in the countries of origin in order to carry out personal monitoring of the passengers.

2.23 Disinsection as a public health measure shall continue to be required of all aircraft whether of Cuban or non-Cuban registry. The technical regulations laid down by WHO for the application of insecticides shall be complied with, in conformity with the specifications in subparagraphs a), b) and c).

2.24* The public health authorities of the Ministry of Public Health of the Republic of Cuba shall accept, as proof that disinsection has been carried out, the procedure mentioned above in respect of the General Declaration. The foregoing does not preclude the health authorities from checking for the presence on board of manual equipment or other technical means of disinsection, which they shall do in epidemiological situations or for random checking of disinsecting procedures. In Note 2 to this paragraph concerning the "Certificate of Residual Disinsection", in our country this procedure is followed only on aircraft operated by Cubana de Aviación. No airline owning or leasing foreign aircraft has requested this type of antivectorial processing on aircraft arriving in Cuba.

2.27* Detection on board of live insects which are vectors of human disease after it has been declared that the aircraft has been disinsected entails immediate antivectorial processing by the national health authorities and the imposition of fines, in accordance with the health legislation in force.

2.28* In the usual practice of national airports serving international traffic, aircraft disinsection procedures are integrated and co-ordinated in such a way as to satisfy the requirements of the veterinary, phytosanitary and public health authorities, thus avoiding the separate and repeated performance of disinsection.

2.29* In the usual practice of national airports serving international traffic, aircraft disinsection procedures are integrated and co-ordinated in such a way as to satisfy the requirements of the veterinary, phytosanitary and public health authorities, thus avoiding the separate and repeated performance of disinsection.

* Recommended Practice

CHAPTER 3

3.4 This provision is complied with. It is not required in the case of special tourism, sailors having seafarers' identity documents, or aircrew having crew members' certificates.

3.4.1* It is not yet possible for our passports to be machine readable. They are guaranteed to contain those data which are necessary strictly to identify the bearer and attest to Cuban nationality.

3.5 Current passports are issued at the time of application, i.e. immediately.

3.5.2* Passports are applied for and obtained in territorial offices, at which the applicants present themselves in accordance with their domicile. These offices are located throughout the national territory.

3.5.3* Passports are valid for two years, renewable for an additional two-year period on two consecutive occasions, for a total of six years. Cuba is not in agreement with granting an initial validity of five years renewable once for a total of ten years, since this would necessitate changing the legislation in force.

3.5.4* Passport renewal is carried out immediately.

3.5.7* In practice joint passports are not issued to both spouses, but to one spouse and his/her minor children.

3.5.8* The passport is issued immediately irrespective of bearer's age.

3.6 This provision is complied with only when the passport is accompanied by the Embarkation/Disembarkation Card.

3.8.1* There are no provisions for the machine reading of visas.

3.8.2 This is complied with. Such visas are obtainable in not more than 7 working days, unless this time limit is shortened or extended by reciprocal agreement.

3.8.3 The issuance of entrance visas for visitors is authorized in Cuba at the request of a competent senior official. In other cases, visas are issued for one entry and if the bearer does not enter the country within the next 90 days, the visa requested loses its validity.

3.8.4* The immigration legislation in force, like all legislation, subordinates its requirements to reasons of *force majeure*, which would necessarily have to be exceptional.

This possibility should not be confused with indiscriminate practices and deliberate failure to comply with the above-mentioned legislation.

3.8.5 For the time being the entry of Cubans who have emigrated remains, for obvious reasons, subject to a permit from Immigration to enter Cuba. Those whose migration took place before 1.1.59, as well as those who reside abroad with a foreign residence permit (PRE), may enter whenever they desire and do not require a permit from Immigration.

3.8.7* Our current visa system includes the items shown.

3.9* Only the General Declaration is required. It contains the number of passengers in transit. The passengers must fill in the Embarkation/Disembarkation Card, unless they have visas or permits on a separate piece of paper or a tourist card.

3.10.1 Current legislation establishes the obligation of airlines to provide each passenger with an Embarkation/Disembarkation Card, in accordance with such instructions as may be made with regard to its contents.

3.11 The Ministry of Public Health does not require the Certificate of Vaccination or Revaccination against yellow fever and informs all countries of the world of this annually, through WHO.

3.12* Medical examination of persons arriving by air shall normally be limited to those coming from an area infected with one of the quarantinable diseases (plague, cholera and yellow fever) and having symptoms or clinical signs of these diseases. The remaining passengers having no clinical indications of these diseases and disembarking within the incubation period shall be subject to epidemiological monitoring until the end of that period, depending on the disease suspected.

* Recommended Practice

3.13 In Cuba the identity documents of passengers or crew are not collected, unless infractions are committed which are aimed at flouting clearance procedures and policies governing entry to the country.

3.23 All crew members are licence holders. Crew members' certificates are issued free of charge.

3.24 Flight crew members may identify themselves with their licences in lieu of passports, and with crew members' certificates in lieu of visas.

At the present time visas are not required of crew members from countries extending the same treatment to Cuban crew members.

3.26* There are no immigration limitations on the length of time ground and flight personnel may remain in Cuba to the extent that such personnel are necessary to perform supervisory and technical duties directly connected with the operation of the international air services being performed by such airlines.

3.27 The same as above (3.26) applies to 3.27, to technical personnel of foreign airlines, in the case of forced landings or damage which must be remedied before the flight can be continued.

3.28 Also, for obvious reasons, Cubans are required to have exit permits when travelling with a regular passport but not when carrying a diplomatic, service, official or seaman's passport.

Foreigners remaining more than 90 days in Cuba, other than guests of the Government, are required to have exit permits and therefore, when they remain less than 90 days like visitors, the entrance visa itself can be used for their departure.

CHAPTER 6

6.6* There is participation in ground handling operations, basically on the departure of aircraft. This function takes the form of a control procedure to prevent unauthorized persons from boarding.

It is agreed that there should be no participation in ground handling operations at disembarkation, although personnel should make sure that all passengers proceed to the locations established for immigration control.

6.27* We check on this constantly.

6.28* The immigration averages are less than one minute per passenger at all airports.

6.32* This is applied at the request of the airline.

6.33* Passengers in transit and crew members not entering the country are not cleared. Passengers are given a boarding pass which is taken from them when they board the aircraft. Crew members remain on the ground during the operations. They are only checked against the title page of the flight log and they are authorized to enter the terminal building to carry out work duties and even to make purchases in the shops.

6.35* Authorization is granted at the request of the airline.

6.53 The Ministry of Public Health of the Republic of Cuba, in co-ordination with the airport authorities, guarantees and will in future guarantee at Cuban airports serving international traffic, public health, personnel quarantine, vaccination and revaccination, adequate premises for the administration of public health measures, premises and exterior areas free from any danger of infection and insect vectors of diseases.

6.54* The Ministry of Public Health of the Republic of Cuba, in co-ordination with the airport authorities, guarantees and will in future guarantee at Cuban airports serving international traffic, public health, personnel quarantine, vaccination and revaccination, adequate premises for the administration of public health measures, premises and exterior areas free from any danger of infection and insect vectors of diseases.

6.55* The Ministry of Public Health of the Republic of Cuba, in co-ordination with the airport authorities, guarantees and will in future guarantee at Cuban airports serving international traffic, public health, personnel quarantine, vaccination and revaccination, adequate premises for the administration of public health measures, premises and exterior areas free from any danger of infection and insect vectors of diseases.

* Recommended Practice

28/2/94

6.56* The Ministry of Public Health of the Republic of Cuba, in co-ordination with the airport authorities, guarantees and will in future guarantee at Cuban airports serving international traffic, public health, personnel quarantine, vaccination and revaccination, adequate premises for the administration of public health measures, premises and exterior areas free from any danger of infection and insect vectors of diseases.

6.57* The Ministry of Public Health of the Republic of Cuba and other airport authorities have adopted the necessary measures to ensure that the procurement, preparation, handling, storage and service of food and water intended for human consumption both at airports and on aircraft are hygienically carried out and do not constitute a health hazard, in accordance with the recommendations and standards of the World Health Organization.

6.58* The Ministry of Public Health of the Republic of Cuba, in co-operation with airport authorities, will adopt the necessary measures to ensure that the disposal of excrement, refuse, waste water, food waste, unused food and other dangerous matter, produced on aircraft engaged in international traffic and in airport facilities, are hygienically carried out without constituting an epidemiological hazard, in accordance with WHO recommendations and standards.

6.59* The Ministry of Public Health of the Republic of Cuba maintains a qualified, organized and responsive staff at all times along with facilities for first aid attendance at the airport, and co-ordination procedures with selected hospitals for competent medical attention of the highest order have been established and tested.

6.62 The Ministry of Public Health of the Republic of Cuba provides immediate medical services free of charge to international passengers at every airport in the country and on a 24-hour basis.

6.62.1 The Ministry of Public Health of the Republic of Cuba provides immediate medical services free of charge to international passengers at every airport in the country and on a 24-hour basis.

Cuba does not require International Certificates of Vaccination and vaccinations are only administered to those passengers who expressly request them to satisfy a requirement to visit a third country. In such cases the vaccination is administered free of charge.

6.64* It is not the usual practice for States to station medical personnel at the airports of other countries to examine aircraft, passengers, crew, etc., prior to their departure for those States or countries. In fact, this has never been done. Taking into account public health development and experience in our country, the Ministry of Public Health of the Republic of Cuba, with regard both to medical assistance and to epidemiological control and with respect to public health in the Republic of Cuba, disapproves and is not in agreement with this recommendation.

CHAPTER 8

8.12 The Ministry of Public Health of the Republic of Cuba, as a representative of the Cuban State and an active member of WHO, complies with the provision of the International Health Regulations.

8.13* The Ministry of Public Health of the Republic of Cuba is in agreement that in cases where epidemiological conditions permit and it will result in reducing or eliminating the number of sanitary measures required, agreements be established with the health authorities of other States in conformity with the provisions of the International Health Regulations.

8.14 The Ministry of Public Health of the Republic of Cuba has established that International Certificate of Vaccination forms in compliance with the International Health Regulations be used officially at all International Vaccination Centres in the country.

8.15* Respecting the provision of health regulation notices to foreign international passengers bound for Cuba, the requirements referred to have been specified in this document.

8.16 Compliance with this Recommendation is incumbent upon the pilot-in-command or other authorized crew member to inform the health authorities of the State for which the aircraft is bound of the presence of illness, other than suspected airsickness, in order to facilitate provision for the presence of any special medical personnel and equipment necessary for medical assistance and health procedures on arrival.

* Recommended Practice

CHAPTER 2

2.4 The presentation of General Declaration is required by statute. The ICAO standard form is used.

2.4.4 Customs in Cyprus need the General Declaration as a reporting and clearance document and as such it is required to be stamped and signed for both inbound and outbound traffic.

2.7* The presentation of Cargo Manifest is required.

2.8.1* Information concerning the nature of goods is required in the Cargo Manifest.

CHAPTER 3

3.8.2 Applicants are required to make a personal appearance at the Cyprus Consulate.

3.8.3 Entry visas for visitors are normally made valid for a period of three months from the date of issue, regardless of the number of entries, on the understanding that the duration of each stay may be limited.

3.10 The format of the Embarkation/Disembarkation Card differs from the format set forth in Appendix 5 to Annex 9 in data and colour. The Arrival Card is white and the Departure Card is green.

3.25.2 Crew members arriving as passengers in order to join an aircraft are required to present their national passports.

CHAPTER 4

4.23.1* Unacceptable in principle, but certain articles are exempted.

4.44* The duty-free importation of airline tickets, shipping documents and luggage labels by airlines is provided for under the Customs and Excise Duties Law No. 18 of 1978. Aircraft stores, spare parts, lubricants and fuel are exempted from the payment of duty under the provisions of bilateral air services agreements between the Republic of Cyprus and the governments of various countries whose national airlines use the international airports of the Republic of Cyprus. Certain items may be subject to import duty.

4.46* The duty-free importation of airline tickets, shipping documents and luggage labels by airlines is provided for under the Customs and Excise Duties Law No. 18 of 1978. Aircraft stores, spare parts, lubricants and fuel are exempted from the payment of duty under the provisions of bilateral air services agreements between the Republic of Cyprus and the governments of various countries whose national airlines use the international airports of the Republic of Cyprus. Certain items may be subject to import duty.

4.53 As to the items covered in the note under this paragraph:

(i) acceptable only when the baggage is not shown on the aircraft Cargo Manifest;

(ii) acceptable only when the Customs Authorities are satisfied that these concessions were not granted to the passenger on arrival.

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* Recommended Practice

28/2/94

CHAPTER 2

2.38 An application for landing in the Republic is required to be filed at least 14 days in advance of the intended arrival of the aircraft.

2.40* The charter price is required in addition to the details required in this Recommended Practice. In instances where the charter is an inclusive fare charter, more details may be required.

2.42* Not applicable.

CHAPTER 3

3.5.6* Children over the age of fifteen years require a separate passport.

3.8.3 Entrance visas for visitors are usually issued to be valid for up to a period of three months from the date of issue. Visas are usually issued on a trip-by-trip basis and not on a multiple-entry basis.

3.8.6* Re-entry visas are required from resident aliens.

3.24 Implementation on the condition of reciprocity.

3.24.1 Implementation on the condition of reciprocity.

3.25 Implementation on the condition of reciprocity.

3.25.1* Implementation on the condition of reciprocity.

3.25.2 Implementation on the condition of reciprocity.

3.25.3* Implementation on the condition of reciprocity.

3.30* Presentation of baggage of passengers is required when they leave the Republic.

CHAPTER 4

4.23* Trade samples over the value of US$1 have to be accompanied by a commercial invoice (certificate of value).

4.23.1* Private consignments over the value of Czech CZK 3.000 (retail price) are subject to the levy of import duties.

4.28* Veterinary and plant consignments fall within the purview of the customs authorities.

CHAPTER 5

5.11* Neither free airports nor free zones have been established in the Czech Republic.

5.12* Neither free airports nor free zones have been established in the Czech Republic.

5.13 Warehousing facilities are provided only at international airports.

CHAPTER 6

6.64* Pre-clearance facilities are not provided in the Czech Republic to authorities of the other Contracting States.

6.71* Non-Czech citizens may import up to CZK 100 without a foreign exchange permit unless otherwise specified in a bilateral finance agreement between the Czech Republic and a Contracting State.

* Recommended Practice

CHAPTER 2

2.8 European Community legislation requires that the gross weight and nature of goods be declared.

2.8.1* European Community legislation requires that the gross weight and nature of goods be declared.

2.10 A written Customs Declaration which is a combination of the general declaration and a stores list is required. The declaration covers the stores remaining on board the aircraft.

CHAPTER 3

3.5.6* Children over the age of fifteen years require a separate passport.

3.8.1* Visas to Denmark are not issued in machine readable form.

3.8.2 Normally, applicants for entrance visas must make a personal appearance at a consulate.

3.8.3 Entry visas are normally issued for not more than three months on a trip-by-trip basis.

3.8.6* Re-entry visas are necessary for residents who do not possess a document proving their residence entitlement in Denmark (residence permit).

3.9* The Inter-Nordic passport control area comprising Denmark, Finland, Iceland, Norway and Sweden, requires visitors who hold entry visas to complete a special disembarkation card, which differs from the ICAO format. Others who do not require entry visas are not required to fill out disembarkation cards.

3.25.2 Visas are required from crew members who are nationals of States who otherwise are obliged to obtain visas.

3.25.3* Visas are required from crew members who are nationals of States who otherwise are obliged to obtain visas.

3.37.1 Any person who brings a foreign national into Denmark would be liable to pay a fine if the foreigner in question has no proof of identity and visa to enter Denmark. The negligence or absence thereof of the person who brings in the foreign national has no relevance (Danish Aliens Act).

3.39 Such information will definitely be provided in cases only where the authorities foresee any security problems during transportation.

CHAPTER 4

4.9* European Community recognizes unaccompanied baggage as freight which requires a transport letter.

4.19* European Community member States require separate documents.

4.44* Not all the equipment referred to is admitted under the exemption from customs duties and taxes.

4.45* Not all the equipment referred to is admitted under the exemption from customs duties and taxes.

* Recommended Practice

28/2/94

4.53 b) and c) Unaccompanied baggage is classified and regarded as freight and is physically handled in goods areas, which are different from those areas reserved for passenger baggage.

CHAPTER 5

5.2 Transit visas may be required from nationals of certain countries.

5.4 While transit visas may be required from nationals of certain countries, transfer cargo may require a document specifying in particular the identity of the packages, the aircraft and nature, gross weight and place of loading of the goods.

5.4.1 A transit visa is required prior to the arrival in the country from transit passengers obliged to possess a visa.

5.5 European Community customs law requires that goods brought into a customs territory of the Community shall be subject to customs supervision and may also be subject to checking by the customs authority concerned.

5.8* Passengers who transfer from one international airport to another cannot always be exempt from control.

CHAPTER 6

6.5* European Community customs laws state that duties and other taxes may be paid either in cash or by a guaranteed and certified bank cheque.

6.28* Although customs clearance is expedited and accomplished as soon as possible, there is no guarantee that clearance could be accomplished in the specified time.

6.39* Duty-free goods are sold for export and therefore duty-free shops have to be established at specified places.

6.51* Off-airport bonded warehouses (transit sheds) are allowed only where customs resources are available.

CHAPTER 8

8.19* There is no national air transport facilitation committee in Denmark. The co-ordination of facilitation activities between relevant departments, agencies, organizations, airports and airport operators is done by the Civil Aviation Administration.

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* Recommended Practice

CHAPTER 4

4.9* For the exportation of species or agriculture and livestock products, the International Conventions and the sanitary laws applicable to plants, animals, forests, natural areas and wildlife are observed.

4.9.1* The Ministry of Agriculture does not use the United Nations form for the clearance of cargo of the kind described in the foregoing paragraph.

4.17.1* The Ministry of Agriculture (MAG) requires presentation of the following documents:

— Central Bank import form — Commercial invoice.

— Import authorization from the Ministry of Agriculture and Livestock (MAG)

— Phytosanitary permit granted by the Ministry of Agriculture and Livestock (MAG).

— Phytosanitary certificate from the country of origin of the cargo.

— Air waybill.

— Certificate of payment of customs duties.

4.54 The Ministry of Agriculture and Livestock (MAG) requires the respective phytosanitary and veterinary certificates, prior to shipment of animals and plants.

* Recommended Practice

CHAPTER 2

2.4 The Arab Republic of Egypt requires the presentation of the General Declaration.

2.4.1 The Arab Republic of Egypt requires the presentation of the flight crew names, in addition to those items required in Appendix 1.

2.5 The Arab Republic of Egypt requires the presentation of the flight crew names.

2.6 The Arab Republic of Egypt requires the presentation of the passenger manifest which includes points and dates of embarkation and disembarkation.

2.8.1* The Arab Republic of Egypt requires the nature of goods and the States in which the goods were loaded to be indicated on the cargo manifest.

2.12 The Arab Republic of Egypt requires the authorized agent or pilot-in-command to deliver the following documents to the public authority concerned, before departure or on arrival, as the case may be:

5 copies of the General Declaration;
5 copies of the Passenger Manifest;
3 copies of a simple stores list; and
2 copies of the Cargo Manifest.

2.15 The Arab Republic of Egypt requires the authorized agent or pilot-in-command to deliver the following documents to the public authority concerned, before departure or on arrival, as the case may be:

5 copies of the General Declaration;
5 copies of the Passenger Manifest;
3 copies of a simple stores list; and
2 copies of the Cargo Manifest.

2.19 Handwritten block lettering must not be with indelible pencil.

2.34 Advance notice is required according to rules published in the A.I.P. of the Arab Republic of Egypt.

2.35 Advance notice is required according to rules published in the A.I.P. of the Arab Republic of Egypt.

2.36 Advance notice is required according to rules published in the A.I.P. of the Arab Republic of Egypt.

CHAPTER 3

3.12* If a person coming from a country that is infected with yellow fever does not hold the international certificate mentioned in 3.11, such person will be subject to a medical examination.

CHAPTER 6

6.5* This item is pending as it is being further scrutinized.

6.62 The Arab Republic of Egypt will charge vaccination fees as mentioned in the Egyptian Law NBR. 45/1955 as amended by Decree NBR. 103

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* Recommended Practice

CHAPTER 2

2.6 The Passenger Manifest remains as a requirement for immigration purposes.

2.38 Prior permission for such flights is required 15 days before the intended date of operation in case mail service is used and 7 days when telegram or telex is used.

CHAPTER 3

3.5.3* The initial period of validity of a passport is not more than one year.

3.8 Temporary visitors are required to pay for the issuance of an entry visa.

3.8.3 A temporary visa is valid for a month and upon request can be extended up to a period of two months.

3.10 The Embarkation/Disembarkation Card is a requirement for immigration purposes. Contents of the Embarkation/Disembarkation Card vary from the Annex format.

3.17 Baggage of passengers is subject to customs inspection.

3.17.1 No dual-channel baggage clearance system is installed.

3.25.2 No foreigner shall enter Ethiopia unless he/she is in possession of:

a) a valid passport;
b) a valid entry visa; and
c) an international health certificate.

3.28 Exit visas are required for nationals as well as for temporary visitors at the end of their stay.

3.31 Baggage of outgoing passengers is subject to inspection.

CHAPTER 4

4.13 Cargo and unaccompanied baggage are not exempted from physical examination.

4.24 Imported private gift package and trade samples not exceeding the value of Birr 75 are exempted from duty and other clearance formalities.

4.30 As long as each and every package of the cargo imported by air has uniformity, then their physical examination shall be accomplished on a sampling basis.

4.53 Unaccompanied baggage is treated as cargo. However, declaration formalities shall not be required for unaccompanied baggage not exceeding the weight of 60 kg.

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* Recommended Practice

28/2/94

CHAPTER 2

2.5	A full crew declaration is required in respect of crew who are not in transit on the same aircraft.
2.8	Additionally, weight of cargo in kilograms and details of point of unlading are required.
2.10	A written declaration of stores to be laden is required if the aircraft stops over for more than three hours.
2.13	A separate "NIL" manifest is required in addition to the General Declaration.
2.16	A separate "NIL" manifest is required in addition to the General Declaration.
2.23	Disinsecting of aircraft is carried out by national health authorities. Other methods are not acceptable. Direct entry into certain airports may be denied in respect of aircraft from notified areas.
2.35	More than 2 hours' notice may be required at certain airports.
2.39	On other than scheduled services or a technical refuelling stop, at least 14 days' notice of a commercial flight is required.

CHAPTER 3

3.8.3	Visas are only valid for use within 30 days of issue.
3.10	Items additional to that detailed in Appendix 5 are required.
3.16	A written declaration is required in respect of the crew.
3.24	A flight crew licence is accepted provided the crew concerned arrive/depart on the same aircraft as crew. Crew arriving as passengers and departing as crew or **vice versa** require a valid passport.
3.25	Crew not in possession of a valid licence require a passport.
3.25.2	Crew not in possession of a valid licence require a passport.

CHAPTER 4

4.5	No data-processing facilities are available at present. Requirements will be evaluated when such a system is introduced.
4.6	No data-processing facilities are available at present. Requirements will be evaluated when such a system is introduced.
4.8	No data-processing facilities are available at present. Requirements will be evaluated when such a system is introduced.
4.10	All cargo exported by air must be supported by a Customs Export Entry if over the following value: Commercial $50 Private $100 Unaccompanied Baggage $1 000
4.20	Inclusion of "Value of Customs Purposes" on the air waybill will facilitate clearance.
4.53	Unaccompanied baggage is treated as cargo and a written declaration is required for its clearance.

CHAPTER 3

3.9* Upon entering the Inter-Nordic passport control area (comprising Denmark, Finland, Iceland, Norway and Sweden) visitors holding entry visas are required to complete a special Disembarkation Card (control card) which differs slightly from the ICAO format.

3.10 Upon entering the Inter-Nordic passport control area (comprising Denmark, Finland, Iceland, Norway and Sweden) visitors holding entry visas are required to complete a special Disembarkation Card (control card) which differs slightly from the ICAO format.

CHAPTER 4

4.9* Export declaration is generally required in the case of cargo and unaccompanied baggage.

4.19* The choice between submitting separate documents and a combined document is not always given.

4.23* Documentary requirements do not depend on the value or weight of the consignment but rather on its nature.

4.23.1* The exemption from paying import duties does not depend on the value or weight of the consignment but rather on its nature. Relief from import duties is thus granted in respect of certain samples and certain gifts.

4.24 Customs declaration is not required only in respect of goods imported by private persons for non-commercial purposes.

CHAPTER 5

5.4.1 A transit visa is required to be obtained prior to arrival in Finland for passengers who are obliged to obtain such visa and who intend to leave the international airport area.

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* Recommended Practice

28/2/94

CHAPTER 2

2.8.1* European Community customs legislation requires an indication of the gross weight and nature of the goods on the documents submitted to the customs authorities of France.

CHAPTER 3

3.4 A visa is required as a form of identification in some instances.

3.5.8* Children under 16 years of age do not have to be issued with a separate passport.

3.8 Where a visa is required for purposes of identification of the passenger (as in 3.4 above) such a visa is not issued without charge.

CHAPTER 4

4.9* Unaccompanied baggage is shipped as cargo and as such, is required to be accompanied by an air waybill.

4.44* Not all equipment referred to in this Recommended Practice is admitted duty free.

4.45* Not all equipment referred to in this Recommended Practice is admitted duty free.

4.53 b) and c) Unaccompanied baggage is regarded as cargo and is physically directed to the areas provided for cargo.

CHAPTER 5

5.2 The French authorities, noting that the purpose of certain provisions of Chapter 5 of Annex 9 is being distorted by certain international air transport passengers, are compelled to require that nationals of certain States be in possession of a transit visa prior to their arrival in France. This measure is of a strictly conservatory nature.

The States, whose nationals are referred to in the previous paragraph, are at present Albania, Angola, Bangladesh, Ethiopia, Ghana, Haiti, Nigeria, Pakistan, Somalia, Sri Lanka and Zaire.

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The States, whose nationals are referred to in the previous paragraph, are at present Albania, Angola, Bangladesh, Ethiopia, Ghana, Haiti, Nigeria, Pakistan, Somalia, Sri Lanka and Zaire.

5.5 European Community customs legislation provides that goods introduced into a customs territory in the Community are subject to customs surveillance and may be checked by customs authorities.

5.8* It is not always possible for passengers transferring from one international airport or terminal to another international airport or terminal to be exempt from examination.

CHAPTER 6

6.5* Payment of duties and taxes has to be made either in cash or by guaranteed or certified bank cheque.

6.28* It is not possible for customs administration to undertake to clear all disembarking passengers from a flight within 45 minutes although customs clearance is carried out as expeditiously as possible.

6.39* Duty-free sales are conducted on the notion of exportation of goods and such duty-free shops have to be located at specific points.

6.51* Where airport capacity is limited, off-airport bonded warehouses are allowed only when customs resources are available.

* Recommended Practice

CHAPTER 2

2.8 European Community customs legislation requires that the weight (gross mass) and nature of goods must be indicated in the document presented.

2.8.1* European Community customs legislation requires that the weight (gross mass) and nature of goods must be indicated in the document presented.

2.35 All flight times relating to arrival and departure of all commercial flights at international airports of Germany as well as those that overfly German territory have to be notified, normally four to five months in advance. Non-commercial flights to Frankfurt airport have to abide by the same conditions.

CHAPTER 3

3.8 In principle, all visas for Germany are granted on the payment of a fee. This requirement may be waived or the fee reduced in special circumstances or in instances where Germany has entered into an agreement with other Contracting States.

3.8.3 The validity period of a visa for Germany is not fixed and may vary (for periods of more or less than 12 months) depending on the exigency.

3.8.7* Visas for Germany do not include the number of entries permitted.

3.10 There is no longer a requirement for an Embarkation/Disembarkation Card. However, stateless persons and persons who are citizens of countries that do not have diplomatic ties with Germany have to fill out a "registration form" upon entry and departure.

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3.24.1 Flight crew members of scheduled air services may have their crew member licences and crew member certificates recognized in lieu of passports.

3.25.1* Flight crew members of scheduled air services may have their crew member licences and crew member certificates recognized in lieu of passports.

3.25.2 Crew member licences and crew member certificates are accepted as travel documents only on scheduled air services. They are not accepted in relation to surface transportation or for any other form of travel in Germany.

3.25.3* Crew member licences and crew member certificates are accepted as travel documents only on scheduled air services. They are not accepted in relation to surface transportation or for any other form of travel in Germany.

3.37 German authorities reserve the right to impose punitive sanctions on operators (usually by fine) if German regulations in relation to this Standard are violated.

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3.37.2 German authorities reserve the right to impose puniutive sanctions on operators (usually by fine) if German regulations in relation to these Standard are violated.

* Recommended Practice

CHAPTER 4

4.9* Unaccompanied baggage is regarded as freight and requires the accompaniment of a transport letter.

4.19* The commercial invoice and any certificate of origin are required to be produced separately.

4.44* Not all equipment referred to in this Recommended Practice is admitted free of customs duties.

4.45* Not all equipment referred to in this Recommended Practice is admitted free of customs duties.

4.53 b) and c) Unaccompanied baggage, regarded as freight, is physically handled in areas which are different from those areas reserved for accompanied baggage.

CHAPTER 5

5.1 Only passengers and flight crew members who make more than one intermediate stop in the territory of Germany or leave the transit area of the airport or in the course of their transit journey are transferred to a neighbouring airport would undergo examination.

5.2 Only passengers and flight crew members who make more than one intermediate stop in the territory of Germany or leave the transit area of the airport or in the course of their transit journey are transferred to a neighbouring airport would undergo examination.

5.4 Customs may require a document including the identity of a package in transit, identity of the aircraft which brought it, the nature, gross mass (weight) and place of loading of the cargo.

5.4.1 Only passengers and flight crew members who make more than one intermediate stop in the territory of Germany or leave the transit area of the airport or in the course of their transit journey are transferred to a neighbouring airport would undergo examination.

5.5 European Community customs legislation requires that goods brought into the customs territory of the Community shall be subject to checking by the customs authority.

5.8* Only passengers and flight crew members who make more than one intermediate stop in the territory of Germany or leave the transit area of the airport or in the course of their transit journey are transferred to a neighbouring airport would undergo examination.

5.9* Only passengers and flight crew members who make more than one intermediate stop in the territory of Germany or leave the transit area of the airport or in the course of their transit journey are transferred to a neighbouring airport would undergo examination.

CHAPTER 6

6.5* European Community customs law states that duties and other taxes may be paid either in cash or by a guaranteed and certified bank cheque. There is no provision for payment by credit card.

6.28* While, in practice, customs clearance is given as soon as possible and in most cases within the time allowed by this measure, the customs administrations cannot accept the constraint stipulated in 6.28.

6.31.1 The German airport authorities may be unable to provide assistance during peak operational hours to passengers in order that they transfer their baggage on arrival to other modes of transport. The costs involved in ensuring this process would be unconscionable.

6.39* Duty-free goods are sold for export only and therefore duty-free shops have to be established at specified places.

6.51* When airport capacity is limited, off-airport bonded warehouses (transit sheds) are allowed only when the resources to carry out customs clearance procedures are available.

CHAPTER 8

8.19* Germany does not intend to establish any national or airport facilitation committees.

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* Recommended Practice

GHANA

CHAPTER 3

3.16 Written baggage declarations are required of returning residents.

3.31 All baggage of departing passengers is subject to search.

GREECE

CHAPTER 2

2.4 General Declaration is required to be presented, although the withdrawal of this requirement is being considered. In order to facilitate the operator's task, the General Declaration for scheduled and charter flights may be presented to the authorities after the arrival or departure of the flight, provided this is done on the same day.

2.4.1 The pilot-in-command's full name must be inserted in the appropriate section of the General Declaration.

2.5 The pilot-in-command's full name must be inserted in the appropriate section of the General Declaration.

2.6 A passenger manifest is not required for scheduled flights.

2.7* Cargo manifest is required.

2.8.1* Information concerning the nature of goods must be provided in the cargo manifest.

2.22 Penalties are imposed very seldom and only in special cases.

2.42* In special instances, commercial international flights are operated direct to domestic airports. Generally, Greek law requires that all aircraft that enter or depart from Greece do so at designated international airports.

CHAPTER 3

3.8.3 The validity of the entrance visas for visitors depends on the specific case for which such a visa is required.

3.8.4* Visas for re-entry are required only from resident aliens who are nationals of countries subject to the requirement of entrance visa, unless such persons have a permanent permit in their possession.

3.9* Embarkation/Disembarkation Card is required. However, the format of the card includes only four questions (i.e. name, date of birth, nationality and country of destination or permanent residence).

3.10 Embarkation/Disembarkation Card is required. However, the format of the card includes only four questions (i.e. name, date of birth, nationality and country of destination or permanent residence).

3.13.1 Only passengers who are subject to entrance visa requirements and who wish to make a stopover of up to 48 hours in Greece would have their passports withheld. Such passengers are provided with a special document (town visit card) which is exchanged for the passport on their departure.

3.15 Implemented, but an additional control (customs, health, currency, etc.) may be applied in some instances.

* Recommended Practice

28/2/94

3.24	This Standard is applied only to nationals of countries who reciprocate the courtesy to Greek nationals.
3.25.2	Crew members entering Greece by any means other than air transporation should hold a valid passport.
3.33	An airport tax is levied on all departing passengers and the carrier is responsible for the payment. Also, the carrier is authorized to collect this charge from the passengers.

CHAPTER 4

4.13	This Standard is implemented in practice, although such implementation is not provided for by legislation.
4.14	This Standard is implemented in practice, although such implementation is not provided for by legislation.
4.18	The commercial invoice is not considered the basic document for the accomplishment of customs formalities.
4.19*	Commercial invoice and certificate of origin are required in two separate forms.
4.23*	A simplified form is required.
4.30	This Standard is practically implemented although there is no covering legislation.
4.45*	Only some items specified are admitted duty free.

CHAPTER 5

5.11*	This Recommended Practice has not yet been implemented.
5.12*	This Recommended Practice has not yet been implemented.

CHAPTER 6

6.64*	There are no facilities in Greece.

CHAPTER 8

8.4	This Standard is implemented, although its implementation is not provided for by legislation.
8.5	This Standard is implemented, although its implementation is not provided for by legislation.
8.6	This Standard is implemented, although its implementation is not provided for by legislation.

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* Recommended Practice

CHAPTER 2

2.4 The presentation of the General Declaration is required.

2.4.2 The presentation of the General Declaration is required.

2.4.4 The General Declaration is required to be stamped by the immigration authorities for the purpose of clearance of outbound flights.

2.5 The names of the crew members in full with their nationality are required on the General Declaration.

2.6 The presentation of a passenger manifest is required. The format of a passenger manifest is different from that of Appendix 2.

2.6.1* See remarks in 2.4 and 2.6.

2.8.1* Information concerning the nature of goods in the cargo manifest is required.

2.23 Only the "blocks away" method of disinsection is acceptable.

2.34 Due to reasons of flight safety, permission of the Director General of Civil Aviation is required for such flights and for that purpose an application should be submitted at least 72 hours in advance.

2.35 Due to reasons of flight safety, permission of the Director General of Civil Aviation is required for such flights and for that purpose an application should be submitted at least 72 hours in advance.

2.38 A few more particulars are required to be given in the application, details of which can be seen in the facilitation component of the AIP-India.

CHAPTER 3

3.3 Passengers who have visited Yellow Fever Zone within the last 6 days may be required to produce a certificate of vaccination/revaccination.

3.8 Generally, a fee is charged for the grant of a visa.

3.8.3 Visas and transit visas are normally valid for single journeys unless otherwise specified. Tourists are granted visas, however, for three journeys valid for stays of 3 to 6 months duration in India.

3.8.6* Resident aliens require visas for re-entry.

3.10 Separate Embarkation/Disembarkation Cards are required. The formats of these cards differ from that of Appendix 5.

3.12* Persons arriving within 6 days of leaving a yellow fever infected area may be subjected to a medical examination.

3.16 The right to demand a written declaration under certain circumstances is reserved.

3.24.1 The privileges of temporary admission are extended to a flight crew member of an aircraft operated for remuneration or hire but which is not engaged in the operation of scheduled international air services, provided that the airline is also operating scheduled international air services to India.

* Recommended Practice

28/2/94

3.25.1* See remarks in 3.24.1.

3.25.3* See remarks in 3.24.1.

3.30* The presentation of baggage of departing passengers may be required for inspection by the customs authorities on a sampling and selective basis.

3.31 The presentation of baggage of departing passengers may be required for inspection by the customs authorities on a sampling and selective basis.

3.33 Operators are liable to be held responsible under Indian law.

CHAPTER 4

4.9* The waiver reflected in this provision cannot be agreed to.

4.13 Physical examination is carried out on a sampling and selective basis.

4.23* All imported air cargo is required to have governmental clearance documents.

4.23.1* Bona fide gifts up to Rs. 750/- sent by post and bona fide gifts sent by airfreight that are valued up to Rs. 200/- and trade samples which are valued up to Rs. 1 300/- are allowed to be imported free of duty. In other cases, customs duty will always be payable unless otherwise exempted.

4.25* Provisional clearance is permitted in limited cases only as per Section 18 of the Customs Act, 1962.

4.27 Besides appropriate narcotics control measures, there are also anti-smuggling measures applied.

4.44* The duty-free entry of ground equipment and security equipment is not permitted.

4.45* The material listed in the Note to this provision is liable to be subject to the payment of import duty except in the case of charts.

4.46* There is no duty-free admittance of airlines' documentation. Printed matter in book form, charts, maps, topographical plans and technical drawings, however, is exempted from being subject to the payment of duty.

4.51 Re-forwarding will be subject to examination on the merits of the case.

CHAPTER 5

5.2 Passengers would have to remain either in the aircraft or inside the direct transit area. The operator concerned would have to file the passenger manifest and the cargo manifest indicating all details of passengers and cargo in direct transit in a manner similar to the filing of details relating to disembarking passengers and unloaded cargo.

5.4 When traffic is transferred from one flight to another, the documents required by the customs authorities are to be furnished and such transfer is carried out under customs supervision.

CHAPTER 8

8.12 The provisions of International Health Regulations (1969) of the World Health Organization are complied with except to the extent of the reservations filed.

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* Recommended Practice

CHAPTER 2

2.4 General Declaration is required.

2.4.2 Passenger Manifest and General Declaration signed by the pilot-in-command, or authorized agent on behalf of the pilot-in-command, are required.

2.5 In addition to total number of crew, names and position of the crew are required.

2.6 Passenger Manifest is required.

2.8 Data-processing technique format is not acceptable yet. Cargo Manifest is required.

2.12 The following are required: five copies of the General Declaration; six copies of the Passenger Manifest; four copies of the Cargo Manifest; and two copies of a simple stores list.

2.14 Not acceptable.

2.15 The following are required: five copies of the General Declaration; six copies of the Passenger Manifest; and four copies of the Cargo Manifest.

2.19 Documents produced by electronic data-processing techniques are not acceptable.

2.34 Approval should be obtained 14 days in advance.

2.36 The designated agency is the Directorate General of Air Communications.

CHAPTER 3

3.4 Temporary visitors arriving in Indonesia are required to have a valid passport and visa. Visas are issued by the Indonesian Embassies or Consulates abroad. Separate passports are required for children under 16 years of age, unless accompanied by their parents. No document or visa is required for passengers arriving and departing in the same through-flight or transferring to another flight at the same airport.

3.8.2 Entrance visas for temporary visitors are valid for three months from the date of issuance with the understanding that the duration of each stay is subjected to the following conditions:

a) tourist visas may be extended at the local Immigration office for up to 45 days from the date of arrival;

b) visitor-visas (visas for business or social visits) may be extended at the local Immigration office for up to 6 months from the date of arrival;

c) citizens of the following countries holding national passports valid for at least three months are allowed to enter Indonesia without a tourist visa for a maximum stay of two months, provided that they enter and leave through: Polonia (Medan), Hang Nadim (Batam), Simpang Tiga (Pakanbaru), Tabing (Padang), Soekarno-Hatta (Jakarta), Ngurah Rai (Bali), Sam Ratulangi (Manado), Pattimura (Ambon), Frans Kaisiepo (Biak), Supadio (Pontianak), El tari (Kupang), Jayapura (Sentani), Tanjung Pinang (Kijang), Tarakan (Tarakan), Solo (Adi Sumarmo) and Merauke (Mopah).

Argentina, Australia, Austria, Belgium, Brazil, Brunei Darussalam, Canada, Chile, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Liechtenstein, Luxembourg, Malaysia, Malta, Morocco, Mexico, Netherlands, New Zealand, Norway, Philippines, Singapore, Republic of Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom, United States of America, Venezuela, Germany and Yugoslavia.

This facility may also apply to business visitors who are citizens of the countries mentioned above as long as their visits are for limited business purposes and not for employment, with or without remuneration.

d) foreign visitors attending a convention in Indonesia will be granted the same facilities as above, provided the convention has been approved by the Indonesian Government.

e) Entrance visas for Taiwanese citizens issued on the above basis are valid if their passports have been issued by the Taiwanese Ministry of Foreign Affairs and they enter Indonesia in Soekarno-Hatta, Ngurah Rai, Polonia or Sekupang (seaport).

3.10 Written supplementary information from temporary visitors shall be required according to the format set out by the Indonesian Government.

3.16 Written Customs Declaration is required.

3.22 Embarking or disembarking crew members who remain at the airport where the aircraft has stopped or within the confines of the cities adjacent thereto, and depart on the same aircraft or on the next regularly scheduled flight from Indonesia may use their crew member licence or certificate in lieu of a passport as long as the names and positions of such crew members are listed in the General Declaration. In all other instances, a valid passport and visa are required.

3.28 Only temporary visitors and Indonesian nationals residing abroad are exempted from obtaining exit permits if their stay does not exceed six months from the date of arrival.

CHAPTER 4

4.4* Not applicable.

4.7* Not applicable.

4.9* Customs Declaration is required.

CHAPTER 5

5.13 Not applicable.

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* Recommended Practice

CHAPTER 2

2.6	The Passenger Manifest is required (one copy only).
2.20	Documents shall be accepted with required fees.
2.31	Not practicable at present.
2.34	Twenty-four hours advance notice and reference to our NOTAM for availability of the airports is required.
2.36	"No objection certificate" is required from the concerned national carrier.

CHAPTER 3

3.5.3*	Iranian passports are valid for 5 years but exit clearance is required.
3.5.4*	Not acceptable.
3.5.5*	Not acceptable.
3.5.6*	Acceptable except when an Iranian child is accompanied by legal guardian.
3.7*	Not acceptable.
3.8.3	Not acceptable.
3.11	Certificate of cholera, yellow fever or smallpox is required.
3.16	Not acceptable.
3.24	Not acceptable.
3.30*	Presentation of departing passengers' baggage is required.
3.31	Not acceptable.
3.33	Acceptable except in special cases.

CHAPTER 4

4.9*	Presentation of documents for unaccompanied baggage is not necessary. In the case of commercial goods, however, their presentation is required.
4.13	Physical examination of air cargo as well as unaccompanied baggage is necessary.
4.15	Customs formalities are to be performed 24 hours before departure of aircraft.
4.21	Documents relating to the clearance of air cargo require charges and fees.
4.23*	Trade samples are not exempt from governmental clearance documents. Private gift packages, however, are exempt from governmental clearance formalities to that extent not considered as to gain benefit.
4.24	Acceptable only for simplification of customs documents and clearance of goods.
4.25*	Not acceptable.
4.26*	Not acceptable.
4.42	Except for the charges, other aspects of the Standard are accepted.
4.44*	Except for the maintenance platforms, steps and cargo weighing devices, the other items are acceptable on the basis of temporary admission.
4.49	Not acceptable at present.
4.50	Operator's declaration must include reasons as to why the cargo was not unladen. If these articles arrive afterwards in the same conditions under a separate air waybill or are unladen by mistake at another airport, they must be separated from the rest and the operator must present a certificate.

* Recommended Practice

CHAPTER 2

2.8 More information is needed on the cargo manifest as per European Community law.

2.8.1* Whether or not the freight manifest is used, European Community customs legislation requires the gross weight and the nature of goods to be stated on the documents presented to the customs.

CHAPTER 4

4.9* Unaccompanied baggage is consigned as freight and in that case under cover of a transport letter.

4.19* The documents specified have to be submitted separately.

4.44* Not all the equipment referred to in this Recommended Practice is admitted under exemption.

4.45* Not all the equipment referred to in this Recommended Practice is admitted under exemption.

4.53 b) and c) Unaccompanied baggage, regarded as freight, is physically handled in goods areas which are different from those areas reserved for passenger baggage.

CHAPTER 5

5.4 Visas may be required from transferring traffic.

5.5 Community customs law states that goods brought into the customs territory of the Community shall be subject to customs supervision and may also be subject to checking by the customs authority.

5.8* Passengers who transfer from one airport or terminal to another cannot always be exempted from control.

CHAPTER 6

6.5* Community customs law states that duties and other taxes may be paid either in cash or by a guaranteed or certified bank cheque.

6.28* While in practice customs clearance is conducted as soon as possible and in most cases within the time specified in this Recommended Practice, customs administration cannot accept such a constraint.

6.39* Duty-free sales are regarded as a fictitious exportation and as such the locations of duty-free shops have to be in specific places.

6.51* When airport capacity is limited, off-airport bonded warehouses are allowed only when customs resources are available.

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* Recommended Practice

CHAPTER 2

2.4	Presentation of a General Declaration is required.
2.5	Specification of the names of crew members is required.
2.7*	A detailed cargo manifest is required.

CHAPTER 3

3.7*	Entrance visas for temporary visitors are required except when such requirement is waived.
3.8	Visas are issued without charge on a reciprocal basis only.
3.8.3	The period of validity of a visa is determined solely by the appropriate authorities.
3.9*	In accordance with Article 26A of the International Sanitary Regulations, a temporary visitor could be required to provide the authorities with a destination address in writing.
3.10	In accordance with Article 26A of the International Sanitary Regulations, a temporary visitor could be required to provide the authorities with a destination address in writing.
3.29*	A crew member certificate is accepted only when the crew member is carried as such on the General Declaration.

CHAPTER 4

4.40	If imported stores are liable to be charged import duties, they remain the liability of the operator until taken out of Israel.
4.53	Unaccompanied baggage cannot receive the same treatment as accompanied baggage, if it is not collected by the passenger and cleared in the passenger customs hall at the international terminal building.

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* Recommended Practice

28/2/94

CHAPTER 2

2.4 The presentation of a General Declaration is required.

2.4.1 In the column in the General Declaration concerning crew, surname with initials and nationality should be entered.

2.4.4 As permission system exists for the departure of foreign trading aircraft, the customs authorities' permission stamp is affixed on the General Declaration which is required to be submitted on departure. In addition, the General Declaration should be signed or stamped by the pilot-in-command or by the authorized agent, since it should be one of the most reliable documents.

2.5 In the column in the General Declaration concerning crew, surname with initials and nationality should be entered.

2.6 The presentation of a Passenger Manifest is required for arriving aircraft.

2.7* Presentation of the Cargo Manifest is required at entry in order that the customs authorities can get necessary information on the cargo promptly and ensure its proper clearance.

2.8 Information with respect to loading and unloading is required to be included in the Cargo Manifest.

2.8.1* Completion of the column concerning the nature of goods in a Cargo Manifest is required for customs purposes.

2.8.2* Details of goods included in the Cargo Manifest are required to be as detailed and descriptive as possible.

2.12 Three copies of the General Declaration are required.

2.15 Presentation of the Passenger Manifest is required for the conduct of customs procedures such as inspection of baggage.

2.34 Written application for permission is required at least 10 days prior to the intended date of such flight, except when the flight follows only air routes.

2.38 Written application for permission is required at least 10 days prior to the intended date of such flight, except when the flight follows only air routes.

2.42* Not applicable.

CHAPTER 3

3.3 The authorities reserve the right to require any documents other than those provided for in Chapter 3 of Annex 9 in instances when a visitor to Japan applies for a stay of more than 90 days duration.

3.4 Expired passports, National Registration Cards, alien resident permits, etc., are not accepted in lieu of a valid passport. However, seafarers' identity documents are accepted in cases when the holders are to join ships in Japan.

* Recommended Practice

3.5.3* Two kinds of passports exist in Japan: one is for a single journey and the other for multiple journeys. In the passport for a single journey, necessary destinations are listed. It continues to be valid indefinitely as long as its bearer remains abroad and ceases to be valid upon the bearer's return to Japan.

The passport for multiple journeys is valid to all States except "Specific Areas" and the period of validity is five years from the date of its issuance.

3.5.4* Although no system for renewal of an expired passport exists, systems for replacement exist in Japan. The period of validity of a renewed passport is five years from the date of the issuance of the original passport.

3.8.3 A visa for a temporary visitor to Japan is normally valid for a single journey within six months.

3.8.4* Where a visitor is found not to possess a valid entry visa for Japan under any circumstances his case would be examined first and decided on merit.

3.8.6* In the case that resident aliens are granted permission for re-entry before departing from Japan, visas are not required.

3.8.7* i) In the Japanese visa, items are listed in a different order.

ii) The duration of validity of visa is normally shown in months or in days.

iii) The duration of the stay is not always included.

3.10 The Embarkation/Disembarkation Card in use in Japan differs in items and format from the Embarkation/Disembarkation Card as set out in Appendix 5.

3.10.2 There is a charge levied on airlines for the provision of the Embarkation/Disembarkation Cards.

3.17.1 Having not yet accepted the Recommendation of the Customs Co-operation Council of 1971, the Japanese administration is unable to adopt this Recommended Practice. However, the dual channel system has been tentatively implemented for Japanese passengers and resident aliens at the Tokyo and the Osaka International Airports since 1970.

3.25.2 A foreign crew member seeking entry into Japan as a transit passenger in order to join an aircraft located at an airport in any other State is required to possess a valid passport and visa, except in the case where permission for port-of-call landing is granted.

3.25.3* A foreign crew member seeking entry into Japan as a transit passenger in order to join an aircraft located at an airport in any other State is required to possess a valid passport and visa, except in the case where permission for port-of-call landing is granted.

3.35.2* The operator is responsible for the custody and care of passengers and crew until they are finally admitted for entry or found to be inadmissible.

3.36 An inadmissible person is transferred to a point outside Japan at the expense of the operator who brought him in.

3.36.1 Japan would not undertake to examine a deportee returned to Japan if he does not possess a valid passport even if he/she is alleged to have stayed in Japan prior to leaving for the country that deported him.

3.36.2 There may be cases where a carrier is obliged to transport an alien away, even after he has been admitted into Japan. Such cases may arise when the carrier is recognized to have brought him to Japan with full knowledge of the fact which constitutes grounds for his (or her) deportation.

3.38 The Japanese authorities are not empowered to seize fraudulent, falsified or counterfeit travel documents unless such documents are abandoned.

* Recommended Practice

3.40* It is practically impossible to inform authorities of other countries of deported persons owing to the large numbers of deportees Japan faces, unless such information is needed to be transmitted for security or other special reasons.

CHAPTER 4

4.13 Permission is required to export cargo and the customs authorities make inspection as necessary.

4.44* Not all the items listed in the Note are exempted from import duties and taxes. However, duty-free importation has been granted on and after 1 April 1974 for those types of equipment specially manufactured to prevent unlawful seizure of aircraft, such as detectors of firearms.

4.45* Except flight simulators and charts, the items listed in the Note are not exempt from customs duties.

4.46* Import duties and taxes are imposed on any document imported by airlines. Printed matter is, however, free of import duties and taxes.

4.47 There are no simplified customs clearance procedures which are applicable specially for the items specified in this Standard.

4.47.1* Customs clearance of aircraft equipment, spare parts, ground, training and security equipment requires the presentation of a regular importation/exportation declaration.

4.48 All normal customs clerarance procedures are required to be complied with in this instance.

4.51 No import or export licences are required for the temporary landing of goods. But in other cases, even where the goods stored in bonded areas (including those stored elsewhere) are exported in their original condition, the reshipment permit has to be acquired.

4.53 With respect to unaccompanied baggage, the presentation of a declaration as documentary evidence for duty-free admittance is required.

CHAPTER 5

5.8* When a passenger transfers from one international airport to another by means of a domestic flight or other domestic transportation, a passport, visa and Embarkation/Disembarkation Card are required.

5.9* When a passenger transfers from one international airport to another by means of a domestic flight or other domestic transportation, a passport, visa and Embarkation/Disembarkation Card are required.

CHAPTER 6

6.51* No imported plant is allowed to be transferred to a bonded warehouse away from the airport.

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* Recommended Practice

KUWAIT

CHAPTER 3

3.5.1* This Practice is not implemented in Kuwait.

3.40* This Practice is not implemented in Kuwait.

* Recommended Practice
28/2/94

MALAWI

CHAPTER 2

2.4 A General Declaration, a sample of which is in Annex 9, is still required. Due to customs regulations the General Declaration must be signed and stamped for both inbound and outbound traffic.

2.6.1* The Passenger Manifest is not needed. Instead, a teletype disembarkation list should be received before the aircraft arrives.

2.7* A cargo manifest is still required.

2.8.1* Information concerning the nature of goods on the cargo manifest is also a requirement.

2.34 Six days advance notification of the arrival of non-scheduled aircraft is required.

2.38 Six days advance notification of the arrival of non-scheduled aircraft is required.

2.39 Fees (Temporary Air Services Permit) may be imposed for such operation.

2.40* In addition, crew and passenger names are required. In the case of an overflight, the time of entry and exit and the routing should be included.

CHAPTER 3

3.17.1 The volume of passengers does not justify the adoption of a dual-channel baggage system.

CHAPTER 6

6.53 Neither animal nor plant quarantine services are available outside airport premises.

* Recommended Practice

28/2/94

MAURITIUS

CHAPTER 2

2.5 Names of crew members are required if they stay overnight.

2.8.1* Information on nature of goods required.

2.34 Seven working days prior notice is required for non-scheduled and private flights.

2.35 Seven working days prior notice is required for non-scheduled and private flights.

2.38 Seven working days prior notice is required for non-scheduled and private flights.

CHAPTER 3

3.8.3 Visas are made valid for twelve months on application.

3.8.6* Resident aliens require re-entry visas.

3.8.9* Requirement is for French or English only.

3.9* Embarkation/Disembarkation Card required.

3.10 Special Embarkation/Disembarkation Card is being introduced.

CHAPTER 4

4.23.1* Duty is payable on dutiable samples that are not re-exported.

CHAPTER 6

6.37.1* Storage facilities are not available.

6.54* Vaccination centre is available off-airport.

6.71* Passengers are allowed to import 700 Mauritian Rupees and export 350 Mauritian Rupees.

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* Recommended Practice

28/2/94

MEXICO

CHAPTER 2

2.6 Presentation of the passenger manifest is required since Mexico wishes to implement Recommended Practice 6.4 which recommends that when a passenger service charge is levied at an international airport in order to avoid facilitation problems such charge should be levied on airlines and not be collected directly from the passenger.

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CHAPTER 2

2.8.1* The gross weight and the nature of the goods must be indicated on the document that is submitted to the customs authorities.

CHAPTER 3

3.4 A visa is required as a form of identification in some instances.

3.5.8* Children under 16 years of age do not have to be issued with a separate passport.

3.8 Where a visa is required for purposes of identification of the passenger (as in 3.4 above), such a visa is not issued without charge.

CHAPTER 4

4.9* Unaccompanied baggage is shipped as cargo and, as such, is required to be accompanied by an air waybill.

4.44* Not all equipment referred to in this Recommended Practice is admitted duty-free.

4.45* Not all equipment referred to in this Recommended Practice is admitted duty-free.

4.53 b) & c) Unaccompanied baggage is regarded as cargo and is physically directed to the areas provided for cargo.

CHAPTER 5

5.5 Goods introduced into the customs territory of the Community are subject to customs surveillance and may be checked by customs authorities.

CHAPTER 6

6.5* Payment of duties and taxes has to be made either in cash or by guaranteed and certified bank cheque.

6.28* It is not possible for the customs administration to undertake to clear all disembarking passengers from a flight within 45 minutes, although customs clearance is carried out as expeditiously as possible.

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* Recommended Practice

28/2/94

CHAPTER 2

2.7* For the time being not acceptable. At the moment the Cargo Manifest is the basic document for customs and operator on the basis of which the clearance formalities are completed.

2.8 The gross weight of the goods has to be included in the documents presented to the customs authorities.

2.8.1* Under the present circumstances not yet acceptable. Completion of the "Nature of goods" column in the Cargo Manifest is essential for customs purposes.

CHAPTER 3

3.8 Issuing visas without a charge is not an obligatory practice in the Kingdom of the Netherlands.

3.8.2 The applicant for a visa may be called upon to appear personally before the issuing authorities.

3.8.3 The principle of making visas valid for more than one journey regardless of the number of entries is acceptable only on condition that it can be waived for reasons of public order, national security or the Kingdom of the Netherlands policy with regard to aliens.

3.18* The manner in which the passenger is cleared in future should take into account the implementation of international conventions.

3.24 Implementation on the condition of reciprocity.

3.24.1 Implementation on the condition of reciprocity.

3.25 Implementation on the condition of reciprocity.

3.25.1* Implementation on the condition of reciprocity.

3.25.2 Implementation on the condition of reciprocity.

3.25.3* Implementation on the condition of reciprocity.

3.40* The Kingdom of the Netherlands considers that informing the public authorities of transit and destination countries of a deportee from the Kingdom would be tantamount to extradition. As such, information of deportation is not transmitted to transit and destination countries.

CHAPTER 4

4.9* Unaccompanied baggage is consigned as freight and should be under cover of a transport document.

4.19* This Recommended Practice cannot be applied. The commercial invoice and the certificate of origin, in case the latter is required, have to be produced separately.

4.44* Duty-free admission cannot be granted for all the equipment concerned.

* Recommended Practice

4.45* Duty-free admission cannot be granted for all the equipment concerned.

4.53 b) and c) Unaccompanied baggage, which is regarded as freight, is physically handled in areas allocated for freight-handling.

CHAPTER 5

5.4 The customs authorities can, by means of a brief declaration, demand the production of a document in which, on the one hand, the identification of the goods and the aircraft, and on the other hand, the nature, the gross weight and the place of loading of the goods are mentioned.

5.5 Customs legislation requires that goods brought into the customs territory of the Kingdom of the Netherlands be subject to customs supervision and may be subject to checking by customs authorities.

5.8* Passengers who transfer from one international airport or terminal to another international airport or terminal would not always be exempt from control.

5.11* The Kingdom of the Netherlands is in favour of this Recommended Practice, but does not intend to establish "free airports", as the national customs legislation provides for extensive facilities for storage and handling of goods on and in the vicinity of airports.

This legislation offers more opportunities than a system of "free airports" would do whilst the supervision by the customs can more easily be carried out.

CHAPTER 6

6.5* Customs legislation requires that duties and other taxes be paid either in cash or by guaranteed and certified bank cheque.

6.28* While customs clearance is expedited as far as possible, customs administrators cannot undertake to clear all disembarking passengers of a flight within 45 minutes.

6.39* Duty-free sales are considered to be sales accomplishing the fictitious exportation of goods and as such, duty-free shops have to be established at specified points.

6.51* Off-airport bonded warehouses are allowed when airport capacity is limited and only where customs resources are available.

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* Recommended Practice

28/2/94

CHAPTER 2

2.23 Disinsection is required to encompass animal, plant and public health concerns.

CHAPTER 3

3.8.6* Visas for re-entry are required for resident aliens.

3.9* New Zealand requires entry and departure cards for all passengers entering and leaving New Zealand.

3.16 A written baggage declaration is required from passengers and crew.

3.25.2 Crew members travelling as passengers require passports.

3.25.3* Crew members travelling as passengers require passports.

3.37.1 Operators can be fined.

CHAPTER 4

4.31 Some cargo of interest to the Ministry of Agriculture and Fisheries requires quarantine clearance at the airport of arrival.

4.40 Not acceptable. Under New Zealand customs law, ownership of the goods may not be clearly established and may be subject to dispute between two or more parties concerned. In these circumstances a claim may then be made on the original importer.

4.44* Not acceptable. A number of concessions exist and there is provision for individual goods or types of goods to be given concessionary entry, each case being judged on its merits. No over-all concessions exist or are envisaged to cover broad groupings of items.

4.45* Not acceptable. A number of concessions exist and there is provision for individual goods or types of goods to be given concessionary entry, each case being judged on its merits. No over-all concessions exist or are envisaged to cover broad groupings of items.

4.49 Unacceptable to New Zealand. Duty and taxes will be levied on appropriate items.

4.53 Not acceptable. Unaccompanied baggage is treated as cargo and is not subject to any customs concessions.

CHAPTER 5

5.4.1 Those who do not otherwise qualify for visa-free entry are required to obtain visas (Immigration Act 1987).

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* Recommended Practice

CHAPTER 3

3.8 There is a fee charged for the issuance of a visa for Norway.

3.8.3 Entrance visas for temporary visitors are normally issued for one trip only and each stay limited to three months.

3.9* Upon entering the Inter-Nordic passport control area, comprising Denmark, Finland, Iceland, Norway and Sweden, temporary visitors holding entrance visas are, irrespective of means of transportation, required to complete a special Embarkation/Disembarkation Card which differs slightly from the ICAO format. (For the vast majority of travellers, visas and consequently Embarkation/Disembarkation Cards are not required.)

3.10 Upon entering the Inter-Nordic passport control area, comprising Denmark, Finland, Iceland, Norway and Sweden, temporary visitors holding entrance visas are, irrespective of means of transportation, required to complete a special Embarkation/Disembarkation Card which differs slightly from the ICAO format. (For the vast majority of travellers, visas and consequently Embarkation/Disembarkation Cards are not required.)

3.10.1 Upon entering the Inter-Nordic passport control area, comprising Denmark, Finland, Iceland, Norway and Sweden, temporary visitors holding entrance visas are, irrespective of means of transportation, required to complete a special Embarkation/Disembarkation Card which differs slightly from the ICAO format. (For the vast majority of travellers, visas and consequently Embarkation/Disembarkation Cards are not required.)

3.24 Visa is required from crew members being nationals of States who otherwise are obliged to obtain visa.

CHAPTER 4

4.9* Export declaration is generally required.

4.19* The choice between separate documents and a combined document is not left to the trader's option.

4.23* The requirement to submit documents does not depend upon the value or weight of a consignment but upon its nature. No customs declaration is thus required in respect of goods imported by private persons for non-commercial purposes.

4.23.1* The exemption from import duties does not depend on the value or weight of the consignments, but on their nature. Relief from import duty payment is thus granted in respect of certain samples and gifts.

4.24 The requirement to submit documents does not depend upon the value or weight of a consignment but upon its nature. No customs declaration is thus required in respect of goods imported by private persons for non-commercial purposes.

CHAPTER 5

5.4.1 Passengers who are obliged to hold an entry visa for Norway would obtain permission to stay in transit without a visa only if they continue their journey on the same day and remain in the transit area of the airport until they leave Norway.

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* Recommended Practice

28/2/94

CHAPTER 2

2.4 The General Declaration is required on arrival and departure.

2.6 A Passenger Manifest is required on the arrival and departure of aircraft.

2.12 The authorized agent or pilot-in-command is required to deliver to the public authorities concerned:

a) Three copies of the General Declaration.

b) Three copies of the Cargo Manifest, listing and describing the cargo according to points of unlading.

2.34 Notice must be given at least 24 hours in advance of the arrival or the intended overflight of the aircraft.

2.38 Special permission may be given, provided application for such permission is filed at least 72 hours before the intended arrival of the aircraft.

CHAPTER 3

3.5.2* Presentation of a certificate of good conduct is desirable.

3.6 This Standard is implemented in the case of nationals of those countries with which Panama has concluded special agreements. Nationals of other countries are required to present a tourist or transit card or to have obtained a visa.

3.8 In cases where a visa is required, the visa charge is payable except where there are agreements providing for exemption from such payment.

3.8.3 The length of validity of the visa is 90 days from the date of issue. A visitor who has not entered Panamanian territory before expiry of that period must obtain a new visa.

3.8.6* Foreign residents must obtain a return permit which must be countersigned at a Panamanian consulate. Residents who are United States nationals and holders of multiple re-entry visas are exempt from this requirement.

3.9* The Embarkation/Disembarkation Card is required of all passengers without exception.

3.10 The passport number, place of issue of the passport, purpose of visit and length of stay in Panama are also required.

3.17 All baggage is subject to inspection.

3.36 Operators are penalized whenever they are shown to have neglected taking precautions with regard to control documentation. In some cases, passengers are sent back to their place of origin; depending on their economic solvency, they are permitted to enter.

* Recommended Practice

CHAPTER 4

4.12 Export Licences are only required for silver, gold, platinum and bananas. Licences are also required for the export of other goods when, in the opinion of the Executive Body, they are necessary in order to implement any prohibition to export or re-export specific goods.

4.18 The commercial invoice, the consular invoice, the bill of lading, the special permit in cases of restricted importation and, in some cases, the certificate of origin are required for imported goods.

4.19* Where appropriate, separate documents are required.

4.21 Consular formalities (duly attested commercial invoice) and consular fees are required except for goods dispatched by mail.

4.22 Licences are required and the procedures are those laid down in national legislation.

4.23* It is recommended that goods of this kind be sent into the country by mail, and consequently they are exempt from consular formalities and export permits.

4.24 All goods require customs clearance formalities, with the exception of those sent by mail.

4.28* In these cases, inspection by all control services is required.

4.30 All imported goods are subject to inspection.

4.33 It will be subject to inspection if so required by customs and the documentation governing this type of operation will be required.

4.34* Goods in transit are inspected in the airport cargo area. Large pallets and containers are examined at the place of final destination.

4.46* Some airline documents (forms) are subject to formalities and payment of customs duties.

CHAPTER 5

5.4.1 These passengers must obtain a "passenger-in-transit card" which is issued at the airport.

5.12* A free zone has been established at Tocumen International Airport.

CHAPTER 6

6.22* Electronic devices are used to inspect passengers' baggage.

6.59* The medical service at Tocumen Airport is open twenty-four (24) hours a day.

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* Recommended Practice

28/2/94

CHAPTER 2

2.4 The use of a document entitled Traffic Form (Formulario de Trafego) has made it possible to eliminate the following documents: General Declaration, Passenger Manifest and Customs Clearance for entry and exit of goods, permit to load and unload cargo and customs entry declaration.

2.7* Presentation of the Cargo Manifest is required.

2.8 The gross weight of the consignment has also be be indicated.

CHAPTER 3

3.5.1* Machine readable passports are not being used in Portugal, although there are plans to introduce them in the near future.

3.8 There is a charge imposed on all visas except on courtesy visas.

3.9* Embarkation/Disembarkation Card is required except for EEC citizens.

3.10 The Embarkation/Disembarkation Card of Portugal does not have the items "Place of Birth", "Occupation" and "Permanent address" as are found in Appendix 5 of Annex 9. Also, there is provision for obtaining the signature of the passenger in the card of Portugal which has not been made in Appendix 5 to Annex 9.

CHAPTER 4

4.9* Unaccompanied baggage is shipped as cargo and as such is accompanied by an air waybill.

4.19* The commercial invoice and the certificate of origin are required separately.

4.53 b) and c) Unaccompanied baggage is regarded as cargo and is physicially directed to areas provided for cargo.

CHAPTER 5

5.4 The identity of the aircraft involved, the nature and identity of the consignment (packages), the gross weight and the place of lading of the goods may be required to be included in a document to be presented as a summary declaration of goods to the customs authorities.

5.5 Goods introduced into a Portuguese custom territory are subject to customs surveillance and may be checked by customs authorities.

CHAPTER 6

6.5* Payment of duties and taxes may be made either in cash or by guaranteed and certified bank cheque. The use of credit cards as a means of payment is not provided for.

6.28* While customs clearance is carried out as expeditiously as possible, it is not possible to undertake to impose a time limit on the clearance of passengers.

6.39* Duty-free sales are carried out on the basis that such are exports. Therefore, duty-free sales shops have to be located at specific spots.

6.51* When airport capacity is limited, off-airport bonded warehouses are allowed only when customs resources are available.

* Recommended Practice

CHAPTER 2

2.4 The requirement is for presenting a General Declaration.

2.5 The General Declaration shall state the surnames of the crew members.

2.7* A Cargo Manifest is required.

2.8.1* The Cargo Manifest shall specify the kind of cargo.

2.34 A preliminary permit is required for operating such flights in accordance with the procedures set forth in AIP Russian Federation.

2.35 A preliminary permit is required for operating such flights in accordance with the procedures set forth in AIP Russian Federation.

2.36 A preliminary permit is required for operating such flights in accordance with the procedures set forth in AIP Russian Federation.

2.38 A preliminary permit is required for operating such flights in accordance with the procedures set forth in AIP Russian Federation.

2.39 A preliminary permit is required for operating such flights in accordance with the procedures set forth in AIP Russian Federation.

2.40* A preliminary permit is required for operating such flights in accordance with the procedures set forth in AIP Russian Federation.

2.42* Not applicable.

CHAPTER 3

3.7* The requirement is for delivering a valid document providing evidence of the right to arrive in or depart from the Russian Federation.

3.16 Passengers crossing the Russian Federation State border whose cabin-carried articles and baggage are subject to customs clearance shall fill in a customs declaration. All crew members may be cleared on the basis of oral declaration.

3.24 The crew members of foreign airlines arriving in the Russian Federation shall be in possession of valid national passports with Russian visas, unless bilateral agreements stipulate otherwise.

3.24.1 The crew members of foreign airlines arriving in the Russian Federation shall be in possession of valid national passports with Russian visas, unless bilateral agreements stipulate otherwise.

3.25 The crew members of foreign airlines arriving in the Russian Federation shall be in possession of valid national passports with Russian visas, unless bilateral agreements stipulate otherwise.

* Recommended Practice

3.25.1* The crew members of foreign airlines arriving in the Russian Federation shall be in possession of valid national passports with Russian visas, unless bilateral agreements stipulate otherwise.

3.25.2 The crew members of foreign airlines arriving in the Russian Federation shall be in possession of valid national passports with Russian visas, unless bilateral agreements stipulate otherwise.

3.25.3* The crew members of foreign airlines arriving in the Russian Federation shall be in possession of valid national passports with Russian visas, unless bilateral agreements stipulate otherwise.

3.28 Not applicable.

CHAPTER 5

5.4.1 Transit passengers without a transit visa may stay in the airport transit area or in a hotel for foreign transit passengers for a period of 24 hours.

5.11* There are no free airports, zones or storages in the Russian Federation.

5.12* There are no free airports, zones or storages in the Russian Federation.

5.13 There are no free airports, zones or storages in the Russian Federation.

CHAPTER 6

6.64* Activity in the territory of the Russian Federation by representatives of appropriate bodies of other States is not provided for.

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* Recommended Practice

CHAPTER 2

2.4 The General Declaration is required.

2.6 The Passenger Manifest, with an indication of origin and destination, is required.

2.7* The Cargo Manifest and a detailed statement of the goods carried are required.

2.8 The Cargo Manifest and a detailed statement of the goods carried are required.

2.12 More than two copies of the General Declaration, the Cargo Manifest and the List of Stores are required.

2.15 More than two copies of the General Declaration, the Cargo Manifest and the List of Stores are required.

2.40* In addition to the information listed in 2.40, the following information is required:

— call sign of the aircraft
— name of the aircraft commander
— other crew members (names and/or number)
— coordinates of the Rwandan border-crossing points

CHAPTER 3

3.8 There are five types of visas:

— transit visa
— travel visa (8 days to 6 months)
— temporary visa (6 months to 2 years)
— residence visa (indefinite duration)
— diplomatic visa (free of charge)

3.9* Two cards are used:

— Embarkation Card (pink)
— Disembarkation Card (blue)

3.30* Baggage is regularly inspected upon departure.

CHAPTER 4

4.17 An air waybill is required.

CHAPTER 5

5.12* Kigali/Gregoire Kayibanda International Airport has no free zone.

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* Recommended Practice

28/2/94

CHAPTER 2

2.6 The passenger manifest is required.

2.11 A list of the number of pieces of accompanied baggage is required.

2.17 No extra documentation is required only when the aircraft is cleared at one of the airports.

2.23 Disinsecting of an aircraft on a through flight is not required. Aircraft leaving an area infected with yellow fever or Aedes Aegypti for an area receptive to these diseases or where these diseases have been eradicated require disinsection.

2.34 All non-scheduled flights must apply for and obtain permission to land in or overfly Saudi Arabia before departure from the point preceding the port of entry into Saudi Arabian territory.

2.35 Reasons for non-scheduled flights must be given in the application.

2.41* All aircraft, when entering or departing from Saudi Arabia, have to do so at international airports.

CHAPTER 3

3.6 Tourist cards and visas are not given at airports of entry. Both must be obtained before arrival in Saudi Arabia.

3.7* Entry visas are required for all visitors to the Kingdom.

3.9* Supplementary information such as proof of religion is required in addition to the information given in the passenger's identity documents.

3.10 Saudi Arabian Embarkation/Disembarkation Cards do not conform to the format in Appendix 5 of Annex 9.

3.24 Crew licences are not acceptable in lieu of passports and visas.

3.37.1 Operators are liable to pay a fine if documents of passengers they bring into the Kingdom are inadequate or unacceptable or if passengers are inadmissible on other grounds.

CHAPTER 4

4.9* A cargo manifest or certified copy of the manifest is required for the clearance of export cargo.

4.21 Consular charges are levied in connexion with documents for the clearance of air cargo.

4.32 Customs duties and other taxes are waived on containers, pallets and associated equipment brought into the Kingdom on a reciprocal basis.

4.44* There is duty payable on the items included in this Recommended Practice.

* Recommended Practice

CHAPTER 5

5.8* Passengers who transfer from one international airport to another are not exempt from control and all landing and embarkation documents are required to be presented at the transfer.

5.11* Free airports and free zones to not exist in Saudi Arabia.

5.12* Free airports and free zones to not exist in Saudi Arabia.

CHAPTER 6

6.10* The contents of this Recommended Practice have not been implemented.

6.64* There is no pre-clearance facility accorded to other Contracting States in Saudi Arabia in keeping with its immigration requirements.

CHAPTER 7

7.3.3 It must be ensured that all required and relevant documentation has been cleared before take-off.

CHAPTER 8

8.12 Special sanitary regulations are in force in Saudi Arabia.

8.15* No advance information regarding vaccination requirements or the availability of documentation in relation to vaccination is available prior to departure and it is the responsibility of the handling agencies concerned to inform passengers prior to departure.

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* Recommended Practice

28/2/94

CHAPTER 2

2.4 The presentation of a stamped General Declaration is required.

2.7* The presentation of a cargo manifest is required.

2.8.1* Information concerning the nature of goods is required.

2.23 All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

2.24* All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

2.25 All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

2.26* All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

2.27* All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

2.28* All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

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2.31 All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

2.32 All aircraft arriving at Seychelles International Airport are required to have been disinsected on chocks at the last point of departure. Failure to satisfy the Health Authorities that disinsection has been "properly performed" will require the aircraft to be disinsected prior to disembarkation of passengers.

2.33 Permission for non-traffic stops for non-scheduled flights must be obtained from the Director General of Civil Aviation at least 3 working days in advance of the planned flight. (See AIP FAL 0-1/1-2.)

* Recommended Practice

2.34 Permission for non-traffic stops for non-scheduled flights must be obtained from the Director General of Civil Aviation at least 3 working days in advance of the planned flight. (See AIP FAL 0-1/1-2.)

2.35 Permission for non-traffic stops for non-scheduled flights must be obtained from the Director General of Civil Aviation at least 3 working days in advance of the planned flight. (See AIP FAL 0-1/1-2.)

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2.37* Permission for non-traffic stops for non-scheduled flights must be obtained from the Director General of Civil Aviation at least 3 working days in advance of the planned flight. (See AIP FAL 0-1/1-2.)

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2.40* Permission for non-traffic stops for non-scheduled flights must be obtained from the Director General of Civil Aviation at least 3 working days in advance of the planned flight. (See AIP FAL 0-1/1-2.)

CHAPTER 3

3.9* Embarkation/Disembarkation cards are required to be completed. E/D cards do not conform to that laid out in Appendix 5 of Annex 9. Certain additional information is required to be provided by passengers. It is the responsibility of the carrier to issue disembarkation cards to the passengers.

3.10 Embarkation/Disembarkation cards are required to be completed. E/D cards do not conform to that laid out in Appendix 5 of Annex 9. Certain additional information is required to be provided by passengers. It is the responsibility of the carrier to issue disembarkation cards to the passengers.

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3.16 A written declaration is required if crew leaves the airport.

3.17 Although Red and Green channels exist, the Government reserves the right to search all arriving passengers' baggage.

3.17.1 Although Red and Green channels exist, the Government reserves the right to search all arriving passengers' baggage.

* Recommended Practice

CHAPTER 4

4.9* An export entry is required for the exportation of cargo.

4.9.1* An export entry is required for the exportation of cargo.

4.53 Unaccompanied baggage is treated as cargo for the purpose of clearance through customs controls.

CHAPTER 5

5.4 Disembarking passengers, being transferred from one international flight to another at Seychelles International Airport, must pass through immigration controls, except in special circumstances.

5.11* Free Zones are not considered necessary or feasible at present.

5.12* Free Zones are not considered necessary or feasible at present.

5.13 Free Zones are not considered necessary or feasible at present.

CHAPTER 6

6.10* At present, passengers and crew have to proceed across the open apron between the terminal building and the aircraft and vice versa.

6.33* No facilities are provided for passengers not connecting immediately with another aircraft. Passengers are therefore required to pass through Immigration and Customs Controls.

6.35* Transit passengers await connections in the departure lounge.

6.59* No nursing or paramedical staff are available at the airport. First aid is provided until medical help arrives. Ambulance and nursing/medical personnel are made available when prior notice of a requirement is given.

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* Recommended Practice 28/2/94

SINGAPORE

CHAPTER 3

3.10 Supplementary information and information required in Embarkation/ Disembarkation Cards are not all similar to those required in Appendix 5 of Annex 9.

CHAPTER 6

6.62 A fee for yellow fever vaccination is levied since this service is provided by a private clinic at Changi Airport.

28/2/94

CHAPTER 2

2.6 Presentation of a Passenger Manifest is not required. The operator is obliged to disclose passenger information to the Customs Authorities.

2.8.1* Recommended Practice 2.8.2 is applied in the Slovak Republic.

2.40* The price of the charter flight is required. If the flight is organized in conjunction with an "inclusive Tour", more details are required (See FAL 1. paragraph 1.3.2.3 in A.I.P).

2.42* Not applied.

CHAPTER 3

3.8.3 Entry visas for aliens, if required, usually only entitle one entry during the three months from the date of issue, except in special circumstances.

3.8.6* New entry visas for re-entry from resident aliens are required.

3.8.9* At present the text of the Slovak visa is in the national language only.

3.24 In accordance with Regulations valid in the Slovak Republic, flight members' licences and crew members' certificates are not accepted as travel documents or an entrance visa.

3.24.1 In accordance with Regulations valid in the Slovak Republic, flight members' licences and crew members' certificates are not accepted as travel documents or an entrance visa.

3.25 In accordance with Regulations valid in the Slovak Republic, flight members' licences and crew members' certificates are not accepted as travel documents or an entrance visa.

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3.25.2 In accordance with Regulations valid in the Slovak Republic, flight members' licences and crew members' certificates are not accepted as travel documents or an entrance visa.

3.25.3* In accordance with Regulations valid in the Slovak Republic, flight members' licences and crew members' certificates are not accepted as travel documents or an entrance visa.

3.29* Presentation of baggage of passengers departing from the Slovak Republic is required.

3.30* Presentation of baggage of passengers departing from the Slovak Republic is required.

CHAPTER 4

4.23* A commercial invoice (certificate of value) is required for high value trade samples; for trade samples up to an equivalent value of US$1, the declaration of the consignor in the air waybill is sufficient.

* Recommended Practice

28/2/94

4.23.1* Private consignments up to the value of the Slovak retail price of 500 Sk and trade samples of modest value are free from import duties.

4.28* The Customs Authorities decide about consignments of veterinary and plant origin.

4.32.1* The Customs Authorities will accept a declaration from the operator if it is not in contradiction with the declaration of the consignor or consignee.

CHAPTER 5

5.11* No free aerodromes or free zones have been established at Slovak international aerodromes. Warehousing facilities are provided.

5.12* No free aerodromes or free zones have been established at Slovak international aerodromes. Warehousing facilities are provided.

5.13 No free aerodromes or free zones have been established at Slovak international aerodromes. Warehousing facilities are provided.

CHAPTER 6

6.71* Aliens can import without foreign exchange permission 100 Sk unless otherwise specified in respective bilateral financial agreements.

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* Recommended Practice

CHAPTER 2

2.8 European Community customs legislation requires that documents relating to cargo indicate the gross weight of each consignment of cargo.

2.8.1* European Community customs legislation requires that the gross weight and the nature of goods be shown on the documents presented at customs.

2.17 Special interior traffic manifests must be presented before departure from Spain, relating to cargo loaded at an intermediate stop within Spain.

CHAPTER 4

4.9* Unaccompanied baggage is shipped as cargo and as such is covered by a traffic document.

4.13 The customs authorities reserve the right to inspect exported goods and this inspection is carried out on a selective basis.

4.19* The commercial invoice and the certificate of origin are required separately as required by European Community legislation.

4.32.1* Spain follows provisions of international conventions relating to containers and pallets which are usually included in European Community customs legislation.

4.44* Not all items referred to in this Recommended Practice are admitted duty free.

4.45* Not all items referred to in this Recommended Practice are admitted duty free.

4.53 b) and c) European Community customs legislation regards unaccompanied baggage as cargo and as such it is cleared in areas allocated to cargo.

CHAPTER 5

5.4 European Community customs legislation requires that the identity of the aircraft as well as the identity and nature of cargo and baggage, the gross weight and place of lading of the goods may be required by customs as a summary declaration of goods.

5.5 European Community customs legislation requires that any goods introduced into a customs territory shall be subject to customs surveillance and may be checked by customs authorities.

5.8* Passengers who transfer from one international airport or terminal to another airport or terminal cannot always be exempted from control.

CHAPTER 6

6.5* European Community customs legislation requires that payment of duties and taxes may be made either in cash or by certified and guaranteed cheque.

6.28* Clearance of all disembarking passengers of a flight within 45 minutes cannot be guaranteed by the customs authorities although all measures are being taken to expedite clearance.

6.39* Duty-free sales are conducted on the basis that such are exports. Therefore, duty-free shops have to be located at specific points (European Community regulations).

6.51* European Community regulations require that where airport capacity is limited, off-airport bonded warehouses (transit sheds) are allowed only where customs resources are available.

* Recommended Practice

CHAPTER 2

2.4 The General Declaration is still required by Customs and Immigration for statistical purposes.

2.6 The Passenger Manifest is still required by Customs and Immigration for statistical purposes.

2.39 Aircraft engaged in the carriage of passengers, cargo or mail for hire or reward on non-scheduled air services, or a series thereof, are required to obtain a permit from the Director of Civil Aviation and a fee is payable for the issue of such permit.

CHAPTER 3

3.5 Passports are normally issued at least two weeks after receipt of the application except in special cases.

3.5.2* Passports are only issued by the Central Immigration Department.

3.5.3* Period of validity of passports varies between two and five years depending on the immediate requirement of the applicant.

3.7* Visas are required from temporary visitors except visitors from the following countries:

All Commonwealth countries, European Economic Community, Finland, Iceland, Norway, Denmark, Sweden, Israel, San Marino, Uruguay, South Africa and Liechtenstein.

Other nationals may be granted entrance visas on arrival for a period of 2 to 3 days provided there is in existence a valid passport to enable the visitor to regularize his position.

3.8.3 Visas are made valid depending on the visit of the applicant but not more than 90 days from the date of issue. See also 3.7 above.

3.16 A baggage declaration form is required by Customs.

3.17 Although a Baggage Declaration Form is required, some inspection is done on a selective basis for selective flights.

3.17.1 The dual-channel baggage clearance system is not employed but some sampling inspection is done for selected flights.

CHAPTER 4

4.4* Automation has not been considered by the aviation authorities for the foreseeable future and any developments shall be notified accordingly.

4.5 Automation has not been considered by the aviation authorities for the foreseeable future and any developments shall be notified accordingly.

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* Recommended Practice

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4.8.1*	Automation has not been considered by the aviation authorities for the foreseeable future and any developments shall be notified accordingly.
4.9*	The following documents are required by Customs:
	Air Waybill; Invoices; Bill of Entry; Baggage Declaration for unaccompanied baggage; Bank form.
4.9.1*	The following documents are required by Customs:
	Air Waybill; Invoices; Bill of Entry; Baggage Declaration for unaccompanied baggage; Bank form.
4.10	The following documents are required by Customs:
	Air Waybill; Invoices; Bill of Entry; Baggage Declaration for unaccompanied baggage; Bank form.
4.13	Random checks are done for import cargo.

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* Recommended Practice

28/2/94

CHAPTER 3

3.9* Upon entering the Inter-Nordic passport control area, comprising Denmark, Finland, Iceland, Norway and Sweden, temporary visitors holding entry visas are, irrespective of means of transportation, required to complete a special Disembarkation Card which differs from the ICAO format. (For the vast majority of travellers, visas and consequently Disembarkation Cards are not required.)

3.10 Upon entering the Inter-Nordic passport control area, comprising Denmark, Finland, Iceland, Norway and Sweden, temporary visitors holding entry visas are, irrespective of means of transportation, required to complete a special Disembarkation Card which differs from the ICAO format. (For the vast majority of travellers, visas and consequently Disembarkation Cards are not required.)

CHAPTER 4

4.9* Export declaration is generally required.

4.19* The choice between separate documents and a combined form is not always left at the trader's option.

4.23* The required documents do not as a rule depend on the value or weight of the consignments but on their nature. No customs declaration is thus required in respect of goods imported by private persons for non-commercial purposes.

4.23.1* The exemption of import duties does not as a rule depend on the value or weight of the consignments but on their nature. Relief from import duties is thus granted in respect of certain gifts and samples.

4.24 The required documents do not as a rule depend on the value or weight of the consignments but on their nature. No customs declaration is thus required in respect of goods imported by private persons for non-commercial purposes.

CHAPTER 5

5.4.1 Transit stay without a visa is granted only to persons continuing their journey on the same day without leaving the airport.

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* Recommended Practice

CHAPTER 2

2.17 Domestic flights by aircraft which have not cleared customs are in principle not permitted.

CHAPTER 3

3.8 Switzerland cannot undertake to conclude reciprocal or other arrangements to issue entrance visas to temporary visitors without charge.

3.8.3 In cases where the visa is granted the Swiss authorities reserve the right to fix the duration of validity of the visa as well as the number of entries into the State.

3.41 The operator is liable for as long as the legal requirements have not been fulfilled, whether by himself or by a third person.

CHAPTER 4

4.9* In most cases, all that is required for the shipment of cargo by freight traffic is an ordinary export declaration. For certain consignments, the export declaration is replaced by a duplicate waybill, to which a special stamp is affixed.

CHAPTER 5

5.2 Exemption from the requirement for a transit passenger in Switzerland to hold a transit visa is made only in instances where:

a) the passenger is in possession of a valid passport of a country whose nationals are exempted from obtaining a transit visa to Switzerland;

b) the passenger is scheduled to leave the airport within 48 hours;

c) the passenger has necessary identity papers and visa for the country of destination;

d) the passenger has valid reservations and a passenger ticket for the onward journey.

5.4 Exemption from the requirement for a transit passenger in Switzerland to hold a transit visa is made only in instances where:

a) the passenger is in possession of a valid passport of a country whose nationals are exempted from obtaining a transit visa to Switzerland;

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c) the passenger has necessary identity papers and visa for the country of destination;

d) the passenger has valid reservations and a passenger ticket for the onward journey.

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* Recommended Practice

CHAPTER 2

2.4	Presentation of the General Declaration is required.
2.4.2	Not applicable, since Passenger Manifest and General Declaration are required.
2.5	First names, surnames and nationalities of crew members are required.
2.6	Presentation of a Passenger Manifest is required.
2.6.1*	List of passenger names is required to be submitted.
2.7*	Cargo Manifest is required to be submitted.
2.8.1*	Information concerning the nature of goods in the Cargo Manifest is required.
2.12	Four copies of the General Declaration, five copies of the Passenger Manifest, three copies of the Cargo Manifest and one copy of the stores list in respect of stores laden are required before departure of the aircraft.
2.13	Three copies of the General Declaration, three copies of the Passenger Manifest and one copy of the Cargo Manifest are required.
2.14	The use of standard baggage weights for each piece of baggage is not permitted for safety reasons.
2.15	Five copies of the General Declaration, six copies of the Passenger Manifest, four copies of the Cargo Manifest are required to be submitted on arrival of the aircraft.
2.16	Three copies of the General Declaration, three copies of the Passenger Manifest and one copy of the Cargo Manifest are still required.
2.18*	Only English language is required.
2.19	Documents written in pencil are not acceptable.
2.34	Prior permission is required. Detailed requirements are published in AIP — Thailand.
2.35	Prior permission is required. Detailed requirements are published in AIP — Thailand.
2.38	Private aircraft with maximum take-off weight not exceeding 5 700 kg must request permission at least 15 days in advance; seven days in advance for aircraft with maximum take-off weight exceeding 5 700 kg.
2.39 a)	It would take at least seven days to process such an application owing to security considerations. Therefore an application has to be made at least seven days in advance.

CHAPTER 3

3.8.1*	Visas are not issued in machine readable form.
3.8.3	A visitor's visa is usually valid for a period of three months from the date of issue but it may be extended on a case-by-case basis.
3.8.6*	Resident aliens are required to obtain a non-quota immigrant visa before their departure from Thailand.

* Recommended Practice

3.8.7* The authorized duration of stay will be stamped on the visa only on arrival in Thailand.

3.9* Embarkation/Disembarkation Card is required.

3.16 Inbound passengers are required to complete Passenger Declaration Form No. 211.

3.24 Flight crew member licences are accepted for a stay of up to 30 days.

3.24.1 Flight crew member licences are accepted for a stay of up to 30 days.

3.25 Flight crew member licences are accepted for a stay of up to 30 days.

3.25.1* Flight crew member licences are accepted for a stay of up to 30 days.

3.25.2 Passport and an airline's letter stating the departure as crew member are required but visa is required only in case the stay exceeds 15 days.

3.25.3* Passport and an airline's letter stating the departure as crew member are required but visa is required only in case the stay exceeds 15 days.

3.28 Residents must, in addition to the requirements of 3.8.6, have their residence certificates endorsed by the Immigration Authorities before departure.

3.31 Authorities reserve the right to inspect baggage of departing passengers.

3.32 Tax clearance certificates are required from passengers whose stay in Thailand exceeds 30 days' duration in one year or whose income during their stay (of whatever duration) reaches taxable levels.

CHAPTER 4

4.13 Physical examination of cargo and unaccompanied baggage to be exported by air is normally required.

4.15 All cargo must be presented for clearance at the air customs office of the airport.

4.44* The Customs Act of Thailand requires customs duties and other charges or taxes to be paid on the items specified in this Recommended Practice.

4.45* The Customs Act of Thailand requires customs duties and other charges or taxes to be paid on the items specified in this Recommended Practice.

4.46* The Customs Act of Thailand requires customs duties and other charges or taxes to be paid on the items specified in this Recommended Practice.

CHAPTER 5

5.4.1 A transit visa is required from a national of a country which is not included in the list of visa-exempted countries.

CHAPTER 6

6.62.1. Note 1 An amount of 350 Baht shall be charged for a vaccination against yellow fever.

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* Recommended Practice

28/2/94

CHAPTER 2

2.4 A General Declaration is required by the customs authorities when aircraft arrive at the airport.

2.4.4 The General Declaration must be signed and stamped by a proper officer for the purpose of outbound and inbound clearance.

2.5 A Crew Declaration Form must be signed by each member of the crew who must state therein the quantity of dutiable articles that are in their possession.

2.6 The presentation of a Passenger Manifest is required by the Departments of Customs and Immigration.

2.7* The presentation of a Cargo Manifest is required by the Department of Customs.

2.8 Description of cargo should reveal:

a) Marks and number on packages;
b) Number and type/s of packages;
c) Nature of goods;
d) Gross weight of the goods.

CHAPTER 3

3.7* Visa requirements are on a reciprocal basis. Entry visas are not required for Preferential Trade Area (P.T.A). A charge for the issuance of a visa is levied.

3.8.3 Entrance visas are valid for 3 months. A visitor, however, may stay for 12 months provided a visa extension application is made every 3 months.

3.10 On the Embarkation/Disembarkation Card, the Department of Immigration requires the following additional information from non-residents:
a) duration of stay in Uganda;
b) purpose of visit.

3.17.1 At present, no dual-channel baggage clearance system exists, but consideration is being given for the establishment of one during the on-going rehabilitation programme.

CHAPTER 4

4.9* Customs authorities require that individual documents be presented to account for shipments of cargo including unaccompanied baggage.

4.13 Physical verification/examination is required to ascertain the nature and quantity of goods.

4.19* Simplified documents are accepted as long as the following information is given:

a) Exporter's name and address;
b) Consignee's name and address;
c) Number of package/s;
d) Gross weight of the package/s;
e) Nature and quantity of the goods.

4.53 Unaccompanied baggage weighing not more than 100 kg is cleared as personal effects. Unaccompanied baggage whose gross weight is above 100 kg is cleared as cargo.

CHAPTER 5

5.4.1 A transit visa valid for 7 days is granted on arrival.

* Recommended Practice

CHAPTER 2

2.4 A General Declaration is required in certain circumstances, e.g. where aircraft arrive at non-designated airports and aerodromes.

2.7* The Cargo Manifest is normally required for certain general control and anti-smuggling purposes.

2.8 The gross weight for each consignment is also required.

2.8.1* A description of the goods sufficient to identify them, and the gross weight, may be required.

2.10 A written but abbreviated list of stores remaining on board aircraft is required. This enables checks of stores to be kept to a minimum.

CHAPTER 3

3.8 The United Kingdom normally charges for visas or other entry clearances. In certain circumstances the charge is excused.

3.8.1* The United Kingdom supports the concept of Machine Readable Visas but is currently not in a position to implement this Recommended Practice.

3.8.2 Visa applicants may be required to attend personally at the consulate.

3.8.3 United Kingdom entry clearances are normally valid for presentation within six months of issue. Multiple entry clearances are at present valid for presentation for varying periods up to five years.

3.8.4* Where required, United Kingdom visas and entry clearances should be obtained prior to travel and a person will normally be refused entry in the absence of the necessary clearance. The immigration officer has discretion to waive the requirement for an entry clearance in exceptional circumstances.

3.8.6* Stateless persons or foreign nationals of a country for which the United Kingdom has a visa requirement under the Immigration Rules require visas for entry unless they are travelling on valid United Kingdom travel documents authorizing their return.

Holders of refugee travel documents issued under the 1951 Convention relating to the Status of Refugees by countries which are signatories to the 1959 Council of Europe Agreement on Refugees do not require visas if coming for visits of three months or less.

Nationals of countries or stateless persons who would normally be required to obtain visas before travelling to the United Kingdom are exempt from the requirement, provided that:

a. they had indefinite leave to enter or remain in the United Kingdom when they last left and that they have not been away for longer than two years;

or

b. having previously been in the United Kingdom, they seek to return within the period of an earlier permission granted for more than six months;

* Recommended Practice

or

c. they are otherwise exempt from United Kingdom immigration control; for example, they have an entitlement to the Right of Abode (a passport should bear a Certificate of Entitlement to the Right of Abode) or diplomatic status in the United Kingdom.

3.8.7* A United Kingdom visa does not show the period of stay. This is granted by the immigration officer on arrival.

3.9* Disembarkation Cards must normally be completed by all passengers except nationals of Member States of the European Community. Embarkation Cards are issued selectively and, where required, will be given to passengers before departure from the United Kingdom.

3.10 The cards in use require the address in the United Kingdom to be recorded and the passenger's signature.

3.10.2 Disembarkation Cards must be provided by the carrier at his expense and distributed to all passengers who need to complete them.

3.16 A written declaration is generally required from crew members. The advantage of written declarations is that, if they are satisfactory, Customs may not need to interview crew members.

3.18* The normal arrangements for immigration clearance in the United Kingdom provide for examination at the first point of entry into the Common Travel Area of Great Britain and Northern Ireland, the Channel Islands, the Isle of Man and the Republic of Ireland.

3.23 Crew member certificates are not issued by the United Kingdom Public Authorities to crew members of the United Kingdom airline whether or not they are required to be licensed.

Identification documents bearing photographs of the holders are issued to United Kingdom aircrew members, licensed and unlicensed, by United Kingdom airlines, and by airport authorities on their behalf, the validity of which may be checked by contacting the issuing authority.

United Kingdom flight crew licences conform to the specification for personnel licences set forth in paragraph 5.1.1 of Annex 1. The date of birth is also included. Following the introduction of computerized licence issues, a photograph of the holder is no longer included, neither is the place of birth nor a statement of the right of re-entry to the State of issue — these items are part of the Annex 9 Appendix 6 crew member certificate specification but are not called for in paragraph 5.1.1 of Annex 1.

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* Recommended Practice

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3.25.2 The United Kingdom requires crew members travelling as passengers to be in possession of valid passports. Visas are normally required by nationals of States with which the United Kingdom has no visa abolition agreement.

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* Recommended Practice

28/2/94

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3.35.2* The operator is responsible for the care and custody of inadmissible passengers, until the person leaves the United Kingdom. The operator will not be required to meet detention expenses in respect of a person who is subsequently admitted, or in respect of a person who on arrival held a Certificate of Entitlement to the Right of Abode, a current entry clearance (visa, entry certificate or Home office Letter of Consent) or a current work permit.

3.36 An airline may not arrange for a person's departure to a country other than that from which he arrived without the prior agreement of the immigration officer.

3.36.2 Passengers who have entered the United Kingdom in breach of the immigration laws are liable to be removed at the expense of the inbound carrier.

3.37.1 The Immigration (Carriers Liability) Act 1987 allows for a charge to be levied on the inbound carrier of a passenger who requires leave to enter and who is carrying incomplete or falsified documents. No liability exists if the person was in possession of the required documentation on embarkation or if any falsity was not reasonably apparent. The charge may also be waived if the carrier shows that all reasonable measures were taken to prevent the carriage of such a person.

3.39 The full reasons for deportation may not be disclosed for reasons of privacy or other considerations.

3.40* The United Kingdom will notify the public authorities in States of transit and destination of a deportation when an escort is required.

CHAPTER 4

4.9* The use of individual documents is required.

* Recommended Practice

4.18 A commercial invoice alone does not contain sufficient information for control purposes and does not constitute a declaration by or on behalf of the importer.

4.19* The commercial invoice and, as the case may be, the certificate of origin are required separately.

4.44* Not all the items of equipment are admitted duty-free.

4.45* Not all the items of equipment are admitted duty-free.

4.53 b) No concessions are granted for unaccompanied baggage.

4.53 c) All unaccompanied baggage is regarded as cargo and removed for Customs examination at premises devoted entirely to cargo.

CHAPTER 5

5.4 A document specifying in particular the identity of the packages and the aircraft and the nature, gross weight and place of loading of the goods may be required by Customs as a summary declaration.

The United Kingdom permits transit without visa for passengers who normally require visas provided that the passenger has:

a. entry facilities for the countries en route and for the final destination;

b. a firm booking to travel by air within twenty-four hours;

c. no purpose in entering the United Kingdom other than to pass through.

This concession does not apply to nationals of the Islamic Republic of Iran, Iraq, Lebanon, Libyan Arab Jamahiriya, Sri Lanka, Somalia, Syrian Arab Republic and Turkey. Nationals of the Islamic Republic of Iran, Lebanon, Libyan Arab Jamahiriya, Somalia, Syrian Arab Republic and Turkey may only transit without visa if travelling on directly from the same airport without approaching immigration controls. Nationals of Iraq and Sri Lanka require visas in order to pass in-transit through the United Kingdom in all circumstances.

5.4.1 The United Kingdom permits transit without visa for passengers who normally require visas, provided that the passenger has:

a. entry facilities for the countries en route and for the final destination;

b. a firm booking to travel by air within twenty-four hours; and

c. no purpose in entering the United Kingdom other than to pass through in transit.

This concession does not apply to nationals of Afghanistan, the Islamic Republic of Iran, Iraq, Lebanon, Libyan Arab Jamahiriya, Somalia, Sri Lanka, Turkey, Uganda and Zaire. Nationals of these countries will require a Transit Visa in all circumstances, including when travelling on directly from the same airport without approaching the immigration control.

* Recommended Practice

5.5 Such goods are subject to Customs surveillance and are required to be capable of being checked by Customs authorities.

5.8* Passengers who transfer from one international airport to another international airport are normally required to pass through United Kingdom immigration control.

5.9* In all circumstances nationals of countries listed in the final paragraph of the differences registered to Standard 5.4.1 will be required to be in possession of a valid Transit Visa. Other passengers who benefit from the normal transit without visa concession and who are transferring from one international airport to another will normally need to complete landing and embarkation cards and pass through immigration controls.

CHAPTER 6

6.5* Payment of duties and taxes may be made either in cash or by banker's cheque, certified and guaranteed.

6.28* Customs clearance is carried out as soon as possible but the length of time involved cannot be assumed.

6.39* Duty-free facilities are restricted to departing passengers only, since duty-free status of goods purchased depends upon their immediate export.

6.51* Where airport capacity is limited, off-airport bonded warehouses (Transit Sheds) are allowed only where Customs resources are available.

6.60* United Kingdom law and practice, which apply to both air and other means of transportation, require in general that the parties responsible for handling the traffic shall provide and maintain such facilities as may be necessary for proper control and examination, etc. of goods and passengers.

6.62 United Kingdom law, which applies to air and other means of transportation, allows for a charge to be made for services for immigration clearance requested by operators additional to those considered to be sufficient for the normal operation of airports designated as Ports of Entry to the United Kingdom.

6.63 United Kingdom law, which applies to air and other means of transportation, allows for a charge to be made for services for immigration clearance requested by operators additional to those considered to be sufficient for the normal operation of airports designated as Ports of Entry to the United Kingdom.

6.64* Such arrangements are not appropriate to the present United Kingdom system of Customs control; there are both legal and practical difficulties.

CHAPTER 8

8.19* The United Kingdom does not have a standing national facilitation committee as such, nor does the Government itself establish facilitation committees at airports. There are, however, national consultative bodies for particular subjects, and ad hoc meetings are arranged when necessary to discuss particular subjects. United Kingdom law allows the Government to require that adequate facilities for consultation be established at airports. Consultation arrangements have been established under these powers at about 40 airports.

* Recommended Practice

HONG KONG

CHAPTER 2

2.4 General Declaration is required by the immigration authority, but only to contain information on details of operator, date of operation, flight number/destinations, names and positions of aircrew and number of passengers.

2.5 Names, nationalities and positions of crew members are required.

2.8 Air cargo reporting requirements are prescribed by local legislation under which no option, as proposed, is provided for.

2.8.1* Information concerning the nature of goods is required.

2.12 Three copies of the Cargo Manifest are required.

2.40* The following documentation is also required:

1) Certificate of competence/air operator's certificate.

2) Third party insurance.

3) Weather minima.

Sufficient time must be allowed for delivery/processing of documents.

CHAPTER 3

3.5.5* The fee charged may exceed the actual cost of issue or renewal.

3.5.8* Minors under 16 years of age have the option of being included in their guardian's passport or obtaining a new passport.

3.7* Although British citizens, Commonwealth citizens and most foreign visitors do not require visas for entry into Hong Kong; visas are required for certain categories of visitors who hold passports of countries not recognized by Her Majesty's Government or those who hold non-national travel documents.

3.8 A fee is charged for the issuance of a visa.

3.8.1* Visas are not issued in machine readable form at the time of preparation of this edition of the Supplement.

3.8.3 Visas are usually made valid for a period of three months from the date of issue.

3.8.4* Visitors who do not possess a visa when required will normally be refused admission into Hong Kong. However, they will be allowed to stay overnight in off-airport accommodation until their departure, under assurance and guarantee of the airline operator who brought them into Hong Kong.

* Recommended Practice

28/2/94

3.8.5	The entry visas are required for certain categories of foreign residents.
3.9*	Embarkation/Disembarkation Cards are required to be completed.
3.10	The format at Appendix 5 is not acceptable. The cards in use are of a different size and format and include additional information relating to address in Hong Kong and signature. This information is required for electronic data processing.
3.17.1	It is not intended to adopt the dual-channel baggage clearance system.
3.25.2	Crew members travelling as passengers must be in possession of valid passports. "Dead head" or "positioning" crew members travelling as passengers may use the aircrew certificates to clear immigration formalities provided they are travelling in uniform and in their own company's aircraft.
3.25.3*	Crew members travelling as passengers must be in possession of valid passports. "Dead head" or "positioning" crew members travelling as passengers may use the aircrew certificates to clear immigration formalities provided they are travelling in uniform and in their own company's aircraft.
3.29*	This is not acceptable. Legislation now requires passengers, except those holding a valid Hong Kong identity card, to complete a departure card.
3.36	Not acceptable. Legislation now provides for the removal of any persons found inadmissible in Hong Kong to their last port of embarkation or place of origin, or place of nationality of deportee.
3.36.1	Not acceptable. Legislation now provides for the removal of any persons found inadmissible in Hong Kong to their last port of embarkation or place of origin, or place of nationality of deportee.
3.37.1	A fine may be imposed on the operator (by law) if a passenger is not in possession of the proper documents.

CHAPTER 5

5.4.1	A visa is required by stateless aliens and by nationals of certain countries.
5.11*	It is not proposed to establish free airports.
5.12*	It is not proposed to establish a free zone at the international airport.

CHAPTER 6

6.6*	It is not intended that airlines be offered any choice but to accept the service of an agent authorized by the airport authority.

* Recommended Practice

(United States, including Guam,
Puerto Rico and the U.S. Virgin Islands)

CHAPTER 2

2.3 Written crew baggage declaration is required in certain circumstances, and a special Embarkation/Disembarkation Card is required for most alien crew members.

2.4 A General Declaration for all inbound and outbound flights with commercial cargo is required. However, in cases of outbound flights with commercial cargo this requirement may be waived if a declaratory statement is made on the Cargo Manifest. No declaration is made for outbound flights without commercial cargo if customs clearance is obtained by telephone.

2.4.1 Each crew member must be listed showing surname, given name and middle initial.

2.4.4 The signing or stamping of the General Declaration protects the carrier by serving as proof of clearance.

2.5 The crew list is required by statute.

2.7* There is a statutory requirement for the Cargo Manifest.

2.8 In order to combat illicit drug trafficking, the United States requires the following additional information:

1) the shipper's and consignee's name and address;
2) the type of air waybills;
3) weight of cargo;
4) number of house air waybills.

2.8.1* Nature of goods information is required.

2.10 Stores list required in all cases but may be recorded on General Declaration in lieu of a separate list.

2.21 There is a statutory requirement that such changes can only be made prior to or at the time of formal entry of the aircraft.

2.35 Advance notice is required of the number of citizens and aliens on board (non-scheduled flights only).

2.40* A copy of the contract for remuneration or hire is required to be a part of the application in the case of non-common carrier operations.

2.42* Single inspection is accorded certain aircraft not by size of aircraft but rather by type of operation. Loads (cargo) of an agricultural nature require inspection by a plant or animal quarantine inspector.

CHAPTER 3

3.3 Medical reports are required in some instances.

* Recommended Practice

28/2/94

3.7* Nationals of certain countries which meet certain criteria are allowed to seek admission to the United States without a visa up to 90 days as a visitor or on business (permitted under a pilot programme to aliens from contiguous countries and adjacent islands or in instances of emergency. In addition, admissible aliens arriving on a carrier which has signed an immediate-transit agreement with the United States are given visas provided they possess travel documents establishing their identity, nationality and entitlement to enter some country other than the United States.

3.8.3 The duration of stay of a passenger is determined at the port of entry on the merits of each case.

3.8.4* A visitor to the United States cannot enter without documentation required.

3.10.1 The operator is responsible for passengers completing the Embarkation/Disembarkation Card.

3.10.2 Embarkation/Disembarkation Cards may be purchased from the United States Government, Superintendent of Documents.

3.16 Written baggage declarations by crew members are required in some instances.

3.17.1 The United States uses a multiple channel system rather than the dual-channel clearance system.

3.24 Crew members, except those eligible under the visa waiver pilot programme (see 3.7 above) are required to have valid passports and valid visas to enter the United States.

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CHAPTER 4

4.44* Regulations require entry of such items, most of which are dutiable by law.

4.45* Certain items in this category are dutiable by law.

4.49 Aircraft equipment and parts, certified for use in civil aircraft, may be entered duty free by any national entitled to most-favoured nation tariff treatment. Security equipment and parts, unless certified for use in the aircraft, are not included.

* Recommended Practice

4.50 Carriers are required to submit new documentation to explain the circumstances under which cargo manifested is not unladen. No penalty is imposed if the carrier properly reports this condition.

4.52 The procedures for adding, deleting, or correcting manifest items require filing a separate document.

CHAPTER 5

5.1 Such traffic must be inspected at airports where passengers are required to disembark from the aircraft and no suitable sterile area is available.

5.2 Passports and visas are waived for admissible aliens arriving on a carrier which is signatory to an agreement assuring immediate transit of its passengers provided they have a travel document or documents establishing identity, nationality, and ability to enter some country other than the United States.

5.3 Such traffic must be inspected at airports where no suitable sterile area is available.

5.4 Passports and visas are waived for admissible aliens arriving on a carrier which is signatory to an agreement assuring immediate transit of its passengers provided they have a travel document or documents establishing identity, nationality, and ability to enter some country other than the United States.

5.4.1 Passengers will not be required to obtain and present a visa if they will be departing from the United States within eight hours of arrival or on the first flight thereafter departing for their destination.

5.8* Examination of transit traffic is required by law. Transit passengers without visas are allowed one stopover between the port of arrival and their foreign destination.

5.9* Passports and visas are required generally for transit passengers who are remaining in the United States beyond eight hours or beyond the first available flight to their foreign destinations.

CHAPTER 6

6.3.1* Procedures involving scheduling committees raise a number of antitrust problems under United States law.

6.33* Sterile physical facilities shall be provided, and in-transit passengers within these areas shall be subject to immigration inspection at any time.

CHAPTER 8

8.1* Separate bonds are required.

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* Recommended Practice

28/2/94

CHAPTER 2

2.3	No documents other than those provided for in Chapter 2 of Annex 9 shall be required by June 1992.
2.4	Presentation of the general declaration shall be required until 31 December 1992.
2.7*	Presentation of the cargo manifest is required.
2.8	Additional items for "gross weight, marks and numbers on packages" are to be filled.
2.8.1*	Information concerning the nature of goods is required.
2.10	A stores list may be required.
2.40*	More details may be required in respect of non-scheduled international flights.

CHAPTER 3

3.3	A foreign currency declaration form is required upon arrival.
3.5	Passports are issued to successful applicants after receipt of their application.
3.5.1*	Machine readable passports shall be issued by June 1992.
3.7*	The abolition of the requirement of entrance visas for visitors is under consideration.
3.8	A fee is charged for the issuance of all types of visas except for "gratis" visas.
3.8.3	The issuance of a visa that is valid for twelve months is under consideration.
3.10	The format of embarkation/disembarkation cards differs slightly from that which is set out in Appendix 5 to Annex 9.
3.17.1	Tanzania has not adopted the dual-channel baggage clearance system.
3.30*	All baggage of passengers departing from Tanzania must be presented to customs for inspection.
3.31	All baggage of passengers departing from Tanzania must be presented to customs for inspection.

CHAPTER 4

4.9*	The presentation of simple export documents may be required.
4.10	The presentation of simple export documents may be required.
4.13	Trade goods are examined on a sampling basis. Personal effects and temporary imports on exportation are subjected to physical examination.

* Recommended Practice

4.19* Separate documents are still required. There is no exception made to traders as these documents are issued by different persons/authorities.

4.23* Minimum value requiring documentation is $500.

4.48 Proper documents must be furnished within 48 hours after the items have been admitted or exported.

CHAPTER 5

5.11* Free airports have not been established.

CHAPTER 6

6.4* The State collects all payments for services rendered at international airports.

CHAPTER 8

8.19* National Air Transport Facilitation Committees have not been established in Tanzania.

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* Recommended Practice

28/2/94

CHAPTER 2

2.4 General Declaration is required (Annex 9 format adoption being studied).

2.6 Passenger Manifest is required. (Annex 9 format when used is acceptable to Zambian authorities.)

2.7* Cargo Manifest required. Annex 9 or data from alternative sources accepted.

2.12 Copies required are in excess of ICAO specification.

2.15 Copies required are in excess of ICAO specification.

2.18* Documents should be in English only.

2.38 Prior clearance by commercial non-schedule flights into Zambia is required. Applications for such clearance must be submitted three days before the flight. Temporary Air Services Permits are chargeable.

2.40* More information is required than is on the flight plan. (See AIP of Republic of Zambia section.)

CHAPTER 3

3.8 Visas obtained are chargeable and are required from all temporary visitors. Visitors from all Commonwealth countries are not required to have visas. Visas may be obtained at the port of entry by visitors from those countries that must obtain visas except for visitors from South Africa and West Africa, who must apply for visas before embarking on their journey to Zambia.

3.8.3 Visas are divided into two: Single/Double Visa and Multiple Visa. Single and double visas are valid for three months only while multiple visas are valid for six months.

3.8.7* Items 1-4 are followed. Items 5 and 6 are not followed. The date of expiry is stated as three to six months for single and multiple visas respectively. The number of entries permitted is usually one and authorized duration of each stay is determined at the port of entry where the visitor is issued with a temporary permit.

3.10 The Embarkation/Disembarkation Card is required from all passengers without exception, and additional information on the purpose of the visit, expected length of stay, date and signature is required.

3.10.2 The Embarkation/Disembarkation Card is required from all passengers without exception, and additional information on the purpose of the visit, expected length of stay, date and signature is required.

3.16 Oral declaration of baggage from passengers and crew is acceptable at the discretion of the public authority concerned. Written declarations may also be needed.

3.23 Crew member certificates are not issued in Zambia at the present time to unlicensed crew members. Therefore, unlicensed crew members must have a valid passport and visa.

3.25.2 Not applicable. Crew members travelling as passengers must be in possession of valid passports.

* Recommended Practice

CHAPTER 5

5.11* No free airports or free zones are established at international airports. There are adequate facilities/arrangements and procedures for transit and re-export cargoes.

5.12* No free airports or free zones are established at international airports. There are adequate facilities/arrangements and procedures for transit and re-export cargoes.

CHAPTER 6

6.26 The control channels and desks available are not sufficient.

6.28* It is not possible to clear aircraft in 45 minutes due to inadequate equipment, facilities and personnel in public authorities.

VANUATU

CHAPTER 2

2.5 Depending on operating conditions and security risk, customs reserve the right to require any relevant information regarding aircraft crew.

2.6 Passenger Manifest is required unless alternative arrangements can be made (e.g. a telexed list of passengers).

2.8 The recommended format of Cargo Manifest is acceptable as long as sufficient detail is given in the "Nature of Goods" section.

2.23 Aircraft are disinsected on arrival, before passenger disembarkation.

2.35 Additional details as specified in the applicable Vanuatu AIP are required.

CHAPTER 3

3.9* Customs reserve the right to require the address of arriving and departing passengers in Vanuatu. Immigration also requires some additional information such as length of stay and reason for the visit. Otherwise the recommended format of the Embarkation/Disembarkation Card is acceptable.

3.10 Customs reserve the right to require the address of arriving and departing passengers in Vanuatu. Immigration also requires some additional information such as length of stay and reason for the visit. Otherwise the recommended format of the Embarkation/Disembarkation Card is acceptable.

3.18* Cleared passengers and baggage may be subject to re-examination if the aircraft is carrying uncleared baggage and/or passengers.

3.20 Operators may clear mishandled baggage unless there is a specific reason not to do so.

CHAPTER 4

4.15 Cargo and unaccompanied baggage may only be presented for clearance purposes at an approved airport customs office.

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* Recommended Practice

INTERNATIONAL STANDARDS,
RECOMMENDED PRACTICES AND
PROCEDURES FOR AIR NAVIGATION SERVICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I

(PART I — EQUIPMENT AND SYSTEMS;
PART II — RADIO FREQUENCIES)

FOURTH EDITION OF VOLUME I — APRIL 1985

This edition incorporates all amendments adopted by the Council prior to 6 December 1984 and supersedes, on 21 November 1985, all previous editions of Annex 10.

For information regarding the applicability of the Standards and Recommended Practices and the Procedures for Air Navigation Services, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Bulletin* and in the monthly *Supplement to the Catalogue of ICAO Publications*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-68	Incorporated in this edition		
69	11/11/93	12/10/93	
70	9/11/95	19/9/95	

CORRIGENDA			
No.	Date of issue	Date entered	Entered by
1	Incorporated in this edition		
	16/8/93	8/11/93	

TABLE OF CONTENTS

ATTACHMENTS TO ANNEX 10 — VOLUME I

FOREWORD

Historical background

Standards and Recommended Practices for Aeronautical Telecommunications were first adopted by the Council on 30 May 1949 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 10 to the Convention. They became effective on 1 March 1950. The Standards and Recommended Practices were based on recommendations of the Communications Division at its Third Session in January 1949.

Up to and including the Seventh Edition, Annex 10 was published in one volume containing four Parts together with associated attachments: Part I — Equipment and Systems, Part II — Radio Frequencies, Part III — Procedures, and Part IV — Codes and Abbreviations.

By Amendment 42, Part IV was deleted from the Annex; the codes and abbreviations contained in that Part were transferred to a new document, Doc 8400.

As a result of the adoption of Amendment 44 on 31 May 1965, the Seventh Edition of Annex 10 was replaced by two volumes: Volume I (First Edition) containing Part I — Equipment and Systems, and Part II — Radio Frequencies, and Volume II (First Edition) containing Communication Procedures.

As a result of the adoption of Amendment 70 on 20 March 1995, Annex 10 was restructured to include five volumes: Volume I — Radio Navigation Aids; Volume II — Communication Procedures; Volume III — Communication Systems; Volume IV — Surveillance Radar and Collision Avoidance Systems; and Volume V — Aeronautical Radio Frequency Spectrum Utilization. By Amendment 70, Volumes III and IV were published in 1995 and Volume V was planned for publication with Amendment 71.

Table A shows the origin of Annex 10, and the origin of subsequent amendments, together with a summary of the principal subjects involved and the dates on which the Annex and the amendments were adopted by Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards, Recommended Practices and Procedures specified in Annex 10, should be notified and take effect in accordance with the provisions of Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been deliberately written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices*:

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 10, Volume I

Amendment	*Source(s)*	*Subject(s)*	*Adopted* *Effective* *Applicable*
1st Edition	Third Session of the COM Division	Introduction of Standards and Recommended Practices for radio navigation aids and communication facilities, together with methods of operation, procedures and codes for world-wide application.	30 May 1949 1 March 1950 1 April 1950
1	Third Session of the COM Division	Amendment to provisions for radio teletypewriter terminal equipment in the band 3-30 MHz.	28 March 1951 1 October 1951 1 January 1952
2*	Third Session of the COM Division	Addition of guidance material concerning radio teletypewriter system engineering.	28 March 1951 1 October 1951 1 January 1952
3	Third Session of the COM Division	Standards and Recommended Practices relating to radio frequencies.	28 March 1951 1 October 1951 1 January 1952
4	Third Session of the COM Division	Standards and Recommended Practices relating to communications procedures.	28 March 1951 1 October 1951 1 April 1952
5	Third Session of the COM Division	Standards and Recommended Practices relating to codes and abbreviations.	28 March 1951 1 October 1951 1 April 1952
6	Third Session of the COM Division	Q Code.	1 April 1952 4 July 1952 1 September 1952
7	Air Navigation Commission	Introduction of definitions for height, altitude and elevation in Annex 10.	17 June 1952 1 December 1952 1 April 1953
8	Fourth Session of the COM Division	Amendments concerning definitions, VHF radiotelegraph for aural reception, DME, SRE, NDB, 75 MHz en-route marker beacons, ILS.	17 June 1952 1 December 1952 1 April 1953
9	Fourth Session of the COM Division	Provisions concerning the utilization of offset frequency simplex.	17 June 1952 1 December 1952 1 April 1953
10	Fourth Session of the COM Division	Definitions and procedures relating to the AFS, AMS and Broadcasts.	17 June 1952 1 December 1952 1 April 1953
11	Secretariat proposal	Editorial amendments consequential to Amendment 7, and editorial improvements to Part IV.	17 June 1952 1 December 1952 1 April 1953
12	Fourth Session of the COM Division	Annulment of 5.1.6.7 of Amendment 10 adopted by Council on 17 June 1952.	28 November 1952 1 March 1953 1 April 1953
13	Proposal by Ireland on Recommendations of the Fourth Session of the COM Division	Procedure governing the relay of traffic between an aeronautical station and an aircraft no longer in radio contact.	5 May 1953 15 August 1953 1 October 1953
14	First AN Conference	Specifications for the siting of ILS marker beacons, VHF equisignal localizers and associated monitors.	11 December 1953 1 May 1954 1 June 1954
15	Fifth Session of the COM Division	Amendment of paired frequencies for ILS localizers and glide paths.	2 November 1954 1 March 1955 1 April 1955

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
16	Fifth Session of the COM Division	Provision of additional assignable frequencies in the VHF bands by extending the allotment table and by making provision for decreasing, under certain conditions, the minimum separation between channels.	2 November 1954 1 March 1955 1 April 1955
17	Fifth Session of the COM Division	Addition of Standards and Recommended Practices on interim long distance radio navigation aids and on communications systems; also updating of the ILS specifications.	10 December 1954 1 April 1955 1 October 1955
18	Fifth Session of the COM Division	Establishment of basic rules for the selection of frequencies for radio navigation aids operating in frequency bands above 30 MHz, including frequencies for secondary radar.	10 December 1954 1 April 1955 1 October 1955
19	Fifth Session of the COM Division	Procedure to facilitate downgrading or cancellation of messages not delivered within time specified by originator and requirement for specification of aircraft heading in distress message.	10 December 1954 1 April 1955 1 October 1955
20	Fifth Session of the COM Division	Amendment of codes and abbreviations.	10 December 1954 1 April 1955 1 October 1955
21	Third North Atlantic RAN Meeting	Alignment of radiotelegraphy messages originating in aircraft with radiotelephony messages.	27 May 1955 1 September 1955 1 October 1955
22	Fifth Session of the COM Division	Pairing of localizer and glide path frequencies for the ILS.	18 November 1955 1 April 1956 1 December 1956
23	Air Navigation Commission	Amendment concerning words to be used in spelling in radio-telephony.	18 November 1955 1 March 1956 1 March 1956
24	Fourth Session of the MET Division	Amendment of Q code signal QBB.	18 November 1955 1 April 1956 1 December 1956
25*	Annex 3	Amendment of the Q code signal QUK (consequential to amendment of Annex 3).	8 November 1955 — 1 January 1956
26	Annex 15	New definition of NOTAM and references to NOTAM (consequential to amendment of Annex 15).	22 February 1956 1 July 1956 1 December 1956
27	Second AN Conference	Siting of the inner and middle markers of the ILS and guidance material on the location of the ILS reference point.	11 May 1956 15 September 1956 1 December 1956
28	Procedures of the World Meteorological Organization (WMO) and Annex 3	Amendment of the Q code signals for the reporting of clouds and the introduction of the AIREP reporting procedure.	15 May 1956 15 September 1956 1 December 1956
29	Proposal by Australia	Tape-relay Standards.	4 June 1957 1 October 1957 1 December 1957
30*	Annex 3	Amendment of the Q code signals QUK and QUL (consequential to amendment of Annex 3).	25 November 1957 — 1 December 1957
31	Proposal by France	Amendment of the Q code signals QNH and QNY.	21 March 1958 1 August 1958 1 December 1958

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
32	Sixth Session of the COM Division	Recommendations of the Meeting.	9 June 1958 1 October 1958 1 December 1958
33	ICAO Panel of Teletypewriter Specialists	Communication operational procedures to ensure compatibility between AFTN communication centres employing manual "torn-tape", semi-automatic and fully automatic operation.	15 December 1958 1 May 1959 1 October 1959
34	RAC/SAR Division	Increased number of radio frequencies that may be selected for use in radio survival equipment.	8 December 1959 1 May 1960 1 August 1960
35	Special COM/OPS/RAC/SAR Division	Implementation requirements for VOR, introduction of new DME specification and extension of protection dates for VOR and DME to 1 January 1975.	8 April 1960 1 August 1960 1 January 1961
36	Air Navigation Commission	Substituted "Radiotelephony Speech for International Aviation" for "International Language for Aviation".	8 April 1960 1 August 1960 1 January 1961
37	Fifth Session of the MET Division, AIS and Aeronautical Charts Division	Procedures respecting the forwarding of messages; amendment of Q code signals.	2 December 1960 1 April 1961 1 July 1961
38	Ordinary Administrative Radio Conference (OARC-1959)	Alignment of the provisions in Annex 10 with the related provisions of the Radio Regulations of the International Telecommunication Union (ITU).	20 January 1961 1 June 1961 1 July 1961
39	ICAO Panel of Teletypewriter Specialists	Simplification of communication procedures for diversion routing, clarification of the application of ICAO two-letter abbreviations used in the addresses of messages and communication procedures concerning interstation co-operation.	26 June 1961 1 December 1961 1 January 1962
40	Seventh Session of the COM Division	General updating and amendment of equipment and systems; radio frequencies and procedures.	5 April 1963 1 August 1963 1 November 1963
41	PANS-MET	Amendment of the Q code signals QFE, QFF and QNH to permit the transmission of altimeter settings in units of millibars or tenths of a millibar.	4 June 1963 1 October 1963 1 January 1964
42	Fourth Meeting of the MOTNE Development/Implementation Panel; Seventh Session of the COM Division; proposals by the Federal Republic of Germany, the United Kingdom and the United States	Non-typing or switching signals on the AFTN; new guidance material on ILS course structures and their evaluation; guidance material on ILS course structure and on the more important communication terms of specialized meaning and their definitions; the deletion of Part IV of the Annex as a consequence of the establishment of a new abbreviations and codes document; departure messages and guidance material on the monitoring of SSR.	25 March 1964 1 August 1964 1 January 1965
43	Seventh Session of the COM Division	Amendments concerning the performance of ILS facilities, Category I and Category II.	23 June 1964 1 November 1964 1 February 1965
44	Seventh Session of the COM Division; Fifth Meeting of the ICAO Panel of Teletypewriter Specialists; RAC/SAR and OPS Division; PANS — Radiotelephony Procedures	Breakdown of Annex 10 into two volumes, Volume I (First Edition) containing Part I — Equipment and Systems, and Part II — Radio Frequencies, and Volume II (First Edition) containing Communications Procedures. Changes in the provisions regarding the action to be taken in the case of communications failure and in the case of transfer of communications watch from one radio frequency to another; provisions relating to teletypewriter procedures; deletion of the radiotelephony procedures in the aeronautical mobile service, except for certain basic provisions of the distress procedures.	31 May 1965 1 October 1965 10 March 1966

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
45	Fourth AN Conference; Sixth Meeting of the Panel of Teletypewriter Specialists	Specification of the technical characteristics for VHF survival radio equipment and introduction of the concept of the "ILS reference datum" in lieu of the "ILS reference point"; a number of AFTN technical provisions related to the progressive automation of the AFTN.	12 December 1966 12 April 1967 24 August 1967
46	Fifth Meeting of the ATC Automation Panel	Definitions and technical provisions relating to ATS message transmission on direct or omnibus channels.	7 June 1967 5 October 1967 8 February 1968
47	COM/OPS Divisional Meeting	Updating or expansion of practically every major specification. Of special importance are the changes to the ILS and SSR specifications; the introduction of a system specification for Loran-A; the expanded guidance material on the deployment of VHF communications frequencies and specification, for the first time, of the airborne elements of ADF, VHF and HF SSB Communications Systems.	11 December 1967 11 April 1968 22 August 1968
48	COM/OPS Divisional Meeting; Fifth AN Conference	New method of prescribing VOR/DME coverage; provisions regarding the availability of information on the operational status of radio navigation aids, regarding secondary power supplies of radio navigation and communication systems as well as guidance on power supply switch-over times for radio aids used in the vicinity of aerodromes.	23 January 1969 23 May 1969 18 September 1969
49	First Meeting of the Automated Data Interchange Systems Panel; Sixth AN Conference	Introduction of a 7-unit code for data interchange at medium signalling rates, the medium signalling rates to be used and the types of transmission and modulation for each of them; provisions concerning the secondary surveillance radar ground equipment to ensure immediate recognition of Codes 7600 and 7700 and provisions concerning the use of Code 2000 on Mode A.	1 June 1970 1 October 1970 4 February 1971
50	Second Meeting of the Automated Data Interchange Systems Panel; ANC study on RAN Meeting recommendations of world-wide applicability; Fourth Meeting of the All Weather Operations Panel	Introduction of the term "Hertz (Hz)" in place of the term "cycles per second (c/s)" as the unit of frequency for electric and radiotechnical matters; definition for data signalling rate, the extension of signalling rates to 9 600 bits/second and some explanatory provisions related to the 7-unit coded character set; provisions concerning the pre-flight checking of VOR airborne equipment; definitions for "ILS Point D" and "ILS Point E" and some changes in the provisions relating to the specification for ILS and en-route VHF marker beacons.	24 March 1972 24 July 1972 7 December 1972
51	Third Meeting of the Automated Data Interchange Systems Panel; Third Meeting of the Obstacle Clearance Panel	Technical provisions relating to international ground-ground data interchange; guidance material concerning the lateral placement of the glide path antenna in relation to Annex 14 provisions on obstacle limitation surfaces and objects on strips for runways.	11 December 1972 11 April 1973 16 August 1973
52	Seventh AN Conference	New Standard relating to an emergency locator beacon — aircraft (ELBA); provision for additional localizer and glide path frequency pairs, and the introduction of 25 kHz channel spacing in the VHF band of the International Aeronautical Mobile Service; introduces refinements to the specifications for ILS, SSR and VOR, and extends the protection dates for ILS, DME and VOR from 1975 to 1985.	31 May 1973 1 October 1973 23 May 1974
53	Assembly Resolutions A17-10 and A18-10	Provisions relating to practices to be followed in the event that an aircraft is being subjected to unlawful interference.	7 December 1973 7 April 1974 23 May 1974
54*	Fourth Meeting of the Automated Data Interchange Systems Panel	New Attachment G to Part I of Volume I containing guidance material for ground-ground data interchange over data links at medium and higher signalling rates, and the insertion of cross references in Volume I, Part I, Chapter 4, 4.12.	17 June 1974 — —

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
55	Fifth Meeting of the All Weather Operations Panel; Second Meeting of the Review of the General Concept of Separation Panel; AN Working Group on Regional Plans; Seventh AN Conference	Technical specifications and guidance material for localizer and glide path components of the ILS; guidance material in respect of mandatory change-over points for VOR-defined ATS routes; alignment of the implementation provisions for ILS with those of other radio navigation aids; required geographic separation between ILS facilities and provisions concerning use of the VHF emergency channel (121.5 MHz) in the event of interception of aircraft.	4 February 1975 4 June 1975 9 October 1975
56	Correspondence	Designation of SSR Code 7500 for use in the event of unlawful interference.	12 December 1975 12 April 1976 12 August 1976
57	ASIA/PAC RAN Meeting	Provision of, and maintenance of guard on the VHF frequency 121.5 MHz.	16 June 1976 16 October 1976 6 October 1977
58	ANC study of threshold wheel clearance; Sixth Meeting of the Automated Data Interchange Systems Panel; proposal by France; proposal by IFALPA	Introduction of tables of code conversion between the International Telegraph Alphabet No. 2 and the 7-unit coded character set; modification of the frame check sequence algorithm used for error checking in automated data interchange; amendment of material related to the ILS reference datum, introduction of new material related to the possibility of interference from spurious radiations in the LF/MF band and amendment to the guidance material in Attachments C and G to Part I.	23 & 27 June 1977 27 October 1977 23 February 1978
*59	Ninth AN Conference; ANC study of frangibility requirements emanating from Rec. 3/5 of the Third Meeting of the Obstacle Clearance Panel; COM Divisional Meeting (1976)	Transfer of the SSR Mode B to an unassigned status; cross-reference to the provisions of Annex 14 concerning frangibility criteria for the navigational facilities on operational areas; cross-reference to the provisions of Annex 11 concerning the determination of VOR accuracy and change-over point; introduction of Attachment C to Part II, dealing with Guiding Principles for Long Distance Operational Control Communications.	14 December 1977 14 April 1978 10 August 1978
60	Sixth Meeting of the All Weather Operations Panel	Change of a preferred ILS glide path angle from 2.5 degrees to 3 degrees.	4 December 1978 4 April 1979 29 November 1979
61	Seventh Meeting of the Automated Data Interchange Systems Panel; AWO Divisional Meeting (1978); COM Divisional Meeting (1978)	Introduction of a new series of marginal serial numbers in use by the International Telecommunication Union (ITU) and clarification of the term "Radio Regulations"; change to the definition of the Aeronautical Fixed Telecommunication Network (AFTN); change of the ILS protection date to 1995; addition of information related to the Microwave Landing System (MLS); changes in the radio frequency provisions related to the Final Acts of the ITU World Administrative Radio Conference (WARC) 1978; changes in the provisions related to the introduction of single sideband classes of emission into the high frequency (HF) aeronautical mobile service; clarification of symbols permitted with the 7-unit coded character set; change from single numbered to double numbered code and byte independent data link control procedures; introduction of new material related to character oriented data link control procedures; changes to the definition of operational control communications.	10 December 1979 10 April 1980 27 November 1980
62	Eighth Meeting of the Automated Data Interchange Systems Panel; Eighth Meeting of the All Weather Operations Panel; ANC study related to the interception of civil aircraft; Secretariat recommendation related to the protection date for VOR and DME	Changes to the protection date provisions of VOR and DME; changes and additions to the material related to ILS airborne equipment criteria and criteria on geographic separation of VOR/ILS facilities; addition of material related to the continuous check of channel condition and the use of controlled circuit protocols; changes to the provisions to make the 7-unit coded character set identical to the International Reference Version of International Alphabet No. 5; addition of provisions related to the use of character parity on CIDIN links; addition to the provisions related to character oriented data link control procedures; changes to the provisions related to VHF communication in the event of interception.	14 December 1981 14 April 1982 25 November 1982

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
63	ANC recommendations relating to the assignment of an air-to-air VHF frequency at the request of IFALPA; Secretariat recommendations related to depletion of the SELCAL codes; AIG Divisional Meeting (1979); COM Divisional Meeting (1981)	Changes and additions to the material related to frequencies above 30 MHz used for particular functions to provide for an air-to-air VHF communications channel; addition of material related to the addition of new RED SELCAL tones; changes and additions to the material related to radar characteristics to provide for the recording and retention of radar data; extensive changes and additions to Chapters 1, 2, 3, 4, 5, 6 and Appendix A with respect to ILS, NDB, DME, MLS, radioteletype, VHF and HF communications, survival radio equipment and emergency locator beacons.	13 December 1982 13 April 1983 24 November 1983
64		Volume II only.	
65	ANC recommendations relating to the protection date of aeronautical mobile VHF communications equipment operating on 25 kHz channel spacing at the request of the Kingdom of the Netherlands; Secretariat recommendations related to harmful interference to aeronautical frequency bands from external sources, and related to switching and signalling over aeronautical voice circuits; ANC recommendations relating to SPI pulse in SSR Mode C at the request of the United Kingdom; Ninth Meeting of the All Weather Operations Panel; 10th Meeting of the Automated Data Interchange Systems Panel	Changes to the material related to the protection date of aeronautical mobile VHF communications equipment operating on 25 kHz channel spacing; changes and additions to the material relating to harmful interference to aeronautical frequency bands from external sources; addition of material relating to switching and signalling over aeronautical voice circuits; changes to material relating to SSR SPI pulse transmission; extensive changes to Chapters 3, 4 and Attachments C, G and H with respect to ILS, DME and CIDIN.	6 December 1984 6 April 1985 21 November 1985
66	Air Navigation Commission	SSR Code 2000; use and provision of 121.5 MHz.	14 March 1986 27 July 1986 20 November 1986
67	COM/OPS Divisional Meeting (1985); 10th and 11th Meetings of the All Weather Operations Panel; Second Meeting of the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel; recommendations of the All Weather Operations Panel working group and the Secretariat relating to MLS basic data word parity equations	Refinements of technical specifications for the current secondary surveillance radar (SSR); introduction of technical specifications for SSR Mode S and material on allocation to States and assignment to aircraft of SSR Mode S addresses; extensive changes and additions to the material relating to MLS, DME and ILS; introduction of ILS and MLS protection dates and ICAO ILS/MLS transition plan.	16 March 1987 27 July 1987 22 October 1987
68	11th Meeting of the All Weather Operations Panel; ANC	Refinements of technical specifications for distance measuring equipment (DME); deletion of the requirement for microwave landing system (MLS) Morse Code identification; new provision concerning the installation of 121.5 MHz ground equipment.	29 March 1990 30 July 1990 15 November 1990
69	COM/MET Divisional Meeting (1982); COM/MET/OPS Divisional Meeting (1990); Fourth Meeting of the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel; Fifth Meeting of the Operations Panel; 30th Meeting of the European Air Navigation Planning Group; ANC	Changes to AFTN message procedures and addition of material related to the world area forecast system (WAFS) telecommunications requirements; addition of material related to VHF air-ground data link communications and changes to material concerning VHF off-set carrier systems; updating of material related to SSR Mode S and the 24-bit aircraft addressing scheme; changes to material related to the operational objectives for the ILS facility performance categories; changes to material related to DME/N total system accuracy; changes and additions to material related to emergency location transmitters (ELTs).	22 March 1993 26 July 1993 11 November 1993
70	ANC; Third Meeting of the Aeronautical Fixed Service Systems Planning for Data Interchange Panel; 34th Meeting of the European Air Navigation Planning Group.	Restructuring of Annex 10 into five volumes; deletion of obsolete specifications and guidance material on manual Morse code procedures and teletypewriter systems; inclusion of material on common ICAO data interchange network (CIDIN).	20 March 1995 24 July 1995 9 November 1995

* Did not affect any Standards or Recommended Practices.

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

Note.— The terms "height", "altitude" and "elevation" have been used throughout this Annex in accordance with the definitions of those terms approved by Council at the 13th Meeting of its Twelfth Session and the term "pressure-altitude" in accordance with the definition approved by Council at the 11th Meeting of its Thirteenth Session; these definitions are as follows:

Height:

1) The vertical distance of a level, point or an object considered as a point, measured from a specified datum.

   Note.— The datum may be specified either in the text or in an explanatory note in the publication concerned.

2) The vertical dimension of an object.

   Note.— The term "height" may also be used in a figurative sense for a dimension other than vertical, e.g. the height of a letter or a figure on a runway.

Altitude. The vertical distance of a level, point or an object considered as a point, measured from mean sea level.

Elevation. The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.

Pressure-altitude. An atmospheric pressure expressed in terms of the altitude which corresponds to that pressure in the Standard Atmosphere.

ANNEX 10 — VOLUME I
PART I — EQUIPMENT AND SYSTEMS

Note 1.— All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union.

Note 2.— This Part of Annex 10 includes Standards and Recommended Practices for certain forms of equipment for air navigation aids. While the Contracting State will determine the necessity for specific installations in accordance with the conditions prescribed in the relevant Standard or Recommended Practice, review of the need for specific installation and the formulation of ICAO opinion and recommendations to Contracting States concerned, is carried out periodically by Council, ordinarily on the basis of recommendations of Regional Air Navigation Meetings (Doc 8144, Directives to Regional Air Navigation Meetings and Rules of Procedure for their Conduct*).*

CHAPTER 1. DEFINITIONS

When the following terms are used in Part I of this Annex, they have the following meanings:

Aeronautical fixed circuit. A circuit forming part of the aeronautical fixed service.

Aeronautical fixed service (AFS). A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.

Aeronautical fixed telecommunication network (AFTN). A world-wide system of aeronautical fixed circuits provided, as part of the aeronautical fixed service, for the exchange of messages and/or digital data between aeronautical fixed stations having the same or compatible communications characteristics.

Aeronautical fixed telecommunication network circuit. A circuit forming part of the AFTN.

Aeronautical telecommunication network (ATN). An internetwork architecture that allows ground, air-ground and avionic data subnetworks to interoperate by adopting common interface services and protocols based on the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model.

Note.— Guidance material on the ATN is contained in the Manual of the Aeronautical Telecommunication Network (ATN) *(Doc 9578).*

AFTN group. Three or more radio stations in the aeronautical fixed telecommunications network exchanging communications on the same radio frequency.

Airborne collision avoidance system (ACAS). An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Aircraft address. A unique combination of 24 bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Note.— The aircraft address is also referred to as the Mode S address or the aircraft Mode S address in the context of SSR Mode S.

A2A emission. Telegraphy by the on/off keying of an amplitude modulated audio frequency or audio frequencies, or by the on/off keying of the modulated emission (special case: an unkeyed emission amplitude modulated).

Effective acceptance bandwidth. The range of frequencies with respect to the assigned frequency for which reception is assured when all receiver tolerances have been taken into account.

Effective adjacent channel rejection. The rejection that is obtained at the appropriate adjacent channel frequency when all relevant receiver tolerances have been taken into account.

Fan marker beacon. A type of radio beacon, the emissions of which radiate in a vertical fan-shaped pattern.

ILS reference datum. A point at a specified height located vertically above the intersection of the runway centre line and the threshold and through which the downward extended straight portion of the glide path passes.

Mean power (of a radio transmitter). The average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions.

Note.— A time of 1/10 second during which the mean power is greatest will be selected normally.

Touchdown. The point where the predetermined glide path intercepts the runway.

Note.— "Touchdown" as defined above is only a datum and is not necessarily the actual point at which the aircraft will touch the runway.

Z marker beacon. A type of radio beacon, the emissions of which radiate in a vertical cone-shaped pattern.

CHAPTER 2. RADIO NAVIGATION AIDS

2.1 Aids to final approach and landing

2.1.1 Until 1 January 1998, the standard non-visual aids to final approach and landing shall be the instrument landing system (ILS) conforming to the Standards contained in Part I, 3.1, and the microwave landing system (MLS) conforming to the Standards contained in Part I, 3.11.

2.1.1.1 From 1 January 1998, the standard non-visual aid to be used for final approach and landing shall be the microwave landing system (MLS) conforming to the Standards contained in Part I, 3.11.

2.1.1.2 From 1 January 1995 to 31 December 1997, it shall be permissible to withdraw ILS installations on the basis of regional air navigation agreement, provided that MLS installations are available which provide a level of service equivalent to that of the previous ILS.

2.1.1.3 ILS installations shall not be retained beyond 1 January 2000. From 1 January 1998 to 31 December 1999, any ILS installation conforming to the Standards contained in Part I, 3.1 may be retained as a non-visual aid to final approach and landing only on the basis of regional air navigation agreement.

2.1.1.4 **Recommendation.—** *The transition from ILS to MLS should be in accordance with the ICAO ILS/MLS transition plan shown at Appendix B to Part I.*

2.1.1.5 Where MLS has been installed conforming to the Standards in Part I, 3.11, no change in, or addition to those Standards shall require any equipment modification affecting interoperability or replacement of such equipment between 1 January 1990 and 31 December 2015.

Note 1.— It is intended that, wherever an ILS conforming to the Standards in Part I, 3.1 has been installed, no change in, or addition to, those Standards will require the replacement of such equipment before 1 January 1998.

Note 2.— The locations at which ILS and/or MLS installations are required are normally established on the basis of regional air navigation agreements.

Note 3.— Since visual reference is essential for the final stages of approach and landing, the installation of ILS or MLS does not obviate the need for visual aids to approach and landing in conditions of low visibility.

2.1.1.6 When an ILS is to be provided, the performance category required shall correspond at least to the category of precision approach runway to be served and shall be chosen from those defined and specified in Part I, 3.1.

Note.— Information on operational objectives associated with Performance Categories is given in Section 2 of Attachment C to Part I.

2.1.2 Differences in ILS and MLS installations in any respect from the Standards of Part I, 3.1 and 3.11 respectively shall be published in NOTAM, manuals or other documents used for the dissemination of such aeronautical information.

2.1.2.1 Non-visual aids to final approach and landing that do not conform:

a) to the Standards in Part I, 3.1.2.1, 3.1.2.2 and 3.1.7.1 a) shall not be described by the term ILS;

b) to the Standards in Part I, 3.11.3 shall not be described by the term MLS.

2.1.3 Wherever there is installed a non-visual aid to final approach and landing that is neither an ILS nor an MLS, but which may be used in whole or in part with aircraft equipment designed for use with the ILS or MLS, full details of parts that may be so used shall be published in NOTAM, manuals or other documents used for the dissemination of such aeronautical information.

2.1.4 **Recommendation.—** *A precision approach radar system conforming to the Standards contained in Part I, 3.2 and equipment for two-way communication with aircraft, together with facilities for the efficient co-ordination of these elements with air traffic control, should be installed and operated as a supplement to the ILS wherever:*

a) air traffic control will be materially assisted by such installation in the landing of aircraft intending to use the ILS; and

b) the accuracy or expedition of final approaches or the facilitation of approaches by aircraft not equipped to use the ILS will be materially aided by such installation.

2.1.4.1 **Recommendation.—** *A precision approach radar system should be installed and maintained in operation at airfields where ILS is required under the provision of 2.1.1.1 above but where an ILS installation is technically impracticable.*

2.1.4.2 Only the precision approach radar element (PAR) of the precision approach radar system conforming to the Standards contained in Part I, 3.2.3, together with the equipment and facilities prescribed in 2.1.4 above, shall need to be installed when it is determined that the surveillance radar element (SRE), associated with the precision approach radar system, is not necessary to meet the requirements of air traffic control for the handling of aircraft intending to use the ILS.

Note.— The SRE is not considered, in any circumstances, a satisfactory alternative to the precision approach radar system.

2.1.4.3 **Recommendation.—** *Although SRE is not considered a satisfactory alternative to the precision approach radar system, an SRE conforming to the Standards contained in Part I, 3.2.4 and equipment for two-way communication with aircraft should be installed and operated for:*

a) the assistance of air traffic control in handling aircraft intending to use the ILS;

b) surveillance radar approaches and departures.

2.1.5 **Recommendation.—** *The ILS should be supplemented by a source or sources of guidance information which, when used in conjunction with appropriate procedures, will provide effective guidance to, and efficient coupling (manual or automatic) with, the desired course line.*

Note.— The following sources of guidance have been used for such purposes. Appropriate guidance with respect to a) and b) is contained in Attachment C to Part I, 2.12:

a) a suitably located VHF omnidirectional radio range (VOR) or equivalent;

b) a locator or locators conforming with the specifications in 3.4 of Part I or a suitably located non-directional radio beacon (NDB);

c) a suitably located DME providing continuous distance information during the approach and missed approach phases of flight.

2.1.6 **Recommendation.—** *Where necessary, the MLS should be supplemented by a source or sources of guidance information which, when used in conjunction with appropriate procedures, will provide effective guidance to, and efficient coupling (manual or automatic) with, the selected MLS approach path.*

2.2 Short-distance aids

2.2.1 In localities and along routes where conditions of traffic density and low visibility necessitate a ground based short-distance radio aid to navigation for the efficient exercise of air traffic control, or where such short-distance aid is required for the safe and efficient conduct of aircraft operations, the standard aid shall be the VHF omnidirectional radio range (VOR) of the CW phase comparison type conforming to the Standards contained in Part I, 3.3.

Note 1.— It is not intended that short-distance radio aids to navigation provided in accordance with 2.2.1 above should be required primarily to perform the function of a long-distance navigation aid.

Note 2.— It is intended that, wherever a VOR conforming to the Standard in 2.2.1 above has been installed, no change in, or addition to, that Standard will require the replacement of such equipment before 1 January 1995.

2.2.1.1 **Recommendation.—** *Means should be provided for the pre-flight checking of VOR airborne equipment at aerodromes regularly used by international air traffic.*

Note.— Guidance material on the pre-flight checking of VOR airborne equipment is contained in Attachment E to Part I.

2.2.2 At localities where for operational reasons, or because of air traffic control reasons such as air traffic density or proximity of routes, there is a need for a more precise navigation service than that provided by VOR, distance measuring equipment (DME) (conforming to the Standards in Part I, 3.5) shall be installed and maintained in operation as a complement to VOR.

2.2.2.1 DME/N equipment first installed after 1 January 1989 shall also conform to the Standards in Part I, 3.5 denoted by ‡.

2.2.2.2 **Recommendation.—** *The Standards marked with ‡ should be treated as recommendations until the operative date given in 2.2.2.1 above.*

Note.— It is intended that, wherever a DME conforming to the Standard in 2.2.2 above has been installed, no change in, or addition to, that Standard will require the replacement of such equipment before 1 January 1995.

2.2.3 DME/W conforming to the Standard contained in Part I, 3.5.4.1.3 f) shall be installed only on the basis of regional agreement.

Note.— There are likely to be locations at which DME/W may be usefully installed, especially for national use. Coordination within the Region concerned, or between Regions, is needed to avoid possible interference and to assist in the maintenance of a current and complete frequency allocation plan.

2.2.3.1 **Recommendation.—** *There should be no new installations of DME/W after 1 January 1987.*

2.3 Radio beacons

2.3.1 Non-directional radio beacons (NDB)

2.3.1.1 An NDB conforming to the Standards in Part I, 3.4 shall be installed and maintained in operation at a locality where an NDB, in conjunction with direction-finding equipment in the aircraft, fulfils the operational requirement for a radio aid to navigation.

2.3.2 En-route VHF marker beacons (75 MHz)

2.3.2.1 **Recommendation.—** *Where a VHF marker beacon is required to mark a position on any air route, a fan marker beacon conforming to the Standard contained in Part I, 3.6 should be installed and maintained in operation.*

Note.— This recommendation does not preclude the use of fan marker beacons at points other than on an air route as, for example, an aid to descent under IFR conditions.

2.3.2.2 **Recommendation.—** *Where a VHF marker beacon is required to mark the position of a radio navigation aid giving directional or track guidance, a Z marker conforming to the Standard in Part I, 3.6 should be installed and maintained in operation.*

2.4 Long-distance aids

2.4.1 Until such time as a new station-referenced long-distance radio navigation aids system is agreed to be necessary to permit a better navigational capability and is implemented, or until it is shown that a long-distance navigation system based on self-contained aids is meeting the operational requirements, the facilities Loran-A, Consol and NDB presently installed and providing important coverage over certain vital oceanic areas and land masses shall be retained, and these systems extended and supplemented as may be necessary to meet air traffic requirements.

Note 1.— "Station-referenced" aids are understood to include "ground-referenced" or "satellite-referenced" aids.

"Self-contained" aids are understood to include "Doppler radar", "inertial navigation" and "celestial navigation", or combinations thereof.

Note 2.— Information regarding the operational requirements for long-distance navigation is contained in 2.4 of Attachment A to Part I.

2.5 Secondary surveillance radar (SSR)

2.5.1 When SSR is installed and maintained in operation as an aid to air traffic services, it shall conform with the provisions of Part I, 3.8 unless otherwise specified in this 2.5.

Note.— As referred to in this Annex, Mode A/C transponders are those which conform to the characteristics prescribed in 3.8.1. Mode S transponders are those which conform to the characteristics prescribed in 3.8.2. The functional capabilities of Mode A/C transponders are an integral part of those of Mode S transponders.

2.5.2 Interrogation modes (ground-to-air)

2.5.2.1 Interrogation for air traffic services shall be performed on the modes described in Part I, 3.8.1.4.3 or 3.8.2. The uses of each mode shall be as follows:

1) *Mode A* — to elicit transponder replies for identity and surveillance.

2) *Mode C* — to elicit transponder replies for automatic pressure-altitude transmission and surveillance.

3) *Intermode* —

a) *Mode A/C/S all-call:* to elicit replies for surveillance of Mode A/C transponders and for the acquisition of Mode S transponders.

b) *Mode A/C-only all-call:* to elicit replies for surveillance of Mode A/C transponders. Mode S transponders do not reply.

4) *Mode S* —

a) *Mode S-only all-call:* to elicit replies for acquisition of Mode S transponders.

b) *Broadcast:* to transmit information to all Mode S transponders. No replies are elicited.

c) *Selective:* for surveillance of, and communication with, individual Mode S transponders. For each interrogation, a reply is elicited only from the transponder uniquely addressed by the interrogation.

Note 1.— Mode A/C transponders are suppressed by Mode S interrogations and do not reply.

Note 2.— There are 25 possible interrogation (uplink) formats and 25 possible Mode S reply (downlink) formats. For format assignment see Part I, 3.8.2.3.2, Figures 3-3.6 and 3-3.7.

2.5.2.1.1 **Recommendation.—** *Administrations should co-ordinate with appropriate national and international authorities those implementation aspects of the SSR system which will permit its optimum use.*

Note.— In order to permit the efficient operation of ground equipment designed to eliminate interference from unwanted aircraft transponder replies to adjacent interrogators (defruiting equipment), States may need to develop co-ordinated plans for the assignment of pulse recurrence frequencies (PRF) to SSR interrogators.

2.5.2.1.2 The assignment of Interrogator Identifier (II) codes, where necessary in areas of overlapping coverage across international boundaries of flight information regions, shall be the subject of regional air navigation agreements.

2.5.2.2 Mode A and Mode C interrogations shall be provided.

Note.— This requirement may be satisfied by intermode interrogations which elicit Mode A and Mode C replies from Mode A/C transponders.

2.5.2.3 **Recommendation.—** *In areas where improved aircraft identification is necessary to enhance the effectiveness of the ATC system, SSR ground facilities having Mode S features should include aircraft identification capability.*

Note.— Aircraft identification reporting through the Mode S data link provides unambiguous identification of aircraft suitably equipped.

2.5.2.4 *Side-lobe suppression control interrogation*

2.5.2.4.1 Side-lobe suppression shall be provided in accordance with the provisions of Part I, 3.8.1.4 and 3.8.1.5 on all Mode A, Mode C and intermode interrogations.

2.5.2.4.2 Side-lobe suppression shall be provided in accordance with the provisions of Part I, 3.8.2.1.5.2.1 on all Mode S-only all-call interrogations.

2.5.3 Transponder reply modes (air-to-ground)

2.5.3.1 Transponders shall respond to Mode A interrogations in accordance with the provisions of Part I, 3.8.1.7.12.1 and to Mode C interrogations in accordance with the provisions of Part I, 3.8.1.7.12.2.

Note.— If pressure-altitude information is not available, transponders reply to Mode C interrogations with framing pulses only.

2.5.3.2 Where the need for Mode C automatic pressure-altitude transmission capability within a specified airspace has been determined, transponders, when used within the airspace concerned, shall respond to Mode C interrogations with pressure-altitude encoding in the information pulses.

2.5.3.2.1 **Recommendation.—** *All transponders, regardless of the airspace in which they will be used, should respond to Mode C interrogations with pressure-altitude information.*

Note.— Operation of the Airborne Collision Avoidance System (ACAS) depends upon intruder aircraft reporting pressure-altitude in Mode C replies.

2.5.3.2.2 **Recommendation.—** *The pressure-altitude information provided by Mode S transponders in response to selective interrogations (i.e. in the AC field) should be reported with the best altitude quantization increment available in the aircraft in accordance with the provisions of Part I, 3.8.2.6.5.4.*

2.5.3.2.3 All Mode S transponders installed on or after 1 January 1992 conforming to the requirements defined for Level 2 or above in 2.5.5.1.2 shall report pressure-altitude encoded in the information pulses in Mode C replies and in the AC field of Mode S replies.

2.5.3.3 Transponders used within airspace where the need for Mode S airborne capability has been determined shall also respond to intermode and Mode S interrogations in accordance with the applicable provisions of Part I, 3.8.2.

2.5.3.3.1 Requirements for mandatory carriage of SSR Mode S transponders shall be on the basis of regional air navigation agreements which shall specify the airspace and the airborne implementation time-scales.

2.5.3.3.2 The agreements indicated in 2.5.3.3.1 shall provide at least seven years' notice.

2.5.4 Mode A reply codes (information pulses)

2.5.4.1 All transponders shall be capable of generating 4 096 reply codes conforming to the characteristics given in Part I, 3.8.1.6.2.

2.5.4.1.1 **Recommendation.—** *ATS authorities should establish the procedures for the allotment of SSR codes in conformity with Regional Air Navigation agreements, taking into account other users of the system.*

Note.— Principles for the allocation of SSR codes are given in Doc 4444, Part X.

2.5.4.2 The following Mode A codes shall be reserved for special purposes:

2.5.4.2.1 Code 7700 to provide recognition of an aircraft in an emergency.

2.5.4.2.2 Code 7600 to provide recognition of an aircraft with radiocommunication failure.

2.5.4.2.3 Code 7500 to provide recognition of an aircraft which is being subjected to unlawful interference.

2.5.4.3 Appropriate provisions shall be made in ground decoding equipment to ensure immediate recognition of Mode A codes 7500, 7600 and 7700.

2.5.4.4 **Recommendation.—** *Mode A code 0000 should be reserved for allocation subject to regional agreement, as a general purpose code.*

2.5.4.5 Mode A code 2000 shall be reserved to provide recognition of an aircraft which has not received any instructions from air traffic control units to operate the transponder.

2.5.5 Mode S airborne equipment capability

2.5.5.1 All Mode S transponders shall conform to one of the following four levels:

2.5.5.1.1 *Level 1* — Level 1 transponders shall have the capabilities prescribed in Part I for:

a) Mode A identity and Mode C pressure-altitude reporting (3.8.1);
b) intermode and Mode S all-call transactions (3.8.2.5);
c) addressed surveillance altitude and identity transaction (3.8.2.6.1, 3.8.2.6.3, 3.8.2.6.5 and 3.8.2.6.7);
d) lockout protocols (3.8.2.6.9);
e) basic data protocols except data link capability reporting (3.8.2.6.10); and
f) air-air service transactions (3.8.2.8).

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Note.— Level 1 permits SSR surveillance based on pressure-altitude reporting and the Mode A identity code. In an SSR Mode S environment, technical performance relative to a Mode A/C transponder is improved due to Mode S selective aircraft interrogation.

2.5.5.1.2 *Level 2* — Level 2 transponders shall have the capabilities of 2.5.5.1.1 and also those prescribed in Part I for:

a) standard length communications (Comm-A and Comm-B) (3.8.2.6.2, 3.8.2.6.4, 3.8.2.6.6, 3.8.2.6.8 and 3.8.2.6.11);

b) data link capability reporting (3.8.2.6.10.2.2); and

c) aircraft identification reporting (3.8.2.9).

Note.— Level 2 permits aircraft identification reporting and other standard length data link communications from ground to air and air to ground.

2.5.5.1.3 *Level 3* — Level 3 transponders shall have the capabilities of 2.5.5.1.2 and also those prescribed in Part I for ground-to-air extended length message (ELM) communications (3.8.2.7.1 to 3.8.2.7.5).

Note.— Level 3 permits extended length data link communications from ground to air and thus may provide retrieval from ground-based data banks and receipt of other air traffic services which are not available with Level 2 transponders.

2.5.5.1.4 *Level 4* — Level 4 transponders shall have the capabilities of 2.5.5.1.3 and also those prescribed in Part I for air-to-ground extended length message (ELM) communications (3.8.2.7.6 and 3.8.2.7.7).

Note.— Level 4 permits extended length data link communications from air to ground and thus may provide access from the ground to airborne data sources and the transmission of other data required by air traffic services which are not available with Level 2 transponders.

2.5.5.2 All Mode S transponders used by international civil air traffic shall conform, at least, to the requirements of Level 2 prescribed in 2.5.5.1.2.

Note 1.— Level 1 may be admitted for use within an individual State or within the terms of a regional air navigation agreement. The Mode S Level 1 transponder comprises the minimum set of features for compatible operation of Mode S transponders with SSR Mode S interrogators. It is defined to prevent a proliferation of transponder types below Level 2 which would be incompatible with SSR Mode S interrogators.

Note 2.— The intent of the requirement for a Level 2 capability is to ensure the widespread use of an ICAO standard transponder capability to allow world-wide planning of Mode S ground facilities and services. The requirement also discourages an initial installation with Level 1 transponders that would be rendered obsolete by later requirements in certain airspace for mandatory carriage of transponders having Level 2 capabilities.

2.5.5.3 Mode S transponders installed on aircraft with gross mass in excess of 5 700 kg or a maximum cruising true airspeed capability in excess of 324 km/h (175 kt) shall operate with antenna diversity as prescribed in Part I, 3.8.2.10.4 if:

a) the aircraft individual certificate of airworthiness is first issued on or after 1 January 1990; or

b) Mode S transponder carriage is required on the basis of regional air navigation agreement in accordance with 2.5.3.3.1 and 2.5.3.3.2.

2.5.5.4 *Capability reporting in Mode S squitters*

2.5.5.4.1 Capability reporting in Mode S acquisition squitters (unsolicited downlink transmissions) shall be provided in accordance with the provisions of Chapter 3, 3.8.2.8.4.1 for all Mode S transponders installed on or after 1 January 1995.

2.5.6 SSR Mode S address

2.5.6.1 The SSR Mode S address shall be one of 16 777 214 twenty-four-bit aircraft addresses allocated by ICAO to the State of Registry or common mark registering authority and assigned as prescribed in 3.8.2.4.1.2.3.1.1 and Appendix C to Part I.

2.6 Distance measuring — general

2.6.1 **Recommendation.—** *If a distance measuring facility is installed and maintained in operation for any radio navigational purpose additional to that specified in 2.2.2 above, it should conform to the specification in Part I, 3.5.*

2.7 Ground and flight testing

2.7.1 Radio navigation aids of the types covered by the specifications in Part I, Chapter 3, of this Annex and available for use by aircraft engaged in international air navigation shall be the subject of periodic ground and flight tests.

Note.— Guidance on the ground and flight testing of some ICAO standard facilities is contained in Attachment C to Part I and in Doc 8071.

2.8 Provision of information on the operational status of radio navigation aids

2.8.1 Aerodrome control towers and units providing approach control service shall be provided without delay with information on the operational status of radio navigation aids essential for approach, landing and take-off at the aerodrome(s) with which they are concerned.

2.9 Secondary power supply for radio navigation aids and communication systems

2.9.1 Radio navigation aids and ground elements of communication systems of the type specified in Volume I, Part I of Annex 10 shall be provided with suitable power supplies and means to ensure continuity of service appropriate to the needs of the service provided.

Note.— Guidance material on this subject is contained in Section 8 of Attachment C to Part I.

CHAPTER 3. SPECIFICATIONS FOR RADIO NAVIGATION AIDS

Note.— Specifications concerning the siting and construction of equipment and installations on operational areas aimed at reducing the hazard to aircraft to a minimum are contained in Annex 14, Chapter 8.

3.1 Specification for ILS

3.1.1 Definitions

Angular displacement sensitivity. The ratio of measured DDM to the corresponding angular displacement from the appropriate reference line.

Back course sector. The course sector which is situated on the opposite side of the localizer from the runway.

Course line. The locus of points nearest to the runway centre line in any horizontal plane at which the DDM is zero.

Course sector. A sector in a horizontal plane containing the course line and limited by the loci of points nearest to the course line at which the DDM is 0.155.

DDM — Difference in depth of modulation. The percentage modulation depth of the larger signal minus the percentage modulation depth of the smaller signal, divided by 100.

Displacement sensitivity (localizer). The ratio of measured DDM to the corresponding lateral displacement from the appropriate reference line.

Facility Performance Category I — ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 60 m (200 ft) or less above the horizontal plane containing the threshold.

Note.— This definition is not intended to preclude the use of Facility Performance Category I — ILS below the height of 60 m (200 ft), with visual reference where the quality of the guidance provided permits, and where satisfactory operational procedures have been established.

Facility Performance Category II — ILS. An ILS which provides guidance information from the coverage limit of the ILS to the point at which the localizer course line intersects the ILS glide path at a height of 15 m (50 ft) or less above the horizontal plane containing the threshold.

Facility Performance Category III — ILS. An ILS which, with the aid of ancillary equipment where necessary, provides guidance information from the coverage limit of the facility to, and along, the surface of the runway.

Front course sector. The course sector which is situated on the same side of the localizer as the runway.

Half course sector. The sector, in a horizontal plane containing the course line and limited by the loci of points nearest to the course line at which the DDM is 0.0775.

Half ILS glide path sector. The sector in the vertical plane containing the ILS glide path and limited by the loci of points nearest to the glide path at which the DDM is 0.0875.

ILS continuity of service. That quality which relates to the rarity of radiated signal interruptions. The level of continuity of service of the localizer or the glide path is expressed in terms of the probability of not losing the radiated guidance signals.

ILS glide path. That locus of points in the vertical plane containing the runway centre line at which the DDM is zero, which, of all such loci, is the closest to the horizontal plane.

ILS glide path angle. The angle between a straight line which represents the mean of the ILS glide path and the horizontal.

ILS glide path sector. The sector in the vertical plane containing the ILS glide path and limited by the loci of points nearest to the glide path at which the DDM is 0.175.

Note.— The ILS glide path sector is located in the vertical plane containing the runway centre line, and is divided by the radiated glide path in two parts called upper sector and lower sector, referring respectively to the sectors above and below the glide path.

ILS integrity. That quality which relates to the trust which can be placed in the correctness of the information supplied by the facility. The level of integrity of the localizer or the glide path is expressed in terms of the probability of not radiating false guidance signals.

ILS Point "A". A point on the ILS glide path measured along the extended runway centre line in the approach direction a distance of 7.5 km (4 NM) from the threshold.

ILS Point "B". A point on the ILS glide path measured along the extended runway centre line in the approach direction a distance of 1 050 m (3 500 ft) from the threshold.

ILS Point "C". A point through which the downward extended straight portion of the nominal ILS glide path passes at a height of 30 m (100 ft) above the horizontal plane containing the threshold.

ILS Point "D". A point 4 m (12 ft) above the runway centre line and 900 m (3 000 ft) from the threshold in the direction of the localizer.

ILS Point "E". A point 4 m (12 ft) above the runway centre line and 600 m (2 000 ft) from the stop end of the runway in the direction of the threshold.

Note.— See Attachment C to Part I, Figure C-1.

ILS reference datum (Point "T"). A point at a specified height located above the intersection of the runway centre line and the threshold and through which the downward extended straight portion of the ILS glide path passes.

Two-frequency glide path system. An ILS glide path in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies within the particular glide path channel.

Two-frequency localizer system. A localizer system in which coverage is achieved by the use of two independent radiation field patterns spaced on separate carrier frequencies within the particular localizer VHF channel.

3.1.2 Basic requirements

3.1.2.1 The ILS shall comprise the following basic components:

a) VHF localizer equipment, associated monitor system, remote control and indicator equipment;

b) UHF glide path equipment, associated monitor system, remote control and indicator equipment;

c) VHF marker beacons, associated monitor systems, remote control and indicator equipment, except as provided in 3.1.7.6.6 below.

Note.— It is intended that the air traffic services unit involved in the control of aircraft on the final approach be one of the designated control points receiving without delay information on the operational status of the ILS as derived from the monitors.

3.1.2.1.1 Facility Performance Categories II and III — ILS also shall comprise remote indicator and control equipment, which shall provide indications at designated remote control points of the operational status of all ILS ground system components.

Note.— It is intended that the air traffic system is likely to call for additional provisions which may be found essential for the attainment of full operational Category III capability, e.g. to provide additional lateral and longitudinal guidance during the landing roll-out, and taxiing, and to ensure enhancement of the integrity and reliability of the system.

3.1.2.2 The ILS shall be constructed and adjusted so that, at a specified distance from the threshold, similar instrumental indications in the aircraft represent similar displacements from the course line or ILS glide path as appropriate, irrespective of the particular ground installation in use.

3.1.2.3 The localizer and glide path components specified in 3.1.2.1 a) and b) above which form part of a Facility Performance Category I — ILS shall comply at least with the Standards in 3.1.3 and 3.1.5 below respectively, excepting those in which application to Facility Performance Category II — ILS is prescribed.

3.1.2.4 The localizer and glide path components specified in 3.1.2.1 a) and b) above which form part of a Facility Performance Category II — ILS shall comply with the Standards applicable to these components in a Facility Performance Category I — ILS, as supplemented or amended by the Standards in 3.1.3 and 3.1.5 below in which application to Facility Performance Category II — ILS is prescribed.

3.1.2.5 The localizer and glide path components and other ancillary equipment specified in 3.1.2.1.1 above, which form part of a Facility Performance Category III — ILS, shall otherwise comply with the Standards applicable to these components in Facility Performance Categories I and II — ILS, except as supplemented by the Standards in 3.1.3 and 3.1.5 below in which application to Facility Performance Category III — ILS is prescribed.

3.1.2.6 To ensure an adequate level of safety, the ILS shall be so designed and maintained that the probability of operation within the performance requirements specified is of a high value, consistent with the category of operational performance concerned.

Note.— The specifications for Facility Performance Categories II and III — ILS are intended to achieve the highest degree of system integrity, reliability and stability of operation under the most adverse environmental conditions to be encountered. Guidance material to achieve this objective in Categories II and III operations is given in 2.8 of Attachment C to Part I.

3.1.2.7 At those locations where two separate ILS facilities serve opposite ends of a single runway, an interlock shall ensure that only the localizer serving the approach direction in use shall radiate, except where the localizer in operational use is Facility Performance Category I — ILS and no operationally harmful interference results.

3.1.2.7.1 **Recommendation.—** *At those locations where two separate ILS facilities serve opposite ends of a single runway and where a Facility Performance Category I — ILS is to be used for auto-coupled approaches and landings in visual conditions an interlock should ensure that only the localizer serving the approach direction in use radiates, providing the other localizer is not required for simultaneous operational use.*

Note.— If both localizers radiate there is a possibility of interference to the localizer signals in the threshold region. Additional guidance material is contained in 2.1.9 and 2.13 of Attachment C to Part I.

3.1.2.7.2 At locations where ILS facilities serving opposite ends of the same runway or different runways at the same airport use the same paired frequencies, an interlock shall ensure that only one facility shall radiate at a time. When switching from one ILS facility to another, radiation from both shall be suppressed for not less than 20 seconds.

Note.— Additional guidance material on the operation of localizers on the same frequency channel is contained in 4.2.6 of Part II and 2.1.9 of Attachment C to Part I.

3.1.3 VHF localizer and associated monitor

Introduction.— The specifications of this 3.1.3 cover ILS localizers providing either positive guidance information over 360 degrees of azimuth, or providing such guidance only within a specified portion of the front coverage (see 3.1.3.7.4 below). Where ILS localizers providing positive guidance information in a limited sector are installed, information from some suitably located navigation aid, together with appropriate procedures, will generally be required to ensure that any misleading guidance information outside the sector is not operationally significant.

3.1.3.1 *General*

3.1.3.1.1 The radiation from the localizer antenna system shall produce a composite field pattern which is amplitude modulated by a 90 Hz and a 150 Hz tone. The radiation field pattern shall produce a course sector with one tone predominating on one side of the course and with the other tone predominating on the opposite side.

3.1.3.1.2 When an observer faces the localizer from the approach end of a runway, the depth of modulation of the radio frequency carrier due to the 150 Hz tone shall predominate on his right hand and that due to the 90 Hz tone shall predominate on his left hand.

3.1.3.1.3 All horizontal angles employed in specifying the localizer field patterns shall originate from the centre of the localizer antenna system which provides the signals used in the front course sector.

3.1.3.2 *Radio frequency*

3.1.3.2.1 The localizer shall operate in the band 108 MHz to 111.975 MHz. Where a single radio frequency carrier is used, the frequency tolerance shall not exceed plus or minus 0.005 per cent. Where two radio frequency carriers are used, the frequency tolerance shall not exceed 0.002 per cent and the nominal band occupied by the carriers shall be symmetrical about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than 5 kHz nor more than 14 kHz.

3.1.3.2.2 The emission from the localizer shall be horizontally polarized. The vertically polarized component of the radiation on the course line shall not exceed that which corresponds to a DDM error of 0.016 when an aircraft is positioned on the course line and is in a roll attitude of 20 degrees from the horizontal.

3.1.3.2.2.1 For Facility Performance Category II localizers, the vertically polarized component of the radiation on the course line shall not exceed that which corresponds to a DDM error of 0.008 when an aircraft is positioned on the course line and is in a roll attitude of 20 degrees from the horizontal.

3.1.3.2.2.2 For Facility Performance Category III localizers, the vertically polarized component of the radiation within a sector bounded by 0.02 DDM either side of the course line shall not exceed that which corresponds to a DDM error of 0.005 when an aircraft is in a roll attitude of 20 degrees from the horizontal.

3.1.3.2.3 For Facility Performance Category III localizers, signals emanating from the transmitter shall contain no components which result in an apparent course line fluctuation of more than 0.005 DDM peak to peak in the frequency band 0.01 Hz to 10 Hz.

3.1.3.3 *Coverage*

3.1.3.3.1 The localizer shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation within the localizer and glide path coverage sectors. The localizer coverage sector shall extend from the centre of the localizer antenna system to distances of:

46.3 km (25 NM) within plus or minus 10 degrees from the front course line;

31.5 km (17 NM) between 10 degrees and 35 degrees from the front course line;

18.5 km (10 NM) outside of plus or minus 35 degrees if coverage is provided;

except that, where topographical features dictate or operational requirements permit, the limits may be reduced to 33.3 km (18 NM) within the plus or minus 10-degree sector and 18.5 km (10 NM) within the remainder of the coverage when alternative navigational facilities provide satisfactory coverage within the intermediate approach area. The localizer signals shall be receivable at the distances specified at and above a height of 600 m (2 000 ft) above the elevation of the threshold, or 300 m (1 000 ft) above the elevation of the highest point within the intermediate and final approach areas, whichever is the higher. Such signals shall be receivable, to the distances specified, up to a surface extending outward from the localizer antenna and inclined at 7 degrees above the horizontal.

3.1.3.3.2 In all parts of the coverage volume specified in 3.1.3.3.1 above, other than as specified in 3.1.3.3.2.1, 3.1.3.3.2.2 and 3.1.3.3.2.3 below, the field strength shall be not less than 40 microvolts per metre (minus 114 dBW/m^2).

Note.— This minimum field strength is required to permit satisfactory operational usage of ILS localizer facilities.

3.1.3.3.2.1 For Facility Performance Category I localizers, the minimum field strength on the ILS glide path and within the localizer course sector from a distance of 18.5 km (10 NM) to a height of 60 m (200 ft) above the horizontal plane containing the threshold shall be not less than 90 microvolts per metre (minus 107 dBW/m²).

3.1.3.3.2.2 For Facility Performance Category II localizers, the minimum field strength on the ILS glide path and within the localizer course sector shall be not less than 100 microvolts per metre (minus 106 dBW/m²) at a distance of 18.5 km (10 NM) increasing to not less than 200 microvolts per metre (minus 100 dBW/m²) at a height of 15 m (50 ft) above the horizontal plane containing the threshold.

3.1.3.3.2.3 For Facility Performance Category III localizers, the minimum field strength on the ILS glide path and within the localizer course sector shall be not less than 100 microvolts per metre (minus 106 dBW/m²) at a distance of 18.5 km (10 NM), increasing to not less than 200 microvolts per metre (minus 100 dBW/m²) at 6 m (20 ft) above the horizontal plane containing the threshold. From this point to a further point 4 m (12 ft) above the runway centre line, and 300 m (1 000 ft) from the threshold in the direction of the localizer, and thereafter at a height of 4 m (12 ft) along the length of the runway in the direction of the localizer, the field strength shall be not less than 100 microvolts per metre (minus 106 dBW/m²).

Note.— The field strengths given in 3.1.3.3.2.2 and 3.1.3.3.2.3 above are necessary to provide the signal-to-noise ratio required for improved integrity.

3.1.3.3.3 **Recommendation.—** *Above 7 degrees, the signals should be reduced to as low a value as practicable.*

Note 1.— The requirements in 3.1.3.3.1, 3.1.3.3.2.1, 3.1.3.3.2.2 and 3.1.3.3.2.3 above are based on the assumption that the aircraft is heading directly toward the facility.

Note 2.— Guidance material on significant airborne receiver parameters is given in 2.2.2 and 2.2.4 of Attachment C to Part I.

3.1.3.3.4 When coverage is achieved by a localizer using two radio frequency carriers, one carrier providing a radiation field pattern in the front course sector and the other providing a radiation field pattern outside that sector, the ratio of the two carrier signal strengths in space within the front course sector to the coverage limits specified at 3.1.3.3.1 above shall not be less than 10 dB.

Note.— Guidance material on localizers achieving coverage with two radio frequency carriers is given in the Note to 3.1.3.11.2 below and in 2.7 of Attachment C to Part I.

3.1.3.4 *Course structure*

3.1.3.4.1 For Facility Performance Category I localizers, bends in the course line shall not have amplitudes which exceed the following:

Zone	*Amplitude (DDM) (95% probability)*
Outer limit of coverage to ILS Point "A"	0.031
ILS Point "A" to ILS Point "B"	0.031 at ILS Point "A" decreasing at a linear rate to 0.015 at ILS Point "B"
ILS Point "B" to ILS Point "C"	0.015

3.1.3.4.2 For Facility Performance Categories II and III localizers, bends in the course line shall not have amplitudes which exceed the following:

Zone	*Amplitude (DDM) (95% probability)*
Outer limit of coverage to ILS Point "A"	0.031
ILS Point "A" to ILS Point "B"	0.031 at ILS Point "A" decreasing at a linear rate to 0.005 at ILS Point "B"
ILS Point "B" to the ILS reference datum	0.005
and, for Category III only:	
ILS reference datum to ILS Point "D"	0.005
ILS Point "D" to ILS Point "E"	0.005 at ILS Point "D" increasing at a linear rate to 0.010 at ILS Point "E"

Note 1.— The amplitudes referred to in 3.1.3.4.1 and 3.1.3.4.2 above are the DDMs due to bends as realized on the mean course line, when correctly adjusted.

Note 2.— Guidance material relevant to the localizer course structure is given in 2.1.4, 2.1.6 and 2.1.7 of Attachment C to Part I.

3.1.3.5 *Carrier modulation*

3.1.3.5.1 The nominal depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones shall be 20 per cent along the course line.

3.1.3.5.2 The depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones shall be within the limits of 18 and 22 per cent.

3.1.3.5.3 The following tolerances shall be applied to the frequencies of the modulating tones:

a) the modulating tones shall be 90 Hz and 150 Hz within plus or minus 2.5 per cent;

b) the modulating tones shall be 90 Hz and 150 Hz within plus or minus 1.5 per cent for Facility Performance Category II installations;

c) the modulating tones shall be 90 Hz and 150 Hz within plus or minus 1 per cent for Facility Performance Category III installations;

d) the total harmonic content of the 90 Hz tone shall not exceed 10 per cent; additionally, for Facility Performance Category III localizers, the second harmonic of the 90 Hz tone shall not exceed 5 per cent;

e) the total harmonic content of the 150 Hz tone shall not exceed 10 per cent.

3.1.3.5.3.1 **Recommendation.**— *For Facility Performance Category I — ILS, the modulating tones should be 90 Hz and 150 Hz within plus or minus 1.5 per cent where practicable.*

3.1.3.5.3.2 For Facility Performance Category III localizers, the depth of amplitude modulation of the radio frequency carrier at the power supply frequency or its harmonics, or by other unwanted components, shall not exceed 0.5 per cent. Harmonics of the supply, or other unwanted noise components that may intermodulate with the 90 Hz and 150 Hz navigational tones or their harmonics to produce fluctuations in the course line, shall not exceed 0.05 per cent modulation depth of the radio frequency carrier.

3.1.3.5.3.3 The modulation tones shall be phase-locked so that within the half course sector, the demodulated 90 Hz and 150 Hz wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II localizers: 20 degrees; and

b) for Facility Performance Category III localizers: 10 degrees,

of phase relative to the 150 Hz component, every half cycle of the combined 90 Hz and 150 Hz wave form.

Note 1.— The definition of phase relationship in this manner is not intended to imply a requirement to measure the phase within the half course sector.

Note 2.— Guidance material relative to such measurement is given at Figure C-6 of Attachment C to Part I.

3.1.3.5.3.4 With two-frequency localizer systems, 3.1.3.5.3.3 above shall apply to each carrier. In addition, the 90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Categories I and II localizers: 20 degrees; and

b) for Category III localizers: 10 degrees,

of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction within:

1) for Categories I and II localizers: 20 degrees; and

2) for Category III localizers: 10 degrees,

of phase relative to 150 Hz.

3.1.3.5.3.5 Alternative two-frequency localizer systems that employ audio phasing different from the normal inphase conditions described in 3.1.3.5.3.4 above shall be permitted. In this alternative system, the 90 Hz to 90 Hz phasing and the 150 Hz to 150 Hz phasing shall be adjusted to their nominal values to within limits equivalent to those stated in 3.1.3.5.3.4 above.

Note.— This is to ensure correct airborne receiver operation in the region away from the course line where the two carrier signal strengths are approximately equal.

3.1.3.5.3.6 **Recommendation.**— *The sum of the modulation depths of the radio frequency carrier due to the 90 Hz and 150 Hz tones should not exceed 95 per cent within the required coverage.*

3.1.3.5.3.7 When utilizing a localizer for radiotelephone communications, the sum of the modulation depths of the radio frequency carrier due to the 90 Hz and 150 Hz tones shall not exceed 65 per cent within 10 degrees of the course line and shall not exceed 78 per cent at any other point around the localizer.

3.1.3.6 *Course alignment accuracy*

3.1.3.6.1 The mean course line shall be adjusted and maintained within limits equivalent to the following displacements from the runway centre line at the ILS reference datum:

a) for Facility Performance Category I localizers: plus or minus 10.5 m (35 ft), or the linear equivalent of 0.015 DDM, whichever is less;

b) for Facility Performance Category II localizers: plus or minus 7.5 m (25 ft);

c) for Facility Performance Category III localizers: plus or minus 3 m (10 ft).

3.1.3.6.2 **Recommendation.**— *For Facility Performance Category II localizers, the mean course line should be adjusted and maintained within limits equivalent to plus or minus 4.5 m (15 ft) displacement from runway centre line at the ILS reference datum.*

Note 1.— It is intended that Facility Performance Categories II and III installations be adjusted and maintained so that the limits specified in 3.1.3.6.1 and 3.1.3.6.2 above are reached on very rare occasions. It is further intended that *design and operation of the total ILS ground system be of sufficient integrity to accomplish this aim.*

Note 2.— It is intended that new Category II installations are to meet the requirements of 3.1.3.6.2 above.

Note 3.— Guidance material on measurement of localizer course alignment is given in 2.1.4 of Attachment C to Part I.

3.1.3.7 *Displacement sensitivity*

3.1.3.7.1 The nominal displacement sensitivity within the half course sector at the ILS reference datum shall be 0.00145 DDM/m (0.00044 DDM/ft) except that for Category I localizers, where the specified nominal displacement sensitivity cannot be met, the displacement sensitivity shall be adjusted as near as possible to that value. For Facility Performance Category I localizers on runway codes 1 and 2, the nominal displacement sensitivity shall be achieved at the ILS Point "B". The maximum course sector angle shall not exceed 6 degrees.

Note.— Runway codes 1 and 2 are defined in Annex 14.

3.1.3.7.2 The lateral displacement sensitivity shall be adjusted and maintained within the limits of plus or minus:

a) 17 per cent of the nominal value for Facility Performance Categories I and II;

b) 10 per cent of the nominal value for Facility Performance Category III.

3.1.3.7.3 **Recommendation.—** *For Facility Performance Category II — ILS, displacement sensitivity should be adjusted and maintained within the limits of plus or minus 10 per cent where practicable.*

Note 1.— The figures given in 3.1.3.7.1 and 3.1.3.7.2 above are based upon a nominal sector width of 210 m (700 ft) at the appropriate point, i.e. ILS Point "B" on runway codes 1 and 2, and the ILS reference datum on other runways.

Note 2.— Guidance material on the alignment and displacement sensitivity of localizers using two radio frequency carriers is given in 2.7 of Attachment C to Part I.

Note 3.— Guidance material on measurement of localizer displacement sensitivity is given in 2.9 of Attachment C to Part I.

3.1.3.7.4 The increase of DDM shall be substantially linear with respect to angular displacement from the front course line (where DDM is zero) up to an angle on either side of the front course line where the DDM is 0.180. From that angle to plus or minus 10 degrees, the DDM shall not be less than 0.180. From plus or minus 10 degrees to plus or minus 35 degrees, the DDM shall not be less than 0.155. Where coverage is required outside of the plus or minus 35 degrees sector, the DDM in the area of the coverage, except in the back course sector, shall not be less than 0.155.

Note 1.— The linearity of change of DDM with respect to angular displacement is particularly important in the neighbourhood of the course line.

Note 2.— The above DDM in the 10-35 degree sector is to be considered a minimum requirement for the use of ILS as a landing aid. Wherever practicable a higher DDM, e.g. 0.180, is advantageous to assist high speed aircraft to execute large angle intercepts at operationally desirable distances.

3.1.3.8 *Voice*

3.1.3.8.1 Facility Performance Categories I and II localizers may provide a ground-to-air radiotelephone communication channel to be operated simultaneously with the navigation and identification signals, provided that such operation shall not interfere in any way with the basic localizer function.

3.1.3.8.2 Category III localizers shall not provide such a channel, except where extreme care has been taken in the design and operation of the facility to ensure that there is no possibility of interference with the navigational guidance.

3.1.3.8.3 If the channel is provided, it shall conform with the following Standards:

3.1.3.8.3.1 The channel shall be on the same radio frequency carrier or carriers as used for the localizer function, and the radiation shall be horizontally polarized. Where two carriers are modulated with speech, the relative phases of the modulations on the two carriers shall be such as to avoid the occurrence of nulls within the coverage of the localizer.

3.1.3.8.3.2 The peak modulation depth of the carrier or carriers due to the radiotelephone communications shall not exceed 50 per cent but shall be adjusted so that:

a) the ratio of peak modulation depth due to the radiotelephone communications to that due to the identification signal is approximately 9:1;

b) the sum of modulation components due to use of the radiotelephone channel, navigational signals and identification signals shall not exceed 95 per cent.

3.1.3.8.3.3 The audio frequency characteristics of the radiotelephone channel shall be flat to within 3 dB relative to the level at 1 000 Hz over the range 300 Hz to 3 000 Hz.

3.1.3.9 *Identification*

3.1.3.9.1 The localizer shall provide for the simultaneous transmission of an identification signal, specific to the runway and approach direction, on the same radio frequency carrier or carriers as used for the localizer function. The transmission of the identification signal shall not interfere in any way with the basic localizer function.

3.1.3.9.2 The identification signal shall be produced by Class A2A modulation of the radio frequency carrier or carriers using a modulation tone of 1 020 Hz within plus or minus 50 Hz. The depth of modulation shall be between the limits of 5 and 15 per cent except that, where a radiotelephone communication channel is provided, the depth of modulation shall be adjusted so that the ratio of peak modulation depth due to radiotelephone communications to that due to the identification signal modulation is approximately 9:1 (see 3.1.3.8.3.2 above). The emissions carrying the identification signal shall be horizontally polarized. Where two carriers are modulated with identification signals, the relative phase of the modulations shall be such as to avoid the occurrence of nulls within the coverage of the localizer.

3.1.3.9.3 The identification signal shall employ the International Morse Code and consist of two or three letters. It may be preceded by the International Morse Code signal of the letter "I", followed by a short pause where it is necessary to distinguish the ILS facility from other navigational facilities in the immediate area.

3.1.3.9.4 The identification signal shall be transmitted at a speed corresponding to approximately seven words per minute, and shall be repeated at approximately equal intervals, not less than six times per minute, at all times during which the localizer is available for operational use. When the transmissions of the localizer are not available for operational use, as, for example, after removal of navigational components, or during maintenance or test transmissions, the identification signal shall be suppressed.

3.1.3.10 *Siting*

3.1.3.10.1 The localizer antenna system shall be located on the extension of the centre line of the runway at the stop end, and the equipment shall be adjusted so that the course lines will be in a vertical plane containing the centre line of the runway served. The antenna system shall have the minimum height necessary to satisfy the coverage requirements laid down in 3.1.3.3 above, and the distance from the stop end of the runway shall be consistent with safe obstruction clearance practices.

3.1.3.11 *Monitoring*

3.1.3.11.1 The automatic monitor system shall provide a warning to the designated control points and cause one of the following to occur, within the period specified in 3.1.3.11.3.1 below, if any of the conditions stated in 3.1.3.11.2 below persists:

a) radiation to cease;

b) removal of the navigation and identification components from the carrier;

c) reversion to a lower category in the case of Facility Performance Categories II and III localizers where the reversion requirement exists.

Note.— It is intended that the alternative of reversion offered in 3.1.3.11.1 above may be used only if:

1) the safety of the reversion procedure has been substantiated; and

2) the means of providing information to the pilot on the change of category has adequate integrity.

3.1.3.11.2 The conditions requiring initiation of monitor action shall be the following:

a) for Facility Performance Category I localizers, a shift of the mean course line from the runway centre line equivalent to more than 10.5 m (35 ft), or the linear equivalent to 0.015 DDM, whichever is less, at the ILS reference datum;

b) for Facility Performance Category II localizers, a shift of the mean course line from the runway centre line equivalent to more than 7.5 m (25 ft) at the ILS reference datum;

c) for Facility Performance Category III localizers, a shift of the mean course line from the runway centre line equivalent to more than 6 m (20 ft) at the ILS reference datum;

d) in the case of localizers in which the basic functions are provided by the use of a single-frequency system, a reduction of power output to less than 50 per cent of normal, provided the localizer continues to meet the requirements of 3.1.3.3, 3.1.3.4 and 3.1.3.5 above;

e) in the case of localizers in which the basic functions are provided by the use of a two-frequency system, a reduction of power output for either carrier to less than 80 per cent of normal, except that a greater reduction to between 80 per cent and 50 per cent of normal may be permitted, provided the localizer continues to meet the requirements of 3.1.3.3, 3.1.3.4 and 3.1.3.5 above;

Note.— It is important to recognize that a frequency change resulting in a loss of the frequency difference specified in 3.1.3.2.1 above may produce a hazardous condition. This problem is of greater operational significance for Categories II and III installations. As necessary, this problem can be dealt with through special monitoring provisions or highly reliable circuitry.

f) change of displacement sensitivity to a value differing by more than 17 per cent from the nominal value for the localizer facility.

Note.— In selecting the power reduction figure to be employed in monitoring referred to in 3.1.3.11.2 e) above, particular attention is directed to vertical and horizontal lobe structure (vertical lobing due to different antenna heights) of the combined radiation systems when two carriers are employed. Large changes in the power ratio between carriers may result in low clearance areas and false courses in the off-course areas to the limits of the vertical coverage requirements specified in 3.1.3.3.1 above.

3.1.3.11.2.1 **Recommendation.**— *In the case of localizers in which the basic functions are provided by the use of a two-frequency system, the conditions requiring initiation of monitor action should include the case when the DDM in the required coverage beyond plus or minus 10 degrees from the front course line, except in the back course sector, decreases below 0.155.*

3.1.3.11.3 The total period of radiation, including period(s) of zero radiation, outside the performance limits specified in a), b), c), d), e) and f) of 3.1.3.11.2 above shall be as short as practicable, consistent with the need for avoiding interruptions of the navigation service provided by the localizer.

3.1.3.11.3.1 The total period referred to under 3.1.3.11.3 above shall not exceed under any circumstances:

10 seconds for Category I localizers;

5 seconds for Category II localizers;

2 seconds for Category III localizers.

Note 1.— The total time periods specified are never-to-be-exceeded limits and are intended to protect aircraft in the final stages of approach against prolonged or repeated periods of localizer guidance outside the monitor limits. For this reason, they include not only the initial period of outside tolerance operation but also the total of any or all periods of outside tolerance radiation including period(s) of zero radiation, which might occur during action to restore service, for example, in the course of consecutive monitor functioning and consequent change-over(s) to localizer equipment(s) or elements thereof.

Note 2.— From an operational point of view, the intention is that no guidance outside the monitor limits be radiated after the time periods given, and that no further attempts be made to restore service until a period in the order of 20 seconds has elapsed.

3.1.3.11.3.2 **Recommendation.**— *Where practicable, the total period under 3.1.3.11.3.1 above should be reduced so as not to exceed two seconds for Category II localizers and one second for Category III localizers.*

3.1.3.11.4 Design and operation of the monitor system shall be consistent with the requirement that navigation guidance and identification will be removed and a warning provided at the designated remote control points in the event of failure of the monitor system itself.

Note.— Guidance material on the design and operation of monitor systems is given in 2.1.8 of Attachment C to Part I.

3.1.3.11.5 Any erroneous navigation signals on the carrier occurring during removal of navigation and identification components in accordance with 3.1.3.11.1 b) above shall be suppressed within the total periods allowed in 3.1.3.11.3.1 above.

Note.— To prevent hazardous fluctuations in the radiated signal, localizers employing mechanical modulation equipment may require suppression of navigation components during modulator rundown.

3.1.4 Interference immunity performance for ILS localizer receiving systems

3.1.4.1 After 1 January 1998, the ILS localizer receiving system shall provide adequate immunity to interference from two signal, third-order intermodulation products caused by VHF FM broadcast signals having levels in accordance with the following:

$$2N_1 + N_2 + 72 \leq 0$$

for VHF FM sound broadcasting signals in the range 107.7 – 108.0 MHz

and

$$2N_1 + N_2 + 3\,(24 - 20 \log \frac{\Delta f}{0.4}) \leq 0$$

for VHF FM sound broadcasting signals below 107.7 MHz,

where the frequencies of the two VHF FM sound broadcasting signals produce, within the receiver, a two signal, third-order intermodulation product on the desired ILS localizer frequency.

N_1 and N_2 are the levels (dBm) of the two VHF FM sound broadcasting signals at the ILS localizer receiver input. Neither level shall exceed the desensitization criteria set forth in 3.1.4.2 below.

$\Delta f = 108.1 - f_1$, where f_1 is the frequency of N_1, the VHF FM sound broadcasting signal closer to 108.1 MHz.

3.1.4.2 After 1 January 1998, the ILS localizer receiving system shall not be desensitized in the presence of VHF FM broadcast signals having levels in accordance with the following table:

Frequency (MHz)	*Maximum level of unwanted signal at receiver input*
88-102	+ 15 dBm
104	+ 10 dBm
106	+ 5 dBm
107.9	− 10 dBm

The relationship is linear between adjacent points designated by the above frequencies.

Note.— Guidance material on immunity criteria to be used for the performance quoted in 3.1.4.1 and 3.1.4.2 above is contained in Attachment C to Part I, 2.2.10.

3.1.4.3 After 1 January 1995, all new installations of airborne ILS localizer receiving systems shall meet the provisions of 3.1.4.1 and 3.1.4.2 above.

3.1.4.4 **Recommendation.—** *Airborne ILS localizer receiving systems meeting the immunity performance standards of 3.1.4.1 and 3.1.4.2 above should be placed into operation at the earliest possible date.*

3.1.5 UHF glide path equipment and associated monitor

Note.— θ is used in this paragraph to denote the nominal glide path angle.

3.1.5.1 *General*

3.1.5.1.1 The radiation from the UHF glide path antenna system shall produce a composite field pattern which is amplitude modulated by a 90 Hz and a 150 Hz tone. The pattern shall be arranged to provide a straight line descent path in the vertical plane containing the centre line of the runway, with the 150 Hz tone predominating below the path and the 90 Hz tone predominating above the path to at least an angle equal to 1.75 θ.

3.1.5.1.2 **Recommendation.—** *The UHF glide path equipment should be capable of adjustment to produce a radiated glide path from 2 to 4 degrees with respect to the horizontal.*

3.1.5.1.2.1 **Recommendation.—** *The ILS glide path angle should be 3 degrees. ILS glide path angles in excess of 3 degrees should not be used except where alternative means of satisfying obstruction clearance requirements are impracticable.*

3.1.5.1.2.2 The glide path angle shall be adjusted and maintained within:

a) 0.075 θ from θ for Facility Performance Categories I and II — ILS glide paths;

b) 0.04 θ from θ for Facility Performance Category III — ILS glide paths.

Note 1.— Guidance material on adjustment and maintenance of glide path angles is given in 2.4 of Attachment C to Part I.

Note 2.— Guidance material on ILS glide path curvature, alignment and siting, relevant to the selection of the height of the ILS reference datum is given in 2.4 of Attachment C to Part I and Figure C-5.

3.1.5.1.3 The downward extended straight portion of the ILS glide path shall pass through the ILS reference datum at a height ensuring safe guidance over obstructions and also safe and efficient use of the runway served.

3.1.5.1.4 The height of the ILS reference datum for Facility Performance Categories II and III — ILS shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) is permitted.

3.1.5.1.5 **Recommendation.—** *The height of the ILS reference datum for Facility Performance Category I — ILS should be 15 m (50 ft). A tolerance of plus 3 m (10 ft) is permitted.*

Note 1.— In arriving at the above height values for the ILS reference datum, a maximum vertical distance of 5.8 m (19 ft) between the path of the aircraft glide path antenna and the path of the lowest part of the wheels at the threshold was assumed. For aircraft exceeding this criterion, appropriate steps may have to be taken either to maintain adequate clearance at threshold or to adjust the permitted operating minima.

Note 2.— Appropriate guidance material is given in 2.4 of Attachment C to Part I.

3.1.5.1.6 **Recommendation.—** *The height of the ILS reference datum for Facility Performance Category I — ILS used on short precision approach runway codes 1 and 2 should be 12 m (40 ft). A tolerance of plus 6 m (20 ft) is permitted.*

3.1.5.2 *Radio frequency*

3.1.5.2.1 The glide path equipment shall operate in the band 328.6 MHz to 335.4 MHz. Where a single radio frequency carrier is used, the frequency tolerance shall not exceed 0.005 per cent. Where two carrier glide path systems are used, the frequency tolerance shall not exceed 0.002 per cent and the nominal band occupied by the carriers shall be symmetrical about the assigned frequency. With all tolerances applied, the frequency separation between the carriers shall not be less than 4 kHz nor more than 32 kHz.

3.1.5.2.2 The emission from the glide path equipment shall be horizontally polarized.

3.1.5.2.3 For Facility Performance Category III — ILS glide path equipment, signals emanating from the transmitter shall contain no components which result in apparent glide path fluctuations of more than 0.02 DDM peak to peak in the frequency band 0.01 Hz to 10 Hz.

3.1.5.3 *Coverage*

3.1.5.3.1 The glide path equipment shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation in sectors of 8 degrees in azimuth on each side of the centre line of the ILS glide path, to a distance of at least 18.5 km (10 NM) up to 1.75 θ and down to 0.45 θ above the horizontal or to such lower angle, down to 0.30 θ, as required to safeguard the promulgated glide path intercept procedure.

3.1.5.3.2 In order to provide the coverage for glide path performance specified in 3.1.5.3.1 above, the minimum field strength within this coverage sector shall be 400 microvolts per metre (minus 95 dBW/m²). For Facility Performance Category I glide paths, this field strength shall be provided down to a height of 30 m (100 ft) above the horizontal plane containing the threshold. For Facility Performance Categories II and III glide paths, this field strength shall be provided down to a height of 15 m (50 ft) above the horizontal plane containing the threshold.

Note 1.— The requirements in the foregoing paragraphs are based on the assumption that the aircraft is heading directly toward the facility.

Note 2.— Guidance material on significant airborne receiver parameters is given in 2.2.5 of Attachment C to Part I.

Note 3.— Material concerning reduction in coverage outside 8 degrees on each side of the centre line of the ILS glide path appears in 2.4 of Attachment C to Part I.

3.1.5.4 *ILS glide path structure*

3.1.5.4.1 For Facility Performance Category I — ILS glide paths, bends in the glide path shall not have amplitudes which exceed the following:

Zone	*Amplitude (DDM) (95% probability)*
Outer limit of coverage to ILS Point "C"	0.035

3.1.5.4.2 For Facility Performance Categories II and III — ILS glide paths, bends in the glide path shall not have amplitudes which exceed the following:

Zone	*Amplitude (DDM) (95% probability)*
Outer limit of coverage to ILS Point "A"	0.035
ILS Point "A" to ILS Point "B"	0.035 at ILS Point "A" decreasing at a linear rate to 0.023 at ILS Point "B"
ILS Point "B" to ILS reference datum	0.023

Note 1.— The amplitudes referred to in 3.1.5.4.1 and 3.1.5.4.2 above are the DDMs due to bends as realized on the mean ILS glide path correctly adjusted.

Note 2.— In regions of the approach where ILS glide path curvature is significant, bend amplitudes are calculated from the mean curved path, and not the downward extended straight line.

Note 3.— Guidance material relevant to the ILS glide path course structure is given in 2.1.5 of Attachment C to Part I.

3.1.5.5 *Carrier modulation*

3.1.5.5.1 The nominal depth of modulation of the radio frequency carrier due to each of the 90 Hz and 150 Hz tones shall be 40 per cent along the ILS glide path. The depth of modulation shall not deviate outside the limits of 37.5 per cent to 42.5 per cent.

3.1.5.5.2 The following tolerances shall be applied to the frequencies of the modulating tones:

a) the modulating tones shall be 90 Hz and 150 Hz within 2.5 per cent for Facility Performance Category I — ILS;

b) the modulating tones shall be 90 Hz and 150 Hz within 1.5 per cent for Facility Performance Category II — ILS;

c) the modulating tones shall be 90 Hz and 150 Hz within 1 per cent for Facility Performance Category III — ILS;

d) the total harmonic content of the 90 Hz tone shall not exceed 10 per cent: additionally, for Facility Performance Category III equipment, the second harmonic of the 90 Hz tone shall not exceed 5 per cent;

e) the total harmonic content of the 150 Hz tone shall not exceed 10 per cent.

3.1.5.5.2.1 **Recommendation.—** *For Facility Performance Category I — ILS, the modulating tones should be 90 Hz and 150 Hz within plus or minus 1.5 per cent where practicable.*

3.1.5.5.2.2 For Facility Performance Category III glide path equipment, the depth of amplitude modulation of the radio frequency carrier at the power supply frequency or harmonics, or at other noise frequencies, shall not exceed 1 per cent.

3.1.5.5.3 The modulation shall be phase-locked so that within the ILS half glide path sector, the demodulated 90 Hz and 150 Hz wave forms pass through zero in the same direction within:

a) for Facility Performance Categories I and II — ILS glide paths: 20 degrees;

b) for Facility Performance Category III — ILS glide paths: 10 degrees,

of phase relative to the 150 Hz component, every half cycle of the combined 90 Hz and 150 Hz wave form.

Note 1.— The definition of phase relationship in this manner is not intended to imply a requirement for measurement of phase within the ILS half glide path sector.

Note 2.— Guidance material relating to such measures is given at Figure C-6 of Attachment C to Part I.

3.1.5.5.3.1 With two-frequency glide path systems, 3.1.5.5.3 above shall apply to each carrier. In addition, the

90 Hz modulating tone of one carrier shall be phase-locked to the 90 Hz modulating tone of the other carrier so that the demodulated wave forms pass through zero in the same direction within:

a) for Categories I and II — ILS glide paths: 20 degrees;

b) for Category III — ILS glide paths: 10 degrees,

of phase relative to 90 Hz. Similarly, the 150 Hz tones of the two carriers shall be phase-locked so that the demodulated wave forms pass through zero in the same direction, within:

1) for Categories I and II — ILS glide paths: 20 degrees;

2) for Category III — ILS glide paths: 10 degrees,

of phase relative to 150 Hz.

3.1.5.5.3.2 Alternative two-frequency glide path systems that employ audio phasing different from the normal inphase condition described in 3.1.5.5.3.1 above shall be permitted. In these alternative systems, the 90 Hz to 90 Hz phasing and the 150 Hz to 150 Hz phasing shall be adjusted to their nominal values to within limits equivalent to those stated in 3.1.5.5.3.1 above.

Note.— This is to ensure correct airborne receiver operation within the glide path sector where the two carrier signal strengths are approximately equal.

3.1.5.6 *Displacement sensinvity*

3.1.5.6.1 For Facility Performance Category I — ILS glide paths, the nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at angular displacements above and below the glide path between 0.07 θ and 0.14 θ.

Note.— The above is not intended to preclude glide path systems which inherently have asymmetrical upper and lower sectors.

3.1.5.6.2 **Recommendation.—** *For Facility Performance Category I — ILS glide paths, the nominal angular displacement sensitivity should correspond to a DDM of 0.0875 at an angular displacement below the glide path of 0.12 θ with a tolerance of plus or minus 0.02 θ. The upper and lower sectors should be as symmetrical as practicable within the limits specified in 3.1.5.6.1 above.*

3.1.5.6.3 For Facility Performance Category II — ILS glide paths, the angular displacement sensitivity shall be as symmetrical as practicable. The nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at an angular displacement of:

a) 0.12 θ below path with a tolerance of plus or minus 0.02 θ;

b) 0.12 θ above path with a tolerance of plus 0.02 θ and minus 0.05 θ.

3.1.5.6.4 For Facility Performance Category III — ILS glide paths, the nominal angular displacement sensitivity shall correspond to a DDM of 0.0875 at angular displacements above and below the glide path of 0.12 θ with a tolerance of plus or minus 0.02 θ.

3.1.5.6.5 The DDM below the ILS glide path shall increase smoothly for decreasing angle until a value of 0.22 DDM is reached. This value shall be achieved at an angle not less than 0.30 θ above the horizontal. However, if it is achieved at an angle above 0.45 θ, the DDM value shall not be less than 0.22 at least down to 0.45 θ or to such lower angle, down to 0.30 θ, as required to safeguard the promulgated glide path intercept procedure.

Note.— The limits of glide path equipment adjustment are pictorially represented in Figure C-11 of Attachment C to Part I.

3.1.5.6.6 For Facility Performance Category I — ILS glide paths, the angular displacement sensitivity shall be adjusted and maintained within plus or minus 25 per cent of the nominal value selected.

3.1.5.6.7 For Facility Performance Category II — ILS glide paths, the angular displacement sensitivity shall be adjusted and maintained within plus or minus 20 per cent of the nominal value selected.

3.1.5.6.8 For Facility Performance Category III — ILS glide paths, the angular displacement sensitivity shall be adjusted and maintained within plus or minus 15 per cent of the nominal value selected.

Note.— Explanatory material on ILS glide path adjustment and maintenance values appears at 2.1.5 of Attachment C to Part I.

3.1.5.7 *Monitoring*

3.1.5.7.1 The automatic monitor system shall provide a warning to the designated control points and cause radiation to cease within the periods specified in 3.1.5.7.3.1 below if any of the following conditions persist:

a) shift of the mean ILS glide path angle equivalent to more than minus 0.075 θ to plus 1.10 θ from θ;

b) in the case of ILS glide paths in which the basic functions are provided by the use of a single-frequency system, a reduction of power output to less than 50 per cent, provided the glide path continues to meet the requirements of 3.1.5.3, 3.1.5.4 and 3.1.5.5 above;

c) in the case of ILS glide paths in which the basic functions are provided by the use of two-frequency systems, a reduction of power output for either carrier to less than 80 per cent of normal, except that a greater reduction to between 80 per cent and 50 per cent of normal may be permitted, provided the glide path continues to meet the requirements of 3.1.5.3, 3.1.5.4 and 3.1.5.5 above;

Note.— It is important to recognize that a frequency change resulting in a loss of the frequency difference specified in 3.1.5.2.1 above may produce a hazardous condition. This problem is of greater operational significance for Categories II and III installations. As necessary, this problem can be dealt with through special monitoring provisions or highly reliable circuitry.

d) for Facility Performance Category I — ILS glide paths, a change of the angle between the glide path and the line below the glide path (150 Hz predominating) at which a DDM of 0.0875 is realized by more than plus or minus 0.0375 θ;

e) for Facility Performance Categories II and III — ILS glide paths, a change of displacement sensitivity to a value differing by more than 25 per cent from the nominal value;

f) lowering of the line beneath the ILS glide path at which a DDM of 0.0875 is realized to less than 0.7475 θ from horizontal;

g) a reduction of DDM to less than 0.175 within the specified coverage below the glide path sector.

Note 1.— The value of 0.7475 θ from horizontal is intended to ensure adequate obstacle clearance. This value was derived from other parameters of the glide path and monitor specification. Since the measuring accuracy to four significant figures is not intended, the value of 0.75 θ may be used as a monitor limit for this purpose. Guidance on obstacle clearance criteria is given in PANS-OPS (Doc 8168).

Note 2.— Subparagraphs f) and g) are not intended to establish a requirement for a separate monitor to protect against deviation of the lower limits of the half sector below 0.7475 θ from horizontal.

Note 3.— At glide path facilities where the selected nominal angular displacement sensitivity corresponds to an angle below the ILS glide path which is close to or at the maximum limits specified in 3.1.5.6 above, it may be necessary to adjust the monitor operating limits to protect against sector deviations below 0.7475 θ from horizontal.

Note 4.— Guidance material relating to the condition described in g) appears in 2.4.13 of Attachment C to Part I.

3.1.5.7.2 **Recommendation.**— *Monitoring of the ILS glide path characteristics to smaller tolerances should be arranged in those cases where operational penalties would otherwise exist.*

3.1.5.7.3 The total period of radiation, including period(s) of zero radiation, outside the performance limits specified in a), b), c), d), e) and f) of 3.1.5.7.1 above shall be as short as practicable, consistent with the need for avoiding interruptions of the navigation service provided by the ILS glide path.

3.1.5.7.3.1 The total period referred to under 3.1.5.7.3 above shall not exceed under any circumstances:

6 seconds for Category I — ILS glide paths;

2 seconds for Categories II and III — ILS glide paths.

Note 1.— The total time periods specified are never-to-be-exceeded limits and are intended to protect aircraft in the final stages of approach against prolonged or repeated periods of ILS glide path guidance outside the monitor limits. For this reason, they include not only the initial period of outside tolerance operation but also the total of any or all periods of outside tolerance radiation, including period(s) of zero radiation, which might occur during action to restore service, for example, in the course of consecutive monitor functioning and consequent changeover(s) to glide path equipment(s) or elements thereof.

Note 2.— From an operational point of view, the intention is that no guidance outside the monitor limits be radiated after the time periods given, and that no further attempts be made to restore service until a period in the order of 20 seconds has elapsed.

3.1.5.7.3.2 **Recommendation.**— *Where practicable, the total period specified under 3.1.5.7.3.1 above for Categories II and III — ILS glide paths should not exceed 1 second.*

3.1.5.7.4 Design and operation of the monitor system shall be consistent with the requirement that radiation shall cease and a warning shall be provided at the designated remote control points in the event of failure of the monitor system itself.

Note.— Guidance material on the design and operation of monitor systems is given in 2.1.8 of Attachment C to Part I.

3.1.6 Localizer and glide path frequency pairing

3.1.6.1 The pairing of the runway localizer and glide path transmitter frequencies of an instrument landing system shall be taken from the following list in accordance with the provisions of Part II, 4.2:

Localizer (MHz)	*Glide path (MHz)*	*Localizer (MHz)*	*Glide path (MHz)*
108.1	334.7	109.5	332.6
108.15	334.55	109.55	332.45
108.3	334.1	109.7	333.2
108.35	333.95	109.75	333.05
108.5	329.9	109.9	333.8
108.55	329.75	109.95	333.65
108.7	330.5	110.1	334.4
108.75	330.35	110.15	334.25
108.9	329.3	110.3	335.0
108.95	329.15	110.35	334.85
109.1	331.4	110.5	329.6
109.15	331.25	110.55	329.45
109.3	332.0	110.7	330.2
109.35	331.85	110.75	330.05

Localizer (MHz)	Glide path (MHz)	Localizer (MHz)	Glide path (MHz)
110.9	330.8	111.5	332.9
110.95	330.65	111.55	332.75
111.1	331.7	111.7	333.5
111.15	331.55	111.75	333.35
111.3	332.3	111.9	331.1
111.35	332.15	111.95	330.95

3.1.6.1.1 In those regions where the requirements for runway localizer and glide path transmitter frequencies of an instrument landing system do not justify more than 20 pairs, they shall be selected sequentially, as required, from the following list:

Sequence number	*Localizer (MHz)*	*Glide path (MHz)*
1	110.3	335.0
2	109.9	333.8
3	109.5	332.6
4	110.1	334.4
5	109.7	333.2
6	109.3	332.0
7	109.1	331.4
8	110.9	330.8
9	110.7	330.2
10	110.5	329.6
11	108.1	334.7
12	108.3	334.1
13	108.5	329.9
14	108.7	330.5
15	108.9	329.3
16	111.1	331.7
17	111.3	332.3
18	111.5	332.9
19	111.7	333.5
20	111.9	331.1

3.1.6.2 Where existing ILS localizers meeting national requirements are operating on frequencies ending in even tenths of a megahertz, they shall be re-assigned frequencies, conforming with 3.1.6.1 or 3.1.6.1.1 above as soon as practicable and may continue operating on their present assignments only until this re-assignment can be effected.

3.1.6.3 Existing ILS localizers in the international service operating on frequencies ending in odd tenths of a megahertz shall not be assigned new frequencies ending in odd tenths plus one twentieth of a megahertz except where, by regional agreement, general use may be made of any of the channels listed in 3.1.6.1 above (see Part II, 4.2).

3.1.7 VHF marker beacons

3.1.7.1 *General*

a) There shall be two marker beacons in each installation except as provided in 3.1.7.6.6 below. A third marker beacon may be added whenever, in the opinion of the Competent Authority, an additional beacon is required because of operational procedures at a particular site.

b) The marker beacons shall conform to the requirements prescribed in this 3.1.7. When the installation comprises only two marker beacons, the requirements applicable to the middle marker and to the outer marker shall be complied with.

c) The marker beacons shall produce radiation patterns to indicate predetermined distance from the threshold along the ILS glide path.

3.1.7.1.1 When a marker beacon is used in conjunction with the back course of a localizer, it shall conform with the marker beacon characteristics specified in 3.1.7.

3.1.7.1.2 Identification signals of marker beacons used in conjunction with the back course of a localizer shall be clearly distinguishable from the inner, middle and outer marker beacon identifications, as prescribed in 3.1.7.5.1 below.

3.1.7.2 *Radio frequency*

3.1.7.2.1 The marker beacons shall operate at 75 MHz with a frequency tolerance of plus or minus 0.01 per cent and shall utilize horizontal polarization. As from 1 January 1985 all newly installed marker beacons shall have a frequency tolerance of plus or minus 0.005 per cent. After 1 January 1990 this provision applies for all marker beacons.

3.1.7.2.2 **Recommendation.—** *Marker beacons should operate with a frequency tolerance of plus or minus 0.005 per cent.*

3.1.7.3 *Coverage*

3.1.7.3.1 The marker beacon system shall be adjusted to provide coverage over the following distances, measured on the ILS glide path and localizer course line:

a) *inner marker (where installed):* 150 m plus or minus 50 m (500 ft plus or minus 160 ft);

b) *middle marker:* 300 m plus or minus 100 m (1 000 ft plus or minus 325 ft);

c) *outer marker:* 600 m plus or minus 200 m (2 000 ft plus or minus 650 ft).

3.1.7.3.2 The field strength at the limits of coverage specified in 3.1.7.3.1 above shall be 1.5 millivolts per metre (82 dBW/m²). In addition, the field strength within the coverage area shall rise to at least 3.0 millivolts per metre (76 dBW/m²).

Note 1.— In the design of the ground antenna, it is advisable to ensure that an adequate rate of change of field strength is provided at the edges of coverage. It is also advisable to ensure that aircraft within the localizer course sector will receive visual indication.

Note 2.— Satisfactory operation of a typical airborne marker installation will be obtained if the sensitivity is so adjusted that visual indication will be obtained when the field strength is 1.5 millivolts per metre (82 dBW/m²).

3.1.7.4 *Modulation*

3.1.7.4.1 The modulation frequencies shall be as follows:

a) *inner marker (when installed):* 3 000 Hz;

b) *middle marker:* 1 300 Hz;

c) *outer marker:* 400 Hz.

The frequency tolerance of the above frequencies shall be plus or minus 2.5 per cent, and the total harmonic content of each of the frequencies shall not exceed 15 per cent.

3.1.7.4.2 The depth of modulation of the markers shall be 95 per cent plus or minus 4 per cent.

3.1.7.5 *Identification*

3.1.7.5.1 The carrier energy shall not be interrupted. The audio frequency modulation shall be keyed as follows:

a) *inner marker (when installed):* 6 dots per second continuously;

b) *middle marker:* a continuous series of alternate dots and dashes, the dashes keyed at the rate of 2 dashes per second, and the dots at the rate of 6 dots per second;

c) *outer marker:* 2 dashes per second continuously.

These keying rates shall be maintained to within plus or minus 15 per cent.

3.1.7.6 *Siting*

3.1.7.6.1 The inner marker, when installed, shall be located so as to indicate in low visibility conditions the imminence of arrival at the runway threshold.

3.1.7.6.1.1 **Recommendation.—** *If the radiation pattern is vertical, the inner marker, when installed, should be located between 75 m (250 ft) and 450 m (1 500 ft) from the threshold and at not more than 30 m (100 ft) from the extended centre line of the runway.*

Note 1.— It is intended that the inner marker pattern should intercept the downward extended straight portion of the nominal ILS glide path at the lowest decision height applicable in Category II operations.

Note 2.— Care must be exercised in siting the inner marker to avoid interference between the inner and middle markers. Details regarding the siting of inner markers are contained in 2.10 of Attachment C to Part I.

3.1.7.6.1.2 **Recommendation.—** *If the radiation pattern is other than vertical, the equipment should be located so as to produce a field within the course sector and ILS glide path sector that is substantially similar to that produced by an antenna radiating a vertical pattern and located as prescribed in 3.1.7.6.1.1 above.*

3.1.7.6.2 The middle marker shall be located so as to indicate the imminence, in low visibility conditions, of visual approach guidance.

3.1.7.6.2.1 **Recommendation.—** *If the radiation pattern is vertical, the middle marker should be located 1 050 m (3 500 ft) plus or minus 150 m (500 ft), from the landing threshold at the approach end of the runway and at not more than 75 m (250 ft) from the extended centre line of the runway.*

Note.— See 2.2.2 of Attachment A to Part I, regarding the siting of inner and middle marker beacons.

3.1.7.6.2.2 **Recommendation.—** *If the radiation pattern is other than vertical, the equipment should be located so as to produce a field within the course sector and ILS glide path sector that is substantially similar to that produced by an antenna radiating a vertical pattern and located as prescribed in 3.1.7.6.2.1 above.*

3.1.7.6.3 The outer marker shall be located so as to provide height, distance and equipment functioning checks to aircraft on intermediate and final approach.

3.1.7.6.3.1 **Recommendation.—** *The outer marker should be located 7.2 km (3.9 NM) from the threshold except that, where for topographical or operational reasons this distance is not practicable, the outer marker may be located between 6.5 and 11.1 km (3.5 and 6 NM) from the threshold.*

3.1.7.6.4 **Recommendation.—** *If the radiation pattern is vertical, the outer marker should be not more than 75 m (250 ft) from the extended centre line of the runway. If the radiation pattern is other than vertical, the equipment should be located so as to produce a field within the course sector and ILS glide path sector that is substantially similar to that produced by an antenna radiating a vertical pattern.*

3.1.7.6.5 The positions of marker beacons, or where applicable, the equivalent distance(s) indicated by the DME when used as an alternative to part or all of the marker beacon component of the ILS, shall be published in accordance with the provisions of Annex 15.

3.1.7.6.6 Where the provision of VHF marker beacons is impracticable, a suitably located DME, together with associated monitor system and remote control and indicator equipment shall be an acceptable alternative to part or all of the marker beacon component of the ILS.

Note.— Guidance material relative to the use of DME as an alternative to the marker beacon component of the ILS is contained in Attachment C to Part I, 2.11.

3.1.7.6.6.1 When so used, the DME shall provide distance information operationally equivalent to that furnished by marker beacon(s).

3.1.7.6.6.2 When used as an alternative for the middle marker, the DME shall be frequency paired with the ILS localizer and sited so as to minimize the error in distance information.

3.1.7.6.6.3 The DME in 3.1.7.6.6 above shall conform to the specification in 3.5 below.

3.1.7.7 *Monitoring*

3.1.7.7.1 Suitable equipment shall provide signals for the operation of an automatic monitor. The monitor shall transmit a warning to a control point if either of the following conditions arise:

a) failure of the modulation or keying;

b) reduction of power output to less than 50 per cent of normal.

3.1.7.7.2 **Recommendation.—** *For each marker beacon, suitable monitoring equipment should be provided which will indicate at the appropriate location a decrease of the modulation depth below 50 per cent.*

3.2 Specification for precision approach radar system

Note.— Slant distances are used throughout this specification.

3.2.1 The precision approach radar system shall comprise the following elements:

3.2.1.1 The precision approach radar element (PAR).

3.2.1.2 The surveillance radar element (SRE).

3.2.2 When the PAR only is used, the installation shall be identified by the term PAR or precision approach radar and not by the term "precision approach radar system".

Note.— Provisions for the recording and retention of radar data are contained in Annex 11, Chapter 6.

3.2.3 The precision approach radar element (PAR)

3.2.3.1 *Coverage*

3.2.3.1.1 The PAR shall be capable of detecting and indicating the position of an aircraft of 15 m² echoing area or larger, which is within a space bounded by a 20-degree azimuth sector and a 7-degree elevation sector, to a distance of at least 16.7 km (9 NM) from its respective antenna.

Note.— For guidance in determining the significance of the echoing areas of aircraft, the following table is included:

Private flyer (single-engined): 5 to 10 m².

Small twin-engined aircraft: from 15 m².

Medium twin-engined aircraft: from 25 m².

Four-engined aircraft: from 50 to 100 m².

3.2.3.2 *Siting*

3.2.3.2.1 The PAR shall be sited and adjusted so that it gives complete coverage of a sector with its apex at a point 150 m (500 ft) from the touchdown in the direction of the stop end of the runway and extending plus or minus 5 degrees about the runway centre line in azimuth and from minus 1 degree to plus 6 degrees in elevation.

Note 1.— 3.2.3.2.1 above can be met by siting the equipment with a set-back from the touchdown, in the direction of the stop end of the runway, of 915 m (3 000 ft) or more, for an offset of 120 m (400 ft) from the runway centre line, or of 1 200 m (4 000 ft) or more, for an offset of 185 m (600 ft) when the equipment is aligned to scan plus or minus 10 degrees about the centre line of the runway. Alternatively, if the equipment is aligned to scan 15 degrees to one side and 5 degrees to the other side of the centre line of the runway, then the minimum set-back can be reduced to 685 m (2 250 ft) and 915 m (3 000 ft) for offsets of 120 m (400 ft) and 185 m (600 ft) respectively.

Note 2.— Diagrams illustrating the siting of PAR are given in Attachment C to Part I (Figures C-14 to C-17 inclusive).

3.2.3.3 *Accuracy*

3.2.3.3.1 *Azimuth accuracy.* Azimuth information shall be displayed in such a manner that left-right deviation from the on-course line shall be easily observable. The maximum permissible error with respect to the deviation from the on-course line shall be either 0.6 per cent of the distance from the PAR antenna plus 10 per cent of the deviation from the on-course line or 9 m (30 ft), whichever is greater. The equipment shall be so sited that the error at the touchdown shall not exceed 9 m (30 ft). The equipment shall be so aligned and adjusted that the displayed error at the touchdown shall be a minimum and shall not exceed 0.3 per cent of the distance from the PAR antenna or 4.5 m (15 ft), whichever is greater. It shall be possible to resolve the positions of two aircraft which are at 1.2 degrees in azimuth of one another.

3.2.3.3.2 *Elevation accuracy.* Elevation information shall be displayed in such a manner that up-down deviation from the descent path for which the equipment is set shall be easily observable. The maximum permissible error with respect to the deviation from the on-course line shall be 0.4 per cent of the distance from the PAR antenna plus 10 per cent of the actual linear displacement from the chosen descent path or 6 m (20 ft), whichever is greater. The equipment shall be so sited that the error at the touchdown shall not exceed 6 m (20 ft). The equipment shall be so aligned and adjusted that the displayed error at the touchdown shall be a minimum and shall not exceed 0.2 per cent of the distance from the PAR antenna or 3 m (10 ft), whichever is greater. It shall be possible to resolve the positions of two aircraft that are at 0.6 degree in elevation of one another.

3.2.3.3.3 *Distance accuracy.* The error in indication of the distance from the touchdown shall not exceed 30 m (100 ft) plus 3 per cent of the distance from the touchdown. It shall be possible to resolve the positions of two aircraft which are at 120 m (400 ft) of one another on the same azimuth.

3.2.3.4 Information shall be made available to permit the position of the controlled aircraft to be established with respect to other aircraft and obstructions. Indications shall also permit appreciation of ground speed and rate of departure from or approach to the desired flight path.

3.2.3.5 Information shall be completely renewed at least once every second.

3.2.4 The surveillance radar element (SRE)

3.2.4.1 A surveillance radar used as the SRE of a precision approach radar system shall satisfy at least the following broad performance requirements.

3.2.4.2 *Coverage*

3.2.4.2.1 The SRE shall be capable of detecting aircraft of 15 m^2 echoing area and larger, which are in line of sight of the antenna within a volume described as follows:

The rotation through 360 degrees about the antenna of a vertical plane surface bounded by a line at an angle of 1.5 degrees above the horizontal plane of the antenna, extending from the antenna to 37 km (20 NM); by a vertical line at 37 km (20 NM) from the intersection with the 1.5-degree line up to 2 400 m (8 000 ft) above the level of the antenna; by a horizontal line at 2 400 m (8 000 ft) from 37 km (20 NM) back towards the antenna to the intersection with a line from the antenna at 20 degrees above the horizontal plane of the antenna, and by a 20-degree line from the intersection with the 2 400 m (8 000 ft) line to the antenna.

3.2.4.2.2 **Recommendation.—** *Efforts should be made in development to increase the coverage on an aircraft of 15 m^2 echoing area to at least the volume obtained by amending 3.2.4.2.1 above with the following substitutions:*

— for *1.5 degrees,* read *0.5 degree;*

— for *37 km (20 NM),* read *46.3 km (25 NM);*

— for *2 400 m (8 000 ft),* read *3 000 m (10 000 ft);*

— for *20 degrees,* read *30 degrees.*

Note.— A diagram illustrating the vertical coverage of SRE is given in Attachment C to Part I (Figure C-18).

3.2.4.3 *Accuracy*

3.2.4.3.1 *Azimuth accuracy.* The indication of position in azimuth shall be within plus or minus 2 degrees of the true position. It shall be possible to resolve the positions of two aircraft which are at 4 degrees of azimuth of one another.

3.2.4.3.2 *Distance accuracy.* The error in distance indication shall not exceed 5 per cent of true distance or 150 m, whichever is the greater. It shall be possible to resolve the positions of two aircraft that are separated by a distance of 1 per cent of the true distance from the point of observation or 230 m, whichever is the greater.

3.2.4.3.2.1 **Recommendation.—** *The error in distance indication should not exceed 3 per cent of the true distance or 150 m, whichever is the greater.*

3.2.4.4 The equipment shall be capable of completely renewing the information concerning the distance and azimuth of any aircraft within the coverage of the equipment at least once every 4 seconds.

3.2.4.5 **Recommendation.—** *Efforts should be made to reduce, as far as possible, the disturbance caused by ground echoes or echoes from clouds and precipitation.*

3.3 Specification for VHF omnidirectional radio range (VOR)

3.3.1 General

3.3.1.1 The VOR shall be constructed and adjusted so that similar instrumental indications in aircraft represent equal clockwise angular deviations (bearings), degree for degree from magnetic North as measured from the location of the VOR.

3.3.1.2 The VOR shall radiate a radio frequency carrier with which are associated two separate 30 Hz modulations. One of these modulations shall be such that its phase is independent of the azimuth of the point of observation (reference phase). The other modulation (variable phase) shall be such that its phase at the point of observation differs from that of the reference phase by an angle equal to the bearing of the point of observation with respect to the VOR.

3.3.1.3 The reference and variable phase modulations shall be in phase along the reference meridian through the station.

Note.— The reference and variable phase modulations are in phase when the maximum value of the sum of the radio frequency carrier and the sideband energy due to the variable phase modulation occurs at the same time as the highest instantaneous frequency of the reference phase modulation.

3.3.2 Radio frequency

3.3.2.1 The VOR shall operate in the band 111.975 MHz to 117.975 MHz except that frequencies in the band 108 MHz to 111.975 MHz may be used when, in accordance with the provisions of Part II, 4.2.1 and 4.2.3.1, the use of such frequencies is acceptable. The highest assignable frequency shall be 117.950 MHz. The channel separation shall be in increments of 50 kHz referred to the highest assignable frequency. In areas where 100 kHz or 200 kHz channel spacing is in general use, the frequency tolerance of the radio frequency carrier shall be plus or minus 0.005 per cent.

3.3.2.2 The frequency tolerance of the radio frequency carrier of all new installations implemented after 23 May 1974 in areas where 50 kHz channel spacing is in use shall be plus or minus 0.002 per cent.

3.3.2.3 In areas where new VOR installations are implemented and are assigned frequencies spaced at 50 kHz from existing VORs in the same area, priority shall be given to ensuring that the frequency tolerance of the radio frequency carrier of the existing VORs is reduced to plus or minus 0.002 per cent.

3.3.3 Polarization and pattern accuracy

3.3.3.1 The emission from the VOR shall be horizontally polarized. The vertically polarized component of the radiation shall be as small as possible.

Note.— It is not possible at present to state quantitatively the maximum permissible magnitude of the vertically polarized component of the radiation from the VOR. (Information is provided in the Manual on Testing of Radio Navigation Aids *(Doc 8071) as to flight checks that can be carried out to determine the effects of vertical polarization on the bearing accuracy.)*

3.3.3.2 The accuracy of the bearing information conveyed by the horizontally polarized radiation from the VOR at a distance of approximately four wavelengths for all elevation angles between 0 and 40 degrees, measured from the centre of the VOR antenna system, shall be within plus or minus 2 degrees.

3.3.4 Coverage

3.3.4.1 The VOR shall provide signals such as to permit satisfactory operation of a typical aircraft installation at the levels and distances required for operational reasons, and up to an elevation angle of 40 degrees.

3.3.4.2 **Recommendation.—** *The field strength or power density in space of VOR signals required to permit satisfactory operation of a typical aircraft installation at the minimum service level at the maximum specified service radius should be 90 microvolts per metre or minus 107 dBW/m².*

Note.— Typical effective radiated powers (ERPs) to achieve specified ranges are contained in 3.1 of Attachment C to Part I.

3.3.5 Modulations of navigational signals

3.3.5.1 The radio frequency carrier as observed at any point in space shall be amplitude modulated by two signals as follows:

a) a subcarrier of 9 960 Hz of constant amplitude, frequency modulated at 30 Hz and having a deviation ratio of 16 plus or minus 1 (i.e. 15 to 17):

 1) for the conventional VOR, the 30 Hz component of this FM subcarrier is fixed without respect to azimuth and is termed the "reference phase";

 2) for the Doppler VOR, the phase of the 30 Hz component varies with azimuth and is termed the "variable phase";

b) a 30 Hz amplitude modulation component:

 1) for the conventional VOR, this component results from a rotating field pattern, the phase of which varies with azimuth, and is termed the "variable phase";

 2) for the Doppler VOR, this component, of constant phase with relation to azimuth and constant amplitude, is radiated omnidirectionally and is termed the "reference phase".

3.3.5.2 The depth of modulation of the radio frequency carrier due to the subcarrier of 9 960 Hz shall be within the limits of 28 per cent and 32 per cent.

3.3.5.3 The depth of modulation of the radio frequency carrier due to the 30 Hz or 9 960 Hz signals, as observed at any angle of elevation up to 5 degrees, shall be within the limits of 28 to 32 per cent.

3.3.5.4 The variable and reference phase modulation frequencies shall be 30 Hz within plus or minus 1 per cent.

3.3.5.5 The subcarrier modulation mid-frequency shall be 9 960 Hz within plus or minus 1 per cent.

3.3.5.6

a) For the conventional VOR, the percentage of amplitude modulation of the 9 960 Hz subcarrier shall not exceed 5 per cent.

b) For the Doppler VOR, the percentage of amplitude modulation of the 9 960 Hz subcarrier shall not exceed 40 per cent when measured at a point at least 300 m (1 000 ft) from the VOR.

3.3.5.7 Where 50 kHz VOR channel spacing is implemented, the sideband level of the harmonics of the 9 960 Hz component in the radiated signal shall not exceed the following levels referred to the level of the 9 960 Hz sideband:

Subcarrier	*Level*
9 960 Hz	0 dB reference
2nd harmonic	− 30 dB
3rd harmonic	− 50 dB
4th harmonic and above	− 60 dB

3.3.6 Voice and identification

3.3.6.1 If the VOR provides a simultaneous communication channel ground-to-air, it shall be on the same radio frequency carrier as used for the navigational function. The radiation on this channel shall be horizontally polarized.

3.3.6.2 The peak modulation depth of the carrier on the communication channel shall not be greater than 30 per cent.

3.3.6.3 The audio frequency characteristics of the speech channel shall be within 3 dB relative to the level at 1 000 Hz over the range 300 Hz to 3 000 Hz.

3.3.6.4 The VOR shall provide for the simultaneous transmission of a signal of identification on the same radio frequency carrier as that used for the navigational function. The identification signal radiation shall be horizontally polarized.

3.3.6.5 The identification signal shall employ the International Morse Code and consist of two or three letters. It shall be sent at a speed corresponding to approximately 7 words per minute. The signal shall be repeated at least once every 30 seconds and the modulation tone shall be 1 020 Hz within plus or minus 50 Hz.

3.3.6.5.1 **Recommendation.—** *The identification signal should be transmitted at least three times each 30 seconds, spaced equally within that time period. One of these identification signals may take the form of a voice identification.*

Note.— Where a VOR and DME are associated in accordance with 3.5.2.5 below, the identification provisions of 3.5.3.6.4 below influence the VOR identification.

3.3.6.6 The depth to which the radio frequency carrier is modulated by the code identification signal shall be close to, but not in excess of 10 per cent except that, where a communication channel is not provided, it shall be permissible to increase the modulation by the code identification signal to a value not exceeding 20 per cent.

3.3.6.6.1 **Recommendation.—** *If the VOR provides a simultaneous communication channel ground-to-air, the modulation depth of the code identification signal should be 5 plus or minus 1 per cent in order to provide a satisfactory voice quality.*

3.3.6.7 The transmission of speech shall not interfere in any way with the basic navigational function. When speech is being radiated, the code identification shall not be suppressed.

3.3.6.8 The VOR receiving function shall permit positive identification of the wanted signal under the signal conditions encountered within the specified coverage limits, and with the modulation parameters specified at 3.3.6.5, 3.3.6.6 and 3.3.6.7 above.

3.3.7 Monitoring

3.3.7.1 Suitable equipment located in the radiation field shall provide signals for the operation of an automatic monitor. The monitor shall transmit a warning to a control point, and either remove the identification and navigation components from the carrier or cause radiation to cease if any one or a combination of the following deviations from established conditions arises:

a) a change in excess of 1 degree at the monitor site of the bearing information transmitted by the VOR;

b) a reduction of 15 per cent in the modulation components of the radio frequency signals voltage level at the monitor of either the subcarrier, or 30 Hz amplitude modulation signals, or both.

3.3.7.2 Failure of the monitor itself shall transmit a warning to a control point and either:

a) remove the identification and navigation components from the carrier; or

b) cause radiation to cease.

Note.— Technical material for the guidance of those who may install or operate the VOR appears in Section 3 of Attachment C to Part I.

3.3.8 Interference immunity performance for VOR receiving systems

3.3.8.1 After 1 January 1998, the VOR receiving system shall provide adequate immunity to interference from two signal, third-order intermodulation products caused by VHF FM broadcast signals having levels in accordance with the following:

$$2N_1 + N_2 + 72 \leq 0$$

for VHF FM sound broadcasting signals in the range 107.7 – 108.0 MHz

and

$$2N_1 + N_2 + 3\left(24 - 20 \log \frac{\Delta f}{0.4}\right) \leq 0$$

for VHF FM sound broadcasting signals below 107.7 MHz,

where the frequencies of the two VHF FM sound broadcasting signals produce, within the receiver, a two signal, third-order intermodulation product on the desired VOR frequency.

N_1 and N_2 are the levels (dBm) of the two VHF FM sound broadcasting signals at the VOR receiver input. Neither level shall exceed the desensitization criteria set forth in 3.3.8.2 below.

$\Delta f = 108.1 - f_1$, where f_1 is the frequency of N_1, the VHF FM sound broadcasting signal closer to 108.1 MHz.

3.3.8.2 After 1 January 1998, the VOR receiving system shall not be desensitized in the presence of VHF FM broadcast signals having levels in accordance with the following table:

Frequency (MHz)	*Maximum level of unwanted signal at receiver input*
88-102	+15 dBm
104	+10 dBm
106	+ 5 dBm
107.9	−10 dBm

The relationship is linear between adjacent points designated by the above frequencies.

Note.— Guidance material on immunity criteria to be used for the performance quoted in 3.3.8.1 and 3.3.8.2 above is contained in Attachment C to Part I, 3.6.5.

3.3.8.3 After 1 January 1995, all new installations of airborne VOR receiving systems shall meet the provisions of 3.3.8.1 and 3.3.8.2 above.

3.3.8.4 **Recommendation.—** *Airborne VOR receiving systems meeting the immunity performance standards of 3.3.8.1 and 3.3.8.2 above should be placed into operation at the earliest possible date.*

3.4 Specification for non-directional radio beacon (NDB)

3.4.1 Definitions

Note.— In Attachment C to Part I, guidance is given on the meaning and application of rated coverage and effective coverage and on coverage of NDBs.

Average radius of rated coverage. The radius of a circle having the same area as the rated coverage.

Effective coverage. The area surrounding an NDB within which bearings can be obtained with an accuracy sufficient for the nature of the operation concerned.

Locator. An LF/MF NDB used as an aid to final approach.

Note.— A locator usually has an average radius of rated coverage of between 18.5 and 46.3 km (10 and 25 NM).

Rated coverage. The area surrounding an NDB within which the strength of the vertical field of the ground wave exceeds the minimum value specified for the geographical area in which the radio beacon is situated.

Note.— The above definition is intended to establish a method of rating radio beacons on the normal coverage to be expected in the absence of sky wave transmission and/or anomalous propagation from the radio beacon concerned or interference from other LF/MF facilities, but taking into account the atmospheric noise in the geographical area concerned.

3.4.2 Coverage

3.4.2.1 **Recommendation.—** *The minimum value of field strength in the rated coverage of an NDB should be 70 microvolts per metre.*

Note 1.— Guidance on the field strengths required particularly in the latitudes between 30°N and 30°S is given in 6.1 of Attachment C to Part I, and the relevant ITU provisions are given in Part B, Chapter VIII, Article 35, Section IV of the Radio Regulations.

Note 2.— The selection of locations and times at which the field strength is measured is important in order to avoid abnormal results for the locality concerned; locations on air routes in the area around the beacon are operationally most significant.

3.4.2.2 All notifications or promulgations of NDBs shall be based upon the average radius of the rated coverage.

Note 1.— In classifying radio beacons in areas where substantial variations in rated coverage may occur diurnally and seasonally, such variations should be taken into account.

Note 2.— Beacons having an average radius of rated coverage of between 46.3 and 278 km (25 and 150 NM) may be designated by the nearest multiple of 46.3 km (25 NM) to the average radius of rated coverage, and beacons of rated coverage over 278 km (150 NM) to the nearest multiple of 92.7 km (50 NM).

3.4.2.3 **Recommendation.—** *Where the rated coverage of an NDB is materially different in various operationally significant sectors, its classification should be expressed in terms of the average radius of rated coverage and the angular limits of each sector as follows:*

Radius of coverage of sector/angular limits of sector expressed as magnetic bearing clockwise from the beacon.

Where it is desirable to classify an NDB in such a manner, the number of sectors should be kept to a minimum and preferably should not exceed two.

Note.— The average radius of a given sector of the rated coverage is equal to the radius of the corresponding circle-sector of the same area. Example:

150/210° − 30° 100/30° − 210°

3.4.3 Limitations in radiated power

The power radiated from an NDB shall not exceed by more than 2 dB that necessary to achieve its agreed rated coverage, except that this power may be increased if co-ordinated regionally or if no harmful interference to other facilities will result.

3.4.4 Radio frequencies

3.4.4.1 The radio frequencies assigned to NDBs shall be selected from those available in that portion of the spectrum between 190 kHz and 1 750 kHz.

3.4.4.2 The frequency tolerance applicable to NDBs shall be 0.01 per cent except that, for NDBs of antenna power above 200 W using frequencies of 1 606.5 kHz and above, the tolerance shall be 0.005 per cent.

3.4.4.3 **Recommendation.**— *Where two locators are used as supplements to an ILS, the frequency separation between the carriers of the two should be not less than 15 kHz to ensure correct operation of the radio compass, and preferably not more than 25 kHz in order to permit a quick tuning shift in cases where an aircraft has only one radio compass.*

3.4.4.4 Where locators associated with ILS facilities serving opposite ends of a single runway are assigned a common frequency, provision shall be made to ensure that the facility not in operational use cannot radiate.

Note.— Additional guidance on the operation of locator beacons on common frequency channels is contained in Part II, 3.2.2.

3.4.5 Identification

3.4.5.1 Each NDB shall be individually identified by a two- or three-letter International Morse Code group transmitted at a rate corresponding to approximately 7 words per minute.

3.4.5.2 The complete identification shall be transmitted at least once every 30 seconds, except where the beacon identification is effected by on/off keying of the carrier. In this latter case, the identification shall be at approximately 1-minute intervals, except that a shorter interval may be used at particular NDB stations where this is found to be operationally desirable.

3.4.5.2.1 **Recommendation.**— *Except for those cases where the beacon identification is effected by on/off keying of the carrier, the identification signal should be transmitted at least three times each 30 seconds, spaced equally within that time period.*

3.4.5.3 For NDBs with an average radius of rated coverage of 92.7 km (50 NM) or less that are primarily approach and holding aids in the vicinity of an aerodrome, the identification shall be transmitted at least three times each 30 seconds, spaced equally within that time period.

3.4.5.4 The frequency of the modulating tone used for identification shall be 1 020 Hz plus or minus 50 Hz or 400 Hz plus or minus 25 Hz.

Note.— Determination of the figure to be used would be made regionally, in the light of the considerations contained in 6.5 of Attachment C to Part I.

3.4.6 Characteristics of emissions

Note.— The following specifications are not intended to preclude employment of modulations or types of modulations that may be utilized in NDBs in addition to those specified for identification, including simultaneous identification and voice modulation, provided that these additional modulations do not materially affect the operational performance of the NDBs in conjunction with currently used airborne direction finders, and provided their use does not cause harmful interference to other NDB services.

3.4.6.1 Except as provided in 3.4.6.1.1 below, all NDBs shall radiate an uninterrupted carrier and be identified by on/off keying of an amplitude modulating tone (NON/A2A).

3.4.6.1.1 NDBs other than those wholly or partly serving as holding, approach and landing aids, or those having an average radius of rated coverage of less than 92.7 km (50 NM), may be identified by on/off keying of the unmodulated carrier (NON/A1A) if they are in areas of high beacon density and/or where the required rated coverage is not practicable of achievement because of:

a) radio interference from radio stations;

b) high atmospheric noise;

c) local conditions.

Note.— In selecting the types of emission, the possibility of confusion, arising from an aircraft tuning from a NON/A2A facility to a NON/A1A facility without changing the radio compass from "MCW" to "CW" operation, will need to be kept in mind.

3.4.6.2 For each NDB identified by on/off keying of an audio modulating tone, the depth of modulation shall be maintained as near to 95 per cent as practicable.

3.4.6.3 For each NDB identified by on/off keying of an audio modulating tone, the characteristics of emission during identification shall be such as to ensure satisfactory identification at the limit of its rated coverage.

Note 1.— The foregoing requirement necessitates as high a percentage modulation as practicable, together with maintenance of an adequate radiated carrier power during identification.

Note 2.— With a direction-finder pass band of plus or minus 3 kHz about the carrier, a signal to noise ratio of 6 dB at the limit of rated coverage will, in general, meet the foregoing requirement.

Note 3.— Some considerations with respect to modulation depth are contained in 6.4 of Attachment C to Part I.

3.4.6.4 **Recommendation.—** *The carrier power of an NDB with NON/A2A emissions should not fall when the identity signal is being radiated except that, in the case of an NDB having an average radius of rated coverage exceeding 92.7 km (50 NM), a fall of not more than 1.5 dB may be accepted.*

3.4.6.5 Unwanted audio frequency modulations shall total less than 5 per cent of the amplitude of the carrier.

Note.— Reliable performance of airborne automatic direction-finding equipment (ADF) may be seriously prejudiced if the beacon emission contains modulation by an audio frequency equal or close to the loop switching frequency or its second harmonic. The loop switching frequencies in currently used equipment lie between 30 Hz and 120 Hz.

3.4.6.6 The bandwidth of emissions and the level of spurious emissions shall be kept at the lowest value which the state of technique and the nature of the service permit.

Note.— Article 5 of the Radio Regulations contains the general provisions with respect to technical characteristics of equipment and emissions. Tolerances with respect to spurious emissions are specified in Appendix 8 to the Radio Regulations and guidance material for the determination of the necessary bandwidth is contained in Appendix 6.

3.4.7 Siting of locators

3.4.7.1 **Recommendation.—** *Where locators are used as a supplement to the ILS, they should be located at the sites of the outer and middle marker beacons. Where only one locator is used as a supplement to the ILS, preference should be given to location at the site of the outer marker beacon. Where locators are employed as an aid to final approach in the absence of an ILS, equivalent locations to those applying when an ILS is installed should be selected, taking into account the relevant obstacle clearance provisions of the* Procedures for Air Navigation Services — Aircraft Operations *(Doc 8168)*

3.4.7.2 **Recommendation.—** *Where locators are installed at both the middle and outer marker positions, they should be located, where practicable, on the same side of the extended centre line of the runway in order to provide a track between the locators which will be more nearly parallel to the centre line of the runway.*

3.4.8 Monitoring

3.4.8.1 For each NDB, suitable means shall be provided to enable detection of any of the following conditions at an appropriate location:

a) a decrease in radiated carrier power of more than 50 per cent below that required for the rated coverage;

b) failure to transmit the identification signal;

c) malfunctioning or failure of the means of monitoring itself.

3.4.8.2 **Recommendation.—** *When an NDB is operated from a power source having a frequency which is close to airborne ADF equipment switching frequencies, and where the design of the NDB is such that the power supply frequency is likely to appear as a modulation product on the emission, the means of monitoring should be capable of detecting such power supply modulation on the carrier in excess of 5 per cent.*

3.4.8.3 During the hours of service of a locator, the means of monitoring shall provide for a continuous check on the functioning of the locator as prescribed in 3.4.8.1 a), b) and c) above.

3.4.8.4 **Recommendation.—** *During the hours of service of an NDB other than a locator, the means of monitoring should provide for a continuous check on the functioning of the NDB as prescribed in 3.4.8.1 a), b) and c).*

Note.— Guidance material on the testing of NDBs is contained in 6.6 of Attachment C to Part I.

3.5 Specification for UHF distance measuring equipment (DME)

Note 1.— In the following section, provision is made for three types of DME facility: DME/N for application as outlined in Part I, 2.2.2, DME/W only for application as outlined in Part I, 2.2.3, and DME/P as outlined in 3.11.3 below. Except for spectrum, DME/N and DME/W are identical.

Note 2.— The system characteristics in 3.5.3 below are designed to allow for system compatibility.

Note 3.— In the following paragraphs, those denoted by ‡ are applicable to equipment first installed after 1 January 1989.

3.5.1 Definitions

Control motion noise (CMN). That portion of the guidance signal error which causes control surface, wheel and column motion and could affect aircraft attitude angle during coupled flight, but does not cause aircraft displacement from the desired course and/or glide path. (See 3.11 below.)

DME dead time. A period immediately following the decoding of a valid interrogation during which a received interrogation will not cause a reply to be generated.

Note.— Dead time is intended to prevent the transponder from replying to echoes resulting from multipath effects.

DME/N. Distance measuring equipment, primarily serving operational needs of en-route or TMA navigation, where the "N" stands for narrow spectrum characteristics (to be distinguished from "W").

DME/P. The distance measuring element of the MLS, where the "P" stands for precise distance measurement. The spectrum characteristics are those of DME/N.

DME/W. Distance measuring equipment, primarily serving operational needs of en-route or TMA navigation, where the "W" stands for wide spectrum characteristics (to be distinguished from "N").

Equivalent isotropically radiated power (e.i.r.p.). The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).

Final approach (FA) mode. The condition of DME/P operation which supports flight operations in the final approach and runway regions.

Initial approach (IA) mode. The condition of DME/P operation which supports those flight operations outside the final approach region and which is interoperable with DME/N.

Key down time. The time during which a dot or dash of a Morse character is being transmitted.

MLS approach reference datum. A point on the minimum glide path at a specified height above the threshold. (See 3.11 below.)

MLS datum point. The point on the runway centre line closest to the phase centre of the approach elevation antenna. (See 3.11 below.)

Mode W, X, Y, Z. A method of coding the DME transmissions by time spacing pulses of a pulse pair, so that each frequency can be used more than once.

Partial rise time. The time as measured between the 5 and 30 per cent amplitude points on the leading edge of the pulse envelope, i.e. between points h and i on Figures 3-1 and 3-2.

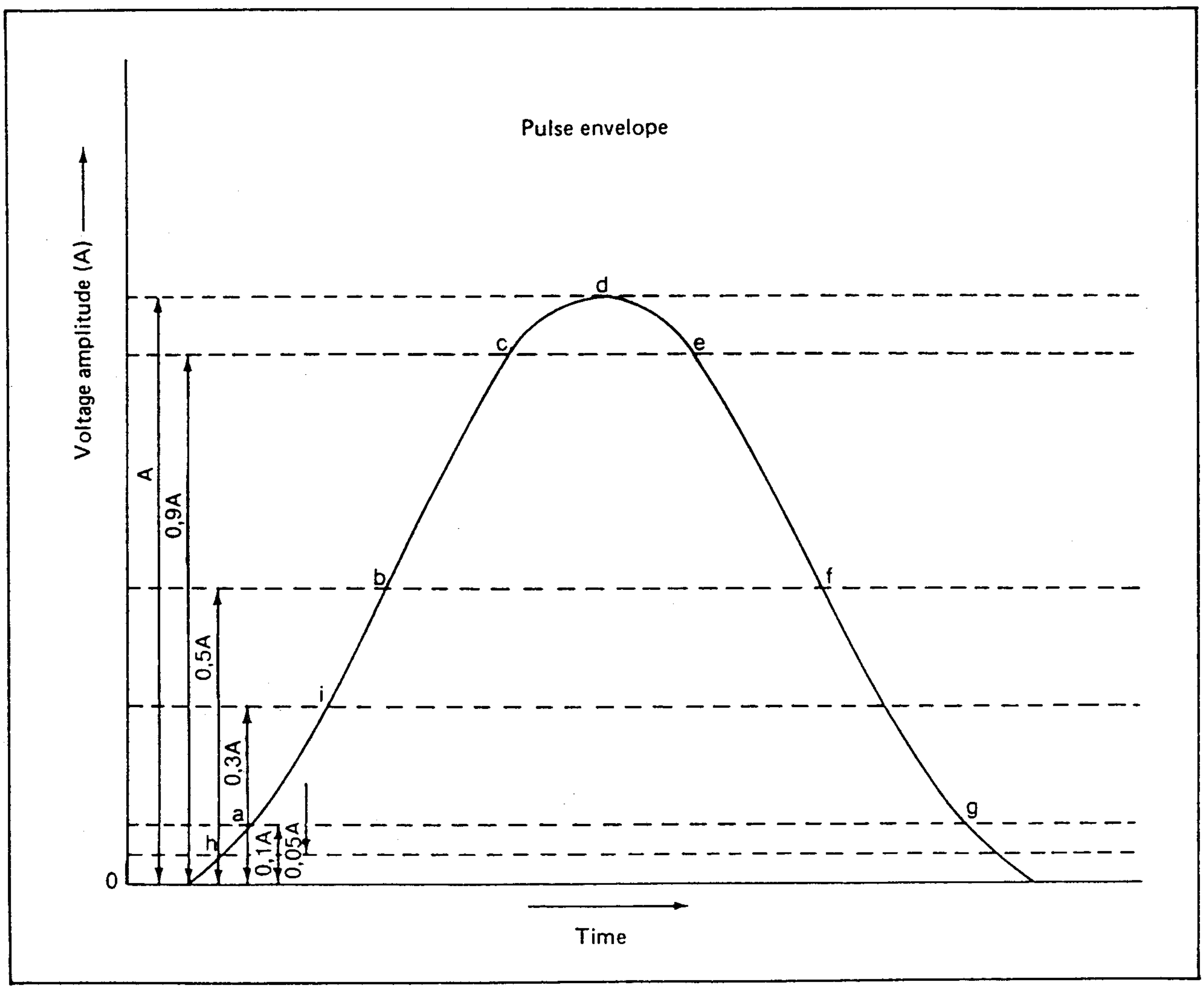


Figure 3-1

Path following error (PFE). That portion of the guidance signal error which could cause aircraft displacement from the desired course and/or glide path. (See 3.11 below.)

Pulse amplitude. The maximum voltage of the pulse envelope, i.e. A in Figure 3-1.

Pulse decay time. The time as measured between the 90 and 10 per cent amplitude points on the trailing edge of the pulse envelope, i.e. between points e and g on Figure 3-1.

Pulse code. The method of differentiating between W, X, Y and Z modes and between FA and IA modes.

Pulse duration. The time interval between the 50 per cent amplitude point on leading and trailing edges of the pulse envelope, i.e. between points b and f on Figure 3-1.

Pulse rise time. The time as measured between the 10 and 90 per cent amplitude points on the leading edge of the pulse envelope, i.e. between points a and c on Figure 3-1.

Reply efficiency. The ratio of replies transmitted by the transponder to the total of received valid interrogations.

Search. The condition which exists when the DME interrogator is attempting to acquire and lock onto the response to its own interrogations from the selected transponder.

System efficiency. The ratio of valid replies processed by the interrogator to the total of its own interrogations.

Track. The condition which exists when the DME interrogator has locked onto replies in response to its own interrogations, and is continuously providing a distance measurement.

Transmission rate. The average number of pulse pairs transmitted from the transponder per second.

Virtual origin. The point at which the straight line through the 30 per cent and 5 per cent amplitude points on the pulse leading edge intersects the 0 per cent amplitude axis (see Figure 3-2).

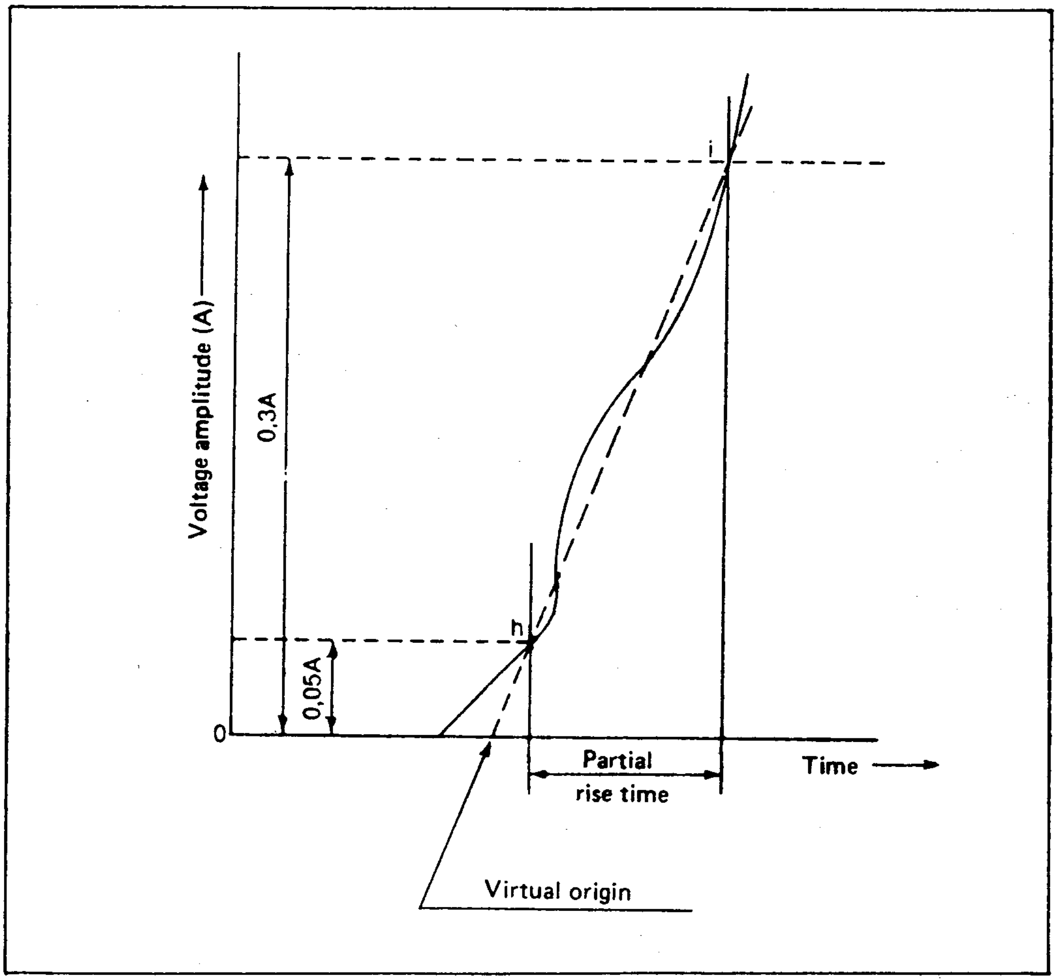


Figure 3-2

3.5.2 General

3.5.2.1 The DME system shall provide for continuous and accurate indication in the cockpit of the slant range distance of an equipped aircraft from an equipped ground reference point.

3.5.2.2 The system shall comprise two basic components, one fitted in the aircraft, the other installed on the ground. The aircraft component shall be referred to as the interrogator and the ground component as the transponder.

3.5.2.3 In operation, interrogators shall interrogate transponders which shall, in turn, transmit to the interrogator replies synchronized with the interrogations, thus providing means for accurate measurement of distance.

3.5.2.4 DME/P shall have two operating modes, IA and FA.

3.5.2.5 When a DME function is combined with either an ILS, MLS or VOR for the purpose of constituting a single facility, they shall be considered to be associated in a manner complying with Part I, 2.2.2, only when:

a) operated on a standard frequency pairing in accordance with 3.5.3.3.5 below;

b) collocated within the limits prescribed for associated facilities in 3.5.2.6 below; and

c) complying with the identification provisions of 3.5.3.6.4 below.

Note.— A single DME facility may be paired with both an ILS and MLS.

3.5.2.6 *Collocation limits for a DME facility associated with an ILS, MLS or VOR facility*

3.5.2.6.1 Associated VOR and DME facilities shall be collocated in accordance with the following:

a) *coaxial collocation:* the VOR and DME antennas are located on the same vertical axis; or

b) *offset collocation:*

1) for those facilities used in terminal areas for approach purposes or other procedures where the highest position fixing accuracy of system capability is required, the separation of the VOR and DME antennas does not exceed 30 m (100 ft) except that, at Doppler VOR facilities, where DME service is provided by a separate facility, the antennas may be separated by more than 30 m (100 ft), but not in excess of 80 m (260 ft);

2) for purposes other than those indicated in 1), the separation of the VOR and DME antennas does not exceed 600 m (2 000 ft).

3.5.2.6.2 *Association of DME with ILS*

Note.— Attachment C to Part I, 2.11 gives guidance on the association of DME with ILS.

3.5.2.6.3 *Association of DME with MLS*

3.5.2.6.3.1 **Recommendation.—** *The DME/P should be sited as close as possible to the MLS azimuth facility.*

Note.— Attachment G to Part I, 5 and Attachment C to Part I, 7.1.6 give guidance on siting of DME with MLS.

3.5.3 System characteristics

3.5.3.1 *Performance*

3.5.3.1.1 *Range.* The system shall provide a means of measurement of slant range distance from an aircraft to a selected transponder to the limit of coverage prescribed by the operational requirements for the selected transponder.

3.5.3.1.2 *Coverage*

3.5.3.1.2.1 When associated with a VOR, DME/N coverage shall be at least that of the VOR to the extent practicable.

3.5.3.1.2.2 When associated with either an ILS or an MLS, DME/N coverage shall be at least that of the respective ILS or of the MLS azimuth angle guidance coverage sectors.

3.5.3.1.2.3 DME/P coverage shall be at least that provided by the MLS azimuth angle guidance coverage sectors.

Note.— This is not intended to specify the operational range and coverage to which the system may be used; spacing of facilities already installed may limit the range in certain areas.

3.5.3.1.3 *Accuracy*

3.5.3.1.3.1 *System accuracy.* The accuracy standards specified herein shall be met on a 95 per cent probability basis.

Note.— The total system limits include errors from all causes such as those from airborne equipment, ground equipment, propagation and random pulse interference effects.

3.5.3.1.3.2 *DME/N accuracy*

Recommendation.— *At distances of from zero to 370 km (200 NM) from the transponder, dependent upon the particular service application, the total system error, excluding reading error, should be not greater than plus or minus 460 m (0.25 NM) plus 1.25 per cent of distance measured.*

‡3.5.3.1.3.3 The total system error shall not exceed plus or minus 370 m (0.2 NM).

Note 1.— This system accuracy is predicated upon the achievement of an airborne interrogator error contribution of not more than plus or minus 315 m (0.17 NM).

Note 2.— In mixed DME/N and DME/P operations it is intended that the achieved accuracy be at least that in 3.5.3.1.3.2 above.

3.5.3.1.3.4 *DME/P accuracy*

Note 1.— In the following, two accuracy standards, 1 and 2, are stated for the DME/P to accommodate a variety of applications.

Note 2.— Guidance on accuracy standards is given in Attachment C to Part I, 7.3.2.

3.5.3.1.3.4.1 *Error components.* The path following error (PFE) shall be comprised of those frequency components of the DME/P error at the output of the interrogator which lie below 1.5 rad/s. The control motion noise (CMN) shall be comprised of those frequency components of the DME/P error at the output of the interrogator which lie between 0.5 rad/s and 10 rad/s.

Note.— Specified error limits at a point are to be applied over a flight path that includes that point. Information on the interpretation of DME/P errors and the measurement of those errors over an interval appropriate for flight inspection is provided in Attachment C to Part I, 7.3.6.1.

3.5.3.1.3.4.2 Errors on the extended runway centre line shall not exceed the values given in Table C at the end of this chapter.

3.5.3.1.3.4.3 In the approach sector, away from the extended runway centre line, the allowable PFE for both standard 1 and standard 2 shall be permitted to increase linearly with angle up to plus or minus 40 degrees MLS azimuth angle where the permitted error is 1.5 times that on the extended runway centre line at the same distance. The allowable CMN shall not increase with angle. There shall be no degradation of either PFE or CMN with elevation angle.

3.5.3.2 *Radio frequencies and polarization.* The system shall operate with vertical polarization in the frequency band 960 MHz to 1 215 MHz. The interrogation and reply frequencies shall be assigned with 1-MHz spacing between channels.

3.5.3.3 *Channelling*

3.5.3.3.1 DME operating channels shall be formed by pairing interrogation and reply frequencies and by pulse coding on the paired frequencies.

3.5.3.3.2 *Pulse coding.* DME/P channels shall have two different interrogation pulse codes as shown in Table B at the end of this chapter. One shall be used in the initial approach (IA) mode; the other shall be used in the final approach (FA) mode.

3.5.3.3.3 DME operating channels shall be chosen from Table A (located at the end of this chapter), of 352 channels in which the channel numbers, frequencies, and pulse codes are assigned.

3.5.3.3.3.1 DME operating channels bearing the suffix "Y" in Table A may be chosen, on the basis of regional agreement, when they have become applicable in accordance with the following:

a) for *restricted use* on or after, whichever is the later of:

   1) 1 January 1966; or

   2) a date prescribed by the Council giving a period of two years or more following approval of the regional agreement concerned;

b) for *general use* on or after, whichever is the later of:

   1) 1 January 1970; or

   2) a date prescribed by the Council giving a period of two years or more following approval of the regional agreement concerned.

Note.— "Restricted use" is intended to refer to the limited use of the channels by only suitably equipped aircraft, without imposing any general requirement for the carriage of DME airborne equipment capable of operating on these channels.

3.5.3.3.4 *Area channel assignment*

3.5.3.3.4.1 In a particular area, the number of DME operating channels to be used shall be decided regionally.

Note.— Standards and Recommended Practices on the utilization of the DME frequency band 960-1 215 MHz are found in Part II, 4.3.

3.5.3.3.4.2 The specific DME operating channels to be assigned in such a particular area shall also be decided regionally, taking into consideration the requirements for co-channel and adjacent channel protection.

3.5.3.3.4.3 **Recommendation.—** *Co-ordination of regional DME channel assignments should be effected through ICAO.*

Note.— The above paragraphs permit the use of DME airborne interrogators having less than the total number of operating channels where so desired.

3.5.3.3.5 *Channel pairing.* When a DME transponder is intended to operate in association with a single VHF navigation facility in the 108 MHz to 117.95 MHz frequency band and/or an MLS angle facility in the 5 031 MHz to

5 091 MHz frequency band, the DME operating channel shall be paired with the VHF channel and/or MLS angle frequency as given in Table A.

Note.— In the ILS/MLS transition period, there may be instances when a DME will be paired with both the ILS frequency and an MLS channel (see 4.3.3.1 of Part II).

3.5.3.4 *Interrogation pulse repetition frequency*

Note.— If the interrogator operates on more than one channel in one second the following specifications apply to the sum of interrogations on all channels.

3.5.3.4.1 *DME/N.* The interrogator average pulse repetition frequency (PRF) shall not exceed 30 pairs of pulses per second, based on the assumption that at least 95 per cent of the time is occupied for tracking.

3.5.3.4.2 *DME/N.* If it is desired to decrease the time of search, the PRF may be increased during search but shall not exceed 150 pairs of pulses per second.

3.5.3.4.3 *DME/N.* **Recommendation.—** *After 15 000 pairs of pulses have been transmitted without acquiring indication of distance, the PRF should not exceed 60 pairs of pulses per second thereafter, until a change in operating channel is made or successful search is completed.*

‡3.5.3.4.4 *DME/N.* When, after a time period of 30 seconds, tracking has not been established the pulse pair repetition frequency shall not exceed 30 pulse pairs per second thereafter.

3.5.3.4.5 *DME/P.* The interrogator pulse repetition frequency shall not exceed the following number of pulse pairs per second:

a) search 40

b) aircraft on the ground 5

c) initial approach mode track 16

d) final approach mode track 40

Note.— A pulse repetition frequency (PRF) of 5 pulse pairs per second on the ground should not be exceeded, but may be if the aircraft requires accurate range information.

It is intended that all PRF changes be achieved by automatic means.

3.5.3.5 *Aircraft handling capacity of the system*

3.5.3.5.1 The aircraft handling capacity of transponders in an area shall be adequate for the peak traffic of the area or 100 aircraft, whichever is the lesser.

3.5.3.5.2 **Recommendation.—** *Where the peak traffic in an area exceeds 100 aircraft, the transponder should be capable of handling that peak traffic.*

Note.— Guidance material on aircraft handling capacity will be found in Attachment C to Part I, 7.1.5.

3.5.3.6 *Transponder identification*

3.5.3.6.1 All transponders shall transmit an identification signal in one of the following forms as required by 3.5.3.6.5 below:

a) an "independent" identification consisting of coded (International Morse Code) identity pulses which can be used with all transponders;

b) an "associated" signal which can be used for transponders specifically associated with a VHF navigation or an MLS angle guidance facility which itself transmits an identification signal.

Note.— An MLS angle guidance facility provides its identification as a digital word transmitted on the data channel into the approach and back azimuth coverage regions as specified in 3.11.4.6.2.1 below.

3.5.3.6.2 Both systems of identification shall use signals, which shall consist of the transmission for an appropriate period of a series of paired pulses transmitted at a repetition rate of 1 350 pulse pairs per second, and shall temporarily replace all reply pulses that would normally occur at that time except as in 3.5.3.6.2.2 below. These pulses shall have similar characteristics to the other pulses of the reply signals.

‡3.5.3.6.2.1 *DME/N.* Reply pulses shall be transmitted between key down times.

3.5.3.6.2.2 *DME/N.* **Recommendation.—** *If it is desired to preserve a constant duty cycle, an equalizing pair of pulses, having the same characteristics as the identification pulse pairs, should be transmitted 100 microseconds plus or minus 10 microseconds after each identity pair.*

3.5.3.6.2.3 *DME/P.* Reply pulses shall be transmitted between key down times.

3.5.3.6.2.4 For the DME/P transponder, reply pulse pairs to valid FA mode interrogations shall also be transmitted during key down times and have priority over identification pulse pairs.

3.5.3.6.2.5 The DME/P transponder shall not employ the equalizing pair of pulses of 3.5.3.6.2.2 above.

3.5.3.6.3 The characteristics of the "independent" identification signal shall be as follows:

a) the identity signal shall consist of the transmission of the beacon code in the form of dots and dashes (International Morse Code) of identity pulses at least once every 40 seconds, at a rate of at least 6 words per minute; and

b) the identification code characteristic and letter rate for the DME transponder shall conform to the following to ensure that the maximum total key down time does not exceed 5 seconds per identification code group. The dots shall be a time duration of 0.1 second to 0.160 second. The dashes shall be typically 3 times the duration of the dots. The duration between dots and/or dashes shall be equal to that of one dot plus or minus 10 per cent. The time duration between letters or numerals shall not be less than three dots. The total period for transmission of an identification code group shall not exceed 10 seconds.

Note.— The tone identification signal is transmitted at a repetition rate of 1 350 pps. This frequency may be used directly in the airborne equipment as an aural output for the pilot, or other frequencies may be generated at the option of the interrogator designer (see 3.5.3.6.2 above).

3.5.3.6.4 The characteristics of the "associated" signal shall be as follows:

a) when associated with a VHF or an MLS angle facility, the identification shall be transmitted in the form of dots and dashes (International Morse Code) as in 3.5.3.6.3 above and shall be synchronized with the VHF facility identification code;

b) each 40-second interval shall be divided into four or more equal periods, with the transponder identification transmitted during one period only and the associated VHF and MLS angle facility identification, where these are provided, transmitted during the remaining periods;

c) for a DME transponder associated with an MLS, the identification shall be the last three letters of the MLS angle facility identification specified in 3.11.4.6.2.1 below.

3.5.3.6.5 *Identification implementation*

3.5.3.6.5.1 The "independent" identification code shall be employed wherever a transponder is not specifically associated with a VHF navigational facility or an MLS facility.

3.5.3.6.5.2 Wherever a transponder is specifically associated with a VHF navigational facility or an MLS facility, identification shall be provided by the "associated" code.

3.5.3.6.6 When voice communications are being radiated on an associated VHF navigational facility, an "associated" signal from the transponder shall not be suppressed.

3.5.3.7 *DME/P mode transition*

3.5.3.7.1 The DME/P interrogator for Standard 1 accuracy shall change from IA mode track to FA mode track at 13 km (7 NM) from the transponder when approaching the transponder, or any other situation when within 13 km (7 NM).

3.5.3.7.2 For Standard 1 accuracy, the transition from IA mode to FA mode track operation may be initiated within 14.8 km (8 NM) from the transponder. Outside 14.8 km (8 NM), the interrogator shall not interrogate in the FA mode.

Note.— 3.5.3.7.1 above does not apply if the transponder is a DME/N or if the DME/P transponder FA mode is inoperative.

3.5.3.8 *System efficiency.* The DME/P system accuracy of 3.5.3.1.3.4 above shall be achieved with a system efficiency of 50 per cent or more.

3.5.4 Detailed technical characteristics of transponder and associated monitor

3.5.4.1 *Transmitter*

3.5.4.1.1 *Frequency of operation.* The transponder shall transmit on the reply frequency appropriate to the assigned DME channel (see 3.5.3.3.3 above).

3.5.4.1.2 *Frequency stability.* The radio frequency of operation shall not vary more than plus or minus 0.002 per cent from the assigned frequency.

3.5.4.1.3 *Pulse shape and spectrum.* The following shall apply to all radiated pulses:

a) *Pulse rise time.*

1) *DME/N.* Pulse rise time shall not exceed 3 microseconds.

2) *DME/P.* Pulse rise time shall not exceed 1.6 microseconds. For the FA mode, the pulse shall have a partial rise time of 0.25 plus or minus 0.05 microsecond. With respect to the FA mode and accuracy standard 1, the slope of the pulse in the partial rise time shall not vary by more than plus or minus 20 per cent. For accuracy standard 2, the slope shall not vary by more than plus or minus 10 per cent.

3) **Recommendation.—** *DME/P.* Pulse rise time should not exceed 1.2 microseconds.

b) Pulse duration shall be 3.5 microseconds plus or minus 0.5 microsecond.

c) Pulse decay time shall nominally be 2.5 microseconds but shall not exceed 3.5 microseconds.

d) The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95 per cent of maximum amplitude and the point of the trailing edge which is 95 per cent of the maximum amplitude, fall below a value which is 95 per cent of the maximum voltage amplitude of the pulse.

e) *For DME/N and DME/P*: the spectrum of the pulse modulated signal shall be such that during the pulse the effective radiated power contained in a 0.5 MHz band centred on frequencies 0.8 MHz above and 0.8 MHz below the nominal channel frequency in each case shall not exceed 200 mW, and the effective radiated power contained in a 0.5 MHz band centred on frequencies 2 MHz above and 2 MHz below the nominal channel frequency in each case shall not exceed 2 mW. The effective radiated power contained within *any* 0.5 MHz band shall decrease monotonically as the band centre frequency moves away from the nominal channel frequency.

Note.— Guidance material relating to the pulse spectrum measurement is provided in Attachment C, Section 7.1.11.

f) For DME/W, the spectrum of the pulse modulated signal shall be such that during the pulse the effective radiated power contained in a 0.5 MHz band centred on frequencies 1.8 MHz above and 1.8 MHz below the nominal channel frequency in each case shall not exceed 200 mW, and the effective radiated power contained in a 0.5 MHz band centred on frequencies 3 MHz above and 3 MHz below the nominal channel frequency in each case shall not exceed 2 mW. Any lobe of the spectrum shall be of less amplitude than the adjacent lobe nearer the nominal channel frequency.

g) To ensure proper operation of the thresholding techniques, the instantaneous magnitude of any pulse turn-on transients which occur in time prior to the virtual origin shall be less than one per cent of the pulse peak amplitude. Initiation of the turn-on process shall not commence sooner than 1 microsecond prior to the virtual origin.

Note 1.— The time "during the pulse" encompasses the total interval from the beginning of pulse transmission to its end. For practical reasons this interval may be measured between the 5 per cent points on the leading and trailing edges of the pulse envelope.

Note 2.— The power contained in the frequency bands specified in 3.5.4.1.3 e) and f) above is the average power during the pulse. Average power in a given frequency band is the energy contained in this frequency band divided by the time of pulse transmission according to Note 1.

3.5.4.1.4 *Pulse spacing*

3.5.4.1.4.1 The spacing of the constituent pulses of transmitted pulse pairs shall be as given in Table B.

3.5.4.1.4.2 *DME/N.* The tolerance on the pulse spacing shall be plus or minus 0.25 microsecond.

3.5.4.1.4.3 *DME/N.* **Recommendation.—** *The tolerance on the DME/N pulse spacing should be plus or minus 0.10 microsecond.*

3.5.4.1.4.4 *DME/P.* The tolerance on the pulse spacing shall be plus or minus 0.10 microsecond.

3.5.4.1.4.5 The pulse spacings shall be measured between the half voltage points on the leading edges of the pulses.

3.5.4.1.5 *Peak power output*

3.5.4.1.5.1 *DME/N.* **Recommendation.—** *The peak effective radiated power should not be less than that required to ensure a peak pulse power density of approximately minus 83 dBW/m² at the maximum specified service range and level.*

‡3.5.4.1.5.2 *DME/N.* The peak equivalent isotropically radiated power shall not be less than that required to ensure a peak pulse power density of minus 89 dBW/m² under all operational weather conditions at any point within coverage specified in 3.5.3.1.2 above.

Note.— Although the Standard in 3.5.4.1.5.2 above implies an improved interrogator receiver sensitivity, it is intended that the power density specified in 3.5.4.1.5.1 above be available at the maximum specified service range and level.

3.5.4.1.5.3 *DME/P.* The peak equivalent isotropically radiated power shall not be less than that required to ensure the following peak pulse power densities under all operational weather conditions:

a) minus 89 dBW/m² at any point within the coverage specified in 3.5.3.1.2 above at ranges greater than 13 km (7 NM) from the transponder antenna;

b) minus 75 dBW/m² at any point within the coverage specified in 3.5.3.1.2 above at ranges less than 13 km (7 NM) from the transponder antenna;

c) minus 70 dBW/m² at the MLS approach reference datum;

d) minus 79 dBW/m² at 2.5 m (8 ft) above the runway surface, at the MLS datum point, or at the farthest point on the runway centre line which is in line of sight of the DME transponder antenna.

Note.— Guidance material relating to the ERP may be found in Sections 7.2.1 and 7.3.8 of Attachment C to Part I.

3.5.4.1.5.4 The peak power of the constituent pulses of any pair of pulses shall not differ by more than 1 dB.

3.5.4.1.5.5 **Recommendation.—** *The reply capability of the transmitter should be such that the transponder should be capable of continuous operation at a transmission rate of 2 700 plus or minus 90 pulse pairs per second (if 100 aircraft are to be served).*

Note.— Guidance on the relationship between number of aircraft and transmission rate is given in Attachment C to Part I, 7.1.5.

3.5.4.1.5.6 The transmitter shall operate at a transmission rate, including randomly distributed pulse pairs and distance reply pulse pairs, of not less than 700 pulse pairs per second except during identity.

The minimum transmission rate shall be as close as practicable to 700 pulse pairs per second. For DME/P, in no case shall it exceed 1 200 pulse pairs per second.

3.5.4.1.6 *Spurious radiation.* During intervals between transmission of individual pulses, the spurious power received and measured in a receiver having the same characteristics as a transponder receiver, but tuned to any DME interrogation or reply frequency, shall be more than 50 dB below the peak pulse power received and measured in the same receiver tuned to the reply frequency in use during the transmission of the required pulses. This provision refers to all spurious transmissions, including modulator and electrical interference.

‡3.5.4.1.6.1 *DME/N.* The spurious power level specified in 3.5.4.1.6 above shall be more than 80 dB below the peak pulse power level.

3.5.4.1.6.2 *DME/P.* The spurious power level specified in 3.5.4.1.6 above shall be more than 80 dB below the peak pulse power level.

3.5.4.1.6.3 *Out-of-band spurious radiation.* At all frequencies from 10 to 1 800 MHz, but excluding the band of frequencies from 960 to 1 215 MHz, the spurious output of the DME transponder transmitter shall not exceed minus 40 dBm in any one kHz of receiver bandwidth.

3.5.4.1.6.4 The equivalent isotropically radiated power of any CW harmonic of the carrier frequency on any DME operating channel shall not exceed minus 10 dBm.

3.5.4.2 *Receiver*

3.5.4.2.1 *Frequency of operation.* The receiver centre frequency shall be the interrogation frequency appropriate to the assigned DME operating channel (see 3.5.3.3.3 above).

3.5.4.2.2 *Frequency stability.* The centre frequency of the receiver shall not vary more than plus or minus 0.002 per cent from the assigned frequency.

3.5.4.2.3 *Transponder sensitivity*

3.5.4.2.3.1 In the absence of all interrogation pulse pairs, with the exception of those necessary to perform the sensitivity measurement, interrogation pulse pairs with the correct spacing and nominal frequency shall trigger the transponder if the peak power density at the transponder antenna is at least:

a) minus 103 dBW/m² for DME/N;

b) minus 86 dBW/m² for DME/P IA mode;

c) minus 75 dBW/m² for DME/P FA mode.

3.5.4.2.3.2 The minimum power densities specified in 3.5.4.2.3.1 above shall cause the transponder to reply with an efficiency of at least:

a) 70 per cent for DME/N;

b) 70 per cent for DME/P IA mode;

c) 80 per cent for DME/P FA mode.

‡3.5.4.2.3.3 *DME/N dynamic range.* The performance of the transponder shall be maintained when the power density of the interrogation signal at the transponder antenna has any value between the minimum specified in 3.5.4.2.3.1 above up to a maximum of minus 22 dBW/m² when installed with ILS or MLS and minus 35 dBW/m² when installed for other applications.

3.5.4.2.3.4 *DME/P dynamic range.* The performance of the transponder shall be maintained when the power density of the interrogation signal at the transponder antenna has any value between the minimum specified in 3.5.4.2.3.1 above up to a maximum of minus 22 dBW/m².

3.5.4.2.3.5 The transponder sensitivity level shall not vary by more than 1 dB for transponder loadings between 0 and 90 per cent of its maximum transmission rate.

‡3.5.4.2.3.6 *DME/N.* When the spacing of an interrogator pulse pair varies from the nominal value by up to plus or minus 1 microsecond, the receiver sensitivity shall not be reduced by more than 1 dB.

3.5.4.2.3.7 *DME/P.* When the spacing of an interrogator pulse pair varies from the nominal value by up to plus or minus 1 microsecond, the receiver sensitivity shall not be reduced by more than 1 dB.

3.5.4.2.4 *Sensitivity reduction*

3.5.4.2.4.1 *DME/N.* **Recommendation.—** *When transponder loading exceeds 90 per cent of the maximum transmission rate, the receiver sensitivity should be automatically reduced in order to limit the transponder replies, so as to ensure that the maximum permissible transmission rate is not exceeded. (The available range of sensitivity reduction should be at least 50 dB.)*

3.5.4.2.4.2 *DME/P.* The receiver sensitivity reduction specified in 3.5.4.2.4.1 above shall be applied to the IA mode but not to the FA mode.

3.5.4.2.5 *Noise.* When the receiver is interrogated at the power densities specified in 3.5.4.2.3.1 above to produce a transmission rate equal to 90 per cent of the maximum, the noise generated pulse pairs shall not exceed 5 per cent of the maximum transmission rate.

3.5.4.2.6 *Bandwidth*

3.5.4.2.6.1 The minimum permissible bandwidth of the receiver shall be such that the transponder sensitivity level shall not deteriorate by more than 3 dB when the total receiver drift is added to an incoming interrogation frequency drift of plus or minus 100 kHz.

3.5.4.2.6.2 *DME/N.* The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above when the input signals are those specified in 3.5.5.1.3 below.

3.5.4.2.6.3 *DME/P — IA mode.* The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above when the input signals are those specified in 3.5.5.1.3 below. The 12 dB bandwidth shall not exceed 2 MHz and the 60 dB bandwidth shall not exceed 10 MHz.

3.5.4.2.6.4 *DME/P — FA mode.* The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above when the input signals are those specified in 3.5.5.1.3 below. The 12 dB bandwidth shall not exceed 6 MHz and the 60 dB bandwidth shall not exceed 20 MHz.

3.5.4.2.6.5 Signals greater than 900 kHz removed from the desired channel nominal frequency and having power densities up to the values specified in 3.5.4.2.3.3 for DME/N and 3.5.4.2.3.4 for DME/P shall not trigger the transponder. Signals arriving at the intermediate frequency shall be suppressed at least 80 dB. All other spurious response or signals within the 960 MHz to 1 215 MHz band and image frequencies shall be suppressed at least 75 dB.

3.5.4.2.7 *Recovery time.* Within 8 microseconds of the reception of a signal between 0 dB and 60 dB above minimum sensitivity level, the minimum sensitivity level of the transponder to a desired signal shall be within 3 dB of the value obtained in the absence of signals. This requirement shall be met with echo suppression circuits, if any, rendered inoperative. The 8 microseconds are to be measured between the half voltage points on the leading edges of the two signals, both of which conform in shape, with the specifications in 3.5.5.1.3 below.

3.5.4.2.8 *Spurious radiations.* Radiation from any part of the receiver or allied circuits shall meet the requirements stated in 3.5.4.1.6 above.

3.5.4.2.9 *CW and echo suppression.*

Recommendation.— *CW and echo suppression should be adequate for the sites at which the transponders will be used.*

Note.— In this connexion, echoes mean undesired signals caused by multipath transmission (reflections, etc.).

3.5.4.2.10 *Protection against interference.*

Recommendation.— *Protection against interference outside the DME frequency band should be adequate for the sites at which the transponders will be used.*

3.5.4.3 *Decoding*

3.5.4.3.1 The transponder shall include a decoding circuit such that the transponder can be triggered only by pairs of received pulses having pulse duration and pulse spacings appropriate to interrogator signals as described in 3.5.5.1.3 and 3.5.5.1.4 below.

3.5.4.3.2 The decoding circuit performance shall not be affected by signals arriving before, between, or after, the constituent pulses of a pair of the correct spacing.

‡3.5.4.3.3 *DME/N — Decoder rejection.* An interrogation pulse pair with a spacing of plus or minus 2 microseconds, or more, from the nominal value and with any signal level up to the value specified in 3.5.4.2.3.3 shall be rejected such that the transmission rate does not exceed the value obtained when interrogations are absent.

3.5.4.3.4 *DME/P — Decoder rejection.* An interrogation pulse pair with a spacing of plus or minus 2 microseconds, or more, from the nominal value and with any signal level up to the value specified in 3.5.4.2.3.4 shall be rejected such that the transmission rate does not exceed the value obtained when interrogations are absent.

3.5.4.4 *Time delay*

3.5.4.4.1 When a DME is associated only with a VHF facility, the time delay shall be the interval from the half voltage point on the leading edge of the second constituent pulse of the interrogation pair and the half voltage point on the leading edge of the second constituent pulse of the reply transmission. This delay shall be consistent with the following table, when it is desired that aircraft interrogators are to indicate distance from the transponder site.

		Pulse pair spacing (μs)		*Time delay (μs)*	
Channel suffix	*Operating mode*	*Interr.*	*Reply*	*1st pulse timing*	*2nd pulse timing*
X	DME/N	12	12	50	50
	DME/P IA M	12	12	50	-
	DME/P FA M	18	12	56	-
Y	DME/N	36	30	56	50
	DME/P IA M	36	30	56	-
	DME/P FA M	42	30	62	-
W	DME/N	-	-	-	-
	DME/P IA M	24	24	50	-
	DME/P FA M	30	24	56	-
Z	DME/N	-	-	-	-
	DME/P IA M	21	15	56	-
	DME/P FA M	27	15	62	-

Note 1.— W and X are multiplexed on the same frequency.

Note 2.— Z and Y are multiplexed on the same frequency.

3.5.4.4.2 When a DME is associated with an MLS angle facility, the time delay shall be the interval from the half voltage point on the leading edge of the first constituent pulse of the interrogation pair and the half voltage point on the leading edge of the first constituent pulse of the reply transmission. This delay shall be 50 microseconds for mode X channels and 56 microseconds for mode Y channels, when it is desired that aircraft interrogators are to indicate distance from the transponder site.

3.5.4.4.2.1 For DME/P transponders, no time delay adjustment shall be permitted.

3.5.4.4.3 **Recommendation.—** *For the DME/N the transponder time delay should be capable of being set to an appropriate value between the nominal value of the time delay minus 15 microseconds and the nominal value of the time delay, to permit aircraft interrogators to indicate zero distance at a specific point remote from the transponder site.*

Note.— Modes not allowing for the full 15 microseconds range of adjustment in transponder time delay may only be adjustable to the limits given by the transponder circuit delay and recovery time.

‡3.5.4.4.3.1 *DME/N.* The time delay shall be the interval from the half voltage point on the leading edge of the first

constituent pulse of the interrogation pair and the half voltage point on the leading edge of the first constituent pulse of the reply transmission.

3.5.4.4.3.2 *DME/P — IA mode.* The time delay shall be the interval from the half voltage point on the leading edge of the first constituent pulse of the interrogation pulse pair to the half voltage point on the leading edge of the first constituent pulse of the reply pulse pair.

3.5.4.4.3.3 *DME/P — FA mode.* The time delay shall be the interval from the virtual origin of the first constituent pulse of the interrogation pulse pair to the virtual origin of the first constituent pulse of the reply pulse pair. The time of arrival measurement points shall be within the partial rise time of the first constituent pulse of the pulse pair in each case.

3.5.4.4.4 **Recommendation** [DME/N].— *Transponders should be sited as near to the point at which zero indication is required as is practicable.*

Note 1.— It is desirable that the radius of the sphere at the surface of which zero indication is given should be as small as possible in order to keep the zone of ambiguity to a minimum.

Note 2.— Guidance material on siting DME with MLS is provided in 7.1.6 of Attachment C to Part I and 5 of Attachment G to Part I.

3.5.4.5 *Accuracy*

3.5.4.5.1 *DME/N.* The transponder shall not contribute more than plus or minus 1 microsecond (150 m (500 ft)) to the over-all system error.

‡3.5.4.5.2 *DME/N.* A transponder associated with a landing aid shall not contribute more than plus or minus 0.5 microsecond (75 m (250 ft)) to the over-all system error.

3.5.4.5.3 *DME/P — FA mode*

3.5.4.5.3.1 *Accuracy standard 1.* The transponder shall not contribute more than plus or minus 10 m (plus or minus 33 ft) PFE and plus or minus 8 m (plus or minus 26 ft) CMN to the over-all system error.

3.5.4.5.3.2 *Accuracy standard 2.* The transponder shall not contribute more than plus or minus 5 m (plus or minus 16 ft) PFE and plus or minus 5 m (plus or minus 16 ft) CMN to the over-all system error.

3.5.4.5.4 *DME/P — IA mode.* The transponder shall not contribute more than plus or minus 15 m (plus or minus 50 ft) PFE and plus or minus 10 m (plus or minus 33 ft) CMN to the over-all system error.

3.5.4.5.5 **Recommendation.**— *When a DME is associated with an MLS angle facility the above accuracy should include the error introduced by the first pulse detection due to the pulse spacing tolerances.*

3.5.4.6 *Efficiency*

3.5.4.6.1 The transponder reply efficiency shall be at least 70 per cent for DME/N and DME/P (IA mode) and 80 per cent for DME/P (FA mode) at all values of transponder loading up to the loading corresponding to 3.5.3.5 above and at the minimum sensitivity level specified in 3.5.4.2.3.1 and 3.5.4.2.3.5 above.

Note.— When considering the transponder reply efficiency value, account is to be taken of the DME dead time and of the loading introduced by the monitoring function.

3.5.4.6.2 *Transponder dead time.* The transponder shall be rendered inoperative for a period normally not to exceed 60 microseconds after a valid interrogation decode has occurred. In extreme cases when the geographical site of the transponder is such as to produce undesirable reflection problems, the dead time may be increased but only by the minimum amount necessary to allow the suppression of echoes for DME/N and DME/P IA mode.

3.5.4.6.2.1 In DME/P the IA mode dead time shall not blank the FA mode channel and vice versa.

3.5.4.7 *Monitoring and control*

3.5.4.7.1 Means shall be provided at each transponder site for the automatic monitoring and control of the transponder in use.

3.5.4.7.2 *DME/N monitoring action*

3.5.4.7.2.1 In the event that any of the conditions specified in 3.5.4.7.2.2 below occur, the monitor shall cause the following action to take place:

a) a suitable indication shall be given at a control point;

b) the operating transponder shall be automatically switched off; and

c) the standby transponder, if provided, shall be automatically placed in operation.

3.5.4.7.2.2 The monitor shall cause the actions specified in 3.5.4.7.2.1 above if:

a) the transponder delay differs from the assigned value by 1 microsecond (150 m (500 ft)) or more;

‡b) in the case of a DME/N associated with a landing aid, the transponder delay differs from the assigned value by 0.5 microsecond (75 m (250 ft)) or more.

3.5.4.7.2.3 **Recommendation.**— *The monitor should cause the actions specified in 3.5.4.7.2.1 above if the spacing between the first and second pulse of the transponder pulse pair differs from the nominal value specified in the table following 3.5.4.4.1 above by 1 microsecond or more.*

3.5.4.7.2.4 **Recommendation.**— *The monitor should also cause a suitable indication to be given at a control point if any of the following conditions arise:*

a) a fall of 3 dB or more in transponder transmitted power output;

b) a fall of 6 dB or more in the minimum transponder receiver sensitivity (provided that this is not due to the action of the receiver automatic gain reduction circuits);

c) the spacing between the first and second pulse of the transponder reply pulse pair differs from the normal value specified in 3.5.4.1.4 above by 1 microsecond or more;

d) variation of the transponder receiver and transmitter frequencies beyond the control range of the reference circuits (if the operating frequencies are not directly crystal controlled).

3.5.4.7.2.5 Means shall be provided so that any of the conditions and malfunctioning enumerated in 3.5.4.7.2.2, 3.5.4.7.2.3 and 3.5.4.7.2.4 above which are monitored can persist for a certain period before the monitor takes action. This period shall be as low as practicable, but shall not exceed 10 seconds, consistent with the need for avoiding interruption, due to transient effects, of the service provided by the transponder.

3.5.4.7.2.6 The transponder shall not be triggered more than 120 times per second for either monitoring or automatic frequency control purposes, or both.

3.5.4.7.3 *DME/P monitoring action*

3.5.4.7.3.1 The monitor system shall cause the transponder radiation to cease and provide a warning at a control point if any of the following conditions persist for longer than the period specified:

a) there is a change in transponder PFE that exceeds the limits specified in either 3.5.4.5.3 or 3.5.4.5.4 above for more than one second. If the FA mode limit is exceeded, but the IA mode limit is maintained, the IA mode may remain operative;

b) there is a reduction in the effective radiated power to less than that necessary to satisfy the requirements specified in 3.5.4.1.5.3 above for a period of more than one second;

c) there is a reduction of 3 dB or more in the transponder sensitivity necessary to satisfy the requirements specified in 3.5.4.2.3 above for a period of more than five seconds in FA mode and ten seconds in IA mode (provided that this is not due to the action of the receiver automatic sensitivity reduction circuits);

d) the spacing between the first and second pulse of the transponder reply pulse pair differs from the value specified in the table in 3.5.4.4.1 above by 0.25 microsecond or more for a period of more than one second.

3.5.4.7.3.2 **Recommendation.—** *The monitor should cause a suitable indication to be given at a control point if there is an increase above 0.3 microseconds or a decrease below 0.2 microseconds of the reply pulse partial rise time which persists for more than one second.*

3.5.4.7.3.3 The period during which erroneous guidance information is radiated shall not exceed the periods specified in 3.5.4.7.3.1 above. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment, if fitted, shall be completed within this time. If the fault is not cleared within the time allowed, the radiation shall cease. After shutdown, no attempt shall be made to restore service until a period of 20 seconds has elapsed.

3.5.4.7.3.4 The transponder shall not be triggered for monitoring purposes more than 120 times per second in the IA mode and 150 times per second in the FA mode.

3.5.4.7.3.5 *DME/N and DME/P monitor failure.* Failure of any part of the monitor itself shall automatically produce the same results as the malfunctioning of the element being monitored.

3.5.5 Technical characteristics of interrogator

Note.— The following subparagraphs specify only those interrogator parameters which must be defined to ensure that the interrogator:

a) does not jeopardize the effective operation of the DME system, e.g. by increasing transponder loading abnormally; and

b) is capable of giving accurate distance readings.

3.5.5.1 *Transmitter*

3.5.5.1.1 *Frequency of operation.* The interrogator shall transmit on the interrogation frequency appropriate to the assigned DME channel (see 3.5.3.3.3 above).

Note.— This specification does not preclude the use of airborne interrogators having less than the total number of operating channels.

3.5.5.1.2 *Frequency stability.* The radio frequency of operation shall not vary more than plus or minus 100 kHz from the assigned value.

3.5.5.1.3 *Pulse shape and spectrum.* The following shall apply to all radiated pulses:

a) *Pulse rise time.*

1) *DME/N.* Pulse rise time shall not exceed 3 microseconds.

2) *DME/P.* Pulse rise time shall not exceed 1.6 microseconds. For the FA mode, the pulse shall have a partial rise time of 0.25 plus or minus 0.05 microsecond. With respect to the FA mode and accuracy standard 1, the slope of the pulse in the partial rise time shall not vary by more than plus or

minus 20 per cent. For accuracy standard 2 the slope shall not vary by more than plus or minus 10 per cent.

3) **Recommendation.**— *DME/P. Pulse rise time should not exceed 1.2 microseconds.*

b) Pulse duration shall be 3.5 microseconds plus or minus 0.5 microsecond.

c) Pulse decay time shall nominally be 2.5 microseconds, but shall not exceed 3.5 microseconds.

d) The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95 per cent of maximum amplitude and the point of the trailing edge which is 95 per cent of the maximum amplitude, fall below a value which is 95 per cent of the maximum voltage amplitude of the pulse.

e) The spectrum of the pulse modulated signal shall be such that at least 90 per cent of the energy in each pulse shall be within 0.5 MHz in a band centred on the nominal channel frequency.

f) To ensure proper operation of the thresholding techniques, the instantaneous magnitude of any pulse turn-on transients which occur in time prior to the virtual origin shall be less than one per cent of the pulse peak amplitude. Initiation of the turn-on process shall not commence sooner than 1 microsecond prior to the virtual origin.

Note 1.— The lower limit of pulse rise time (see 3.5.5.1.3 a) above) and decay time (see 3.5.5.1.3 c) above) are governed by the spectrum requirements in 3.5.5.1.3 e) above.

Note 2.— While 3.5.5.1.3 e) above calls for a practically attainable spectrum, it is desirable to strive for the following spectrum control characteristics: the spectrum of the pulse modulated signal should be such that the power contained in a 0.5 MHz band centred on frequencies 0.8 MHz above and 0.8 MHz below the nominal channel frequency should, in each case, be at least 23 dB below the power contained in a 0.5 MHz band centred on the nominal channel frequency. The power contained in a 0.5 MHz band centred on frequencies 2 MHz above and 2 MHz below the nominal channel frequency should, in each case, be at least 38 dB below the power contained in a 0.5 MHz band centred on the nominal channel frequency. Any additional lobe of the spectrum should be of less amplitude than the adjacent lobe nearer the nominal channel frequency.

3.5.5.1.4 *Pulse spacing*

3.5.5.1.4.1 The spacing of the constituent pulses of transmitted pulse pairs shall be as given in the table in 3.5.4.4.1 above.

3.5.5.1.4.2 *DME/N.* The tolerance on the pulse spacing shall be plus or minus 0.5 microsecond.

3.5.5.1.4.3 *DME/N.* **Recommendation.** — *The tolerance on the pulse spacing should be plus or minus 0.25 microsecond.*

3.5.5.1.4.4 *DME/P.* The tolerance on the pulse spacing shall be plus or minus 0.25 microsecond.

3.5.5.1.4.5 The pulse spacing shall be measured between the half voltage points on the leading edges of the pulses.

3.5.5.1.5 *Pulse repetition frequency*

3.5.5.1.5.1 The pulse repetition frequency shall be as specified in 3.5.3.4 above.

3.5.5.1.5.2 The variation in time between successive pairs of interrogation pulses shall be sufficient to prevent false lock-on.

3.5.5.1.5.3 *DME/P.* In order to achieve the system accuracy specified in 3.5.3.1.3.4 above, the variation in time between successive pairs of interrogation pulses shall be sufficiently random to decorrelate high frequency multipath errors.

Note.— Guidance on DME/P multipath effects is given in Attachment C to Part I, 7.3.7.

3.5.5.1.6 *Spurious radiation.* During intervals between transmission of individual pulses, the spurious pulse power received and measured in a receiver having the same characteristics of a DME transponder receiver, but tuned to any DME interrogation or reply frequency, shall be more than 50 dB below the peak pulse power received and measured in the same receiver tuned to the interrogation frequency in use during the transmission of the required pulses. This provision shall apply to all spurious pulse transmissions. The spurious CW power radiated from the interrogator on any DME interrogation or reply frequency shall not exceed 20 microwatts (minus 47 dBW).

Note.— Although spurious CW radiation between pulses is limited to levels not exceeding minus 47 dBW, States are cautioned that where DME interrogators and secondary surveillance radar transponders are employed in the same aircraft, it may be necessary to provide protection to airborne SSR in the band 1 015 MHz to 1 045 MHz. This protection may be provided by limiting conducted and radiated CW to a level of the order of minus 77 dBW. Where this level cannot be achieved, the required degree of protection may be provided in planning the relative location of the SSR and DME aircraft antennas. It is to be noted that only a few of these frequencies are utilized in the VHF/DME pairing plan.

3.5.5.1.7 **Recommendation.**— *The spurious pulse power received and measured under the conditions stated in 3.5.5.1.6 above should be 80 dB below the required peak pulse power received.*

Note.— Reference 3.5.5.1.6 and 3.5.5.1.7 above — although limitation of spurious CW radiation between pulses to levels not exceeding 80 dB below the peak pulse power received is recommended, States are cautioned that where users employ airborne secondary surveillance radar transponders in the same aircraft, it may be necessary to limit direct and radiated CW to not more than 0.02 microwatt in the frequency band 1 015 MHz to 1 045 MHz. It is to be noted that only a few of these frequencies are utilized in the VHF/DME pairing plan.

3.5.5.1.8 *DME/P.* The peak effective radiated power (ERP) shall not be less than that required to ensure the power densities in 3.5.4.2.3.1 above under all operational weather conditions.

3.5.5.2 *Time delay*

3.5.5.2.1 The time delay shall be consistent with the table in 3.5.4.4.1 above.

3.5.5.2.2 *DME/N.* The time delay shall be the interval between the time of the half voltage point on the leading edge of the second constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication.

‡3.5.5.2.3 *DME/N.* The time delay shall be the interval between the time of the half voltage point on the leading edge of the first constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication.

3.5.5.2.4 *DME/P — IA mode.* The time delay shall be the interval between the time of the half voltage point on the leading edge of the first constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication.

3.5.5.2.5 *DME/P — FA mode.* The time delay shall be the interval between the virtual origin of the leading edge of the first constituent interrogation pulse and the time at which the distance circuits reach the condition corresponding to zero distance indication. The time of arrival shall be measured within the partial rise time of the pulse.

3.5.5.3 *Receiver*

3.5.5.3.1 *Frequency of operation.* The receiver centre frequency shall be the transponder frequency appropriate to the assigned DME operating channel (see 3.5.3.3.3 above).

3.5.5.3.2 *Receiver sensitivity*

‡3.5.5.3.2.1 *DME/N.* The airborne equipment sensitivity shall be sufficient to acquire and provide distance information to the accuracy specified in 3.5.5.4 below for the signal power density specified in 3.5.4.1.5.2 above.

Note.— Although the Standard in ‡3.5.5.3.2.1 above is for DME/N interrogators, the receiver sensitivity is better than that necessary in order to operate with the power density of DME/N transponders given in 3.5.4.1.5.1 above in order to assure interoperability with the IA mode of DME/P transponders.

3.5.5.3.2.2 *DME/P.* The airborne equipment sensitivity shall be sufficient to acquire and provide distance information to the accuracy specified in 3.5.5.4.2 and 3.5.5.4.3 below for the signal power densities specified in 3.5.4.1.5.3 above.

‡3.5.5.3.2.3 *DME/N.* The performance of the interrogator shall be maintained when the power density of the transponder signal at the interrogator antenna is between the minimum values given in 3.5.4.1.5 above and a maximum of minus 18 dBW/m².

3.5.5.3.2.4 *DME/P.* The performance of the interrogator shall be maintained when the power density of the transponder signal at the interrogator antenna is between the minimum values given in 3.5.4.1.5 above and a maximum of minus 18 dBW/m².

3.5.5.3.3 *Bandwidth*

3.5.5.3.3.1 *DME/N.* The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above, when the input signals are those specified in 3.5.4.1.3 above.

3.5.5.3.3.2 *DME/P — IA mode.* The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above, when the input signals are those specified in 3.5.4.1.3 above. The 12-dB bandwidth shall not exceed 2 MHz and the 60-dB bandwidth shall not exceed 10 MHz.

3.5.5.3.3.3 *DME/P — FA mode.* The receiver bandwidth shall be sufficient to allow compliance with 3.5.3.1.3 above when the input signals are those specified in 3.5.5.1.3 above. The 12-dB bandwidth shall not exceed 6 MHz and the 60-dB bandwidth shall not exceed 20 MHz.

3.5.5.3.4 *Interference rejection*

3.5.5.3.4.1 When there is a ratio of desired to undesired co-channel DME signals of at least 8 dB at the input terminals of the airborne receiver, the interrogator shall display distance information and provide unambiguous identification from the stronger signal.

Note.— Co-channel refers to those reply signals which utilize the same frequency and the same pulse pair spacing.

‡3.5.5.3.4.2 *DME/N.* DME signals greater than 900 kHz removed from the desired channel nominal frequency and having amplitudes up to 42 dB above the threshold sensitivity shall be rejected.

3.5.5.3.4.3 *DME/P.* DME signals greater than 900 kHz removed from the desired channel nominal frequency and having amplitudes up to 42 dB above the threshold sensitivity shall be rejected.

3.5.5.3.5 *Decoding*

3.5.5.3.5.1 The interrogator shall include a decoding circuit such that the receiver can be triggered only by pairs of received pulses having pulse duration and pulse spacings appropriate to transponder signals as described in 3.5.4.1.4 above.

‡3.5.5.3.5.2 *DME/N — Decoder rejection.* A reply pulse pair with a spacing of plus or minus 2 microseconds, or more, from the nominal value and with any signal level up to 42 dB above the receiver sensitivity shall be rejected.

3.5.5.3.5.3 *DME/P — Decoder rejection.* A reply pulse pair with a spacing of plus or minus 2 microseconds, or more, from the nominal value and with any signal level up to 42 dB above the receiver sensitivity shall be rejected.

3.5.5.4 *Accuracy*

‡3.5.5.4.1 *DME/N.* The interrogator shall not contribute more than plus or minus 315 m (plus or minus 0.17 NM) to the over-all system error.

3.5.5.4.2 *DME/P — IA mode.* The interrogator shall not contribute more than plus or minus 30 m (plus or minus 100 ft) to the over-all system PFE and not more than plus or minus 15 m (plus or minus 50 ft) to the over-all system CMN.

3.5.5.4.3 *DME/P — FA mode*

3.5.5.4.3.1 *Accuracy standard 1.* The interrogator shall not contribute more than plus or minus 15 m (plus or minus 50 ft) to the over-all system PFE and not more than plus or minus 10 m (plus or minus 33 ft) to the over-all system CMN.

3.5.5.4.3.2 *Accuracy standard 2.* The interrogator shall not contribute more than plus or minus 7 m (plus or minus 23 ft) to the over-all system PFE and not more than plus or minus 7 m (plus or minus 23 ft) to the over-all system CMN.

Note.— Guidance material on filters to assist in achieving this accuracy is given in Attachment C to Part I, 7.3.4.

3.5.5.4.4 *DME/P.* The interrogator shall achieve the accuracy specified in 3.5.3.1.3.4 above with a system efficiency of 50 per cent or more.

Note.— Guidance material on system efficiency is given in Attachment C to Part I, 7.1.1.

3.6 Specification for en-route VHF marker beacons (75 MHz)

3.6.1 Equipment

3.6.1.1 *Frequencies.* The emissions of an en-route VHF marker beacon shall have a radio frequency of 75 MHz plus or minus 0.02 per cent. As from 1 January 1985 all new installed en-route VHF marker beacons shall have a frequency tolerance of plus or minus 0.005 per cent. After 1 January 1990 this provision applies for all en-route VHF marker beacons.

3.6.1.2 *Characteristics of emissions*

3.6.1.2.1 Radio marker beacons shall radiate an uninterrupted carrier modulated to a depth of not less than 95 per cent nor more than 100 per cent. The total harmonic content of the modulation shall not exceed 15 per cent.

3.6.1.2.2 The frequency of the modulating tone shall be 3 000 Hz plus or minus 75 Hz.

3.6.1.2.3 The radiation shall be horizontally polarized.

3.6.1.2.4 *Identification.* If a coded identification is required at a radio marker beacon, the modulating tone shall be keyed so as to transmit dots or dashes or both in an appropriate sequence. The mode of keying shall be such as to provide a dot-and-dash duration together with spacing intervals corresponding to transmission at a rate equivalent to approximately 6 to 10 words per minute. The carrier shall not be interrupted during identification.

3.6.1.2.5 *Coverage and radiation pattern*

Note.— The coverage and radiation pattern of marker beacons will ordinarily be established by Contracting States on the basis of operational requirements, taking into account recommendations of regional meetings.

The most desirable radiation pattern would be one that:

a) in the case of fan marker beacons, results in lamp operation only when the aircraft is within a rectangular parallelepiped, symmetrical about the vertical line through the marker beacon and with the major and minor axes adjusted in accordance with the flight path served;

b) in the case of a Z marker beacon, results in lamp operation only when the aircraft is within a cylinder, the axis of which is the vertical line through the marker beacons.

In practice, the production of such patterns is impracticable and a compromise radiation pattern is necessary. In Attachment C to Part I, antenna systems currently in use and which have proved generally satisfactory are described for guidance. Such designs and any new designs providing a closer approximation to the most desirable radiation pattern outlined above will normally meet operational requirements.

3.6.1.2.6 *Determination of coverage.* The limits of coverage of marker beacons shall be determined on the basis of the field strength specified in 3.1.7.3.2 above.

3.6.1.2.7 *Radiation pattern.*

Recommendation.— *The radiation pattern of a marker beacon normally should be such that the polar axis is vertical, and the field strength in the pattern is symmetrical about the polar axis in the plane or planes containing the flight paths for which the marker beacon is intended.*

Note.— Difficulty in siting certain marker beacons may make it necessary to accept a polar axis that is not vertical.

3.6.1.3 *Monitoring.*

Recommendation.— *For each marker beacon, suitable monitoring equipment should be provided which will show at an appropriate location:*

a) a decrease in radiated carrier power below 50 per cent of the normal;

b) a decrease of modulation depth below 70 per cent;

c) a failure of keying.

Note.— Technical material for the guidance of designers and for those who may install or operate marker beacons appears in Attachment C to Part I.

3.7 Consol system characteristics

Introductory Note.— The Consol ground station radiates dot-and-dash signals, and a position line can be determined by making a count of the dot-and-dash characters heard during the navigational keying cycle transmission period. By reference to the appropriate Consol charts or tables, the observer can determine a position line. Since there are five alternative position lines in each coverage sector of 120 degrees, the observer, if in doubt as to which of these is correct, can generally resolve the ambiguity by taking a bearing on the ground station. The observer can establish his position by reference to two independent Consol ground stations.

3.7.1 Radio frequencies

3.7.1.1 **Recommendation.—** *The radio frequencies assigned to Consol should be selected from those available in that portion of the spectrum between 200 kHz and 415 kHz.*

3.7.2 Identification

Each Consol shall be identified by a two- or three-letter International Morse Code group transmitted at a rate corresponding to approximately 7 words per minute.

3.7.3 Navigational keying

Each Consol shall be keyed type A1A. The keying shall provide interlocked dots and dashes of ⅛ second and ⅜ second duration respectively. The navigational keying cycle shall be of approximately 30-second duration and shall be preceded and followed by a silent interval.

Note.— Close adherence to the 30-second navigational keying cycle will facilitate the design of automatic counters.

3.7.3.1 **Recommendation.—** *The duration of the silent interval should be of the order of 2 to 3 seconds.*

3.8 Secondary surveillance radar (SSR) system characteristics

Note.— Section 3.8.1 prescribes the technical characteristics of SSR systems having only Mode A and Mode C capabilities. Section 3.8.2 prescribes the characteristics of systems with Mode S capabilities.

3.8.1 Systems having only Mode A and Mode C capabilities

Note 1.— In this section, SSR modes are designated by letters A and C. Suffixed letters, e.g. A_2, C_4, are used to designate the individual pulses used in the air-to-ground pulse trains. This common use of letters is not to be construed as implying any particular association of modes and codes.

Note 2.— Provisions for the recording and retention of radar data are contained in Annex 11, Chapter 6.

3.8.1.1 *Interrogation and control (interrogation side-lobe suppression) radio frequencies (ground-to-air)*

3.8.1.1.1 The carrier frequency of the interrogation and control transmissions shall be 1 030 MHz.

3.8.1.1.2 The frequency tolerance shall be plus or minus 0.2 MHz.

3.8.1.1.3 The carrier frequencies of the control transmission and of each of the interrogation pulse transmissions shall not differ from each other by more than 0.2 MHz.

3.8.1.2 *Reply carrier frequency (air-to-ground)*

3.8.1.2.1 The carrier frequency of the reply transmission shall be 1 090 MHz.

3.8.1.2.2 The frequency tolerance shall be plus or minus 3 MHz.

3.8.1.3 *Polarization*

3.8.1.3.1 Polarization of the interrogation, control and reply transmissions shall be predominantly vertical.

3.8.1.4 *Interrogation modes (signals-in-space)*

3.8.1.4.1 The interrogation shall consist of two transmitted pulses designated P_1 and P_3. A control pulse P_2 shall be transmitted following the first interrogation pulse P_1.

3.8.1.4.2 Interrogation Modes A and C shall be as defined in 3.8.1.4.3.

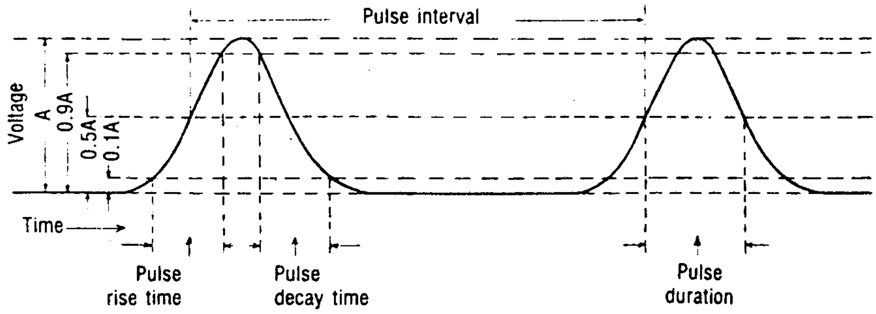
3.8.1.4.3 The interval between P_1 and P_3 shall determine the mode of interrogation and shall be as follows:

Mode A	8 ± 0.2 microseconds
Mode C	21 ± 0.2 microseconds

3.8.1.4.4 The interval between P_1 and P_2 shall be 2.0 plus or minus 0.15 microseconds.

3.8.1.4.5 The duration of pulses P_1, P_2 and P_3 shall be 0.8 plus or minus 0.1 microsecond.

3.8.1.4.6 The rise time of pulses P_1, P_2 and P_3 shall be between 0.05 and 0.1 microsecond.



Definitions

Phase reversal. A 180-degree change in the phase of the radio frequency carrier.

Phase reversal duration. The time between the 10-degree and 170-degree points of a phase reversal.

Pulse amplitude A. The peak voltage amplitude of the pulse envelope.

Pulse decay time. The time between 0.9A and 0.1A on the trailing edge of the pulse envelope.

Pulse duration. The time interval between 0.5A points on leading and trailing edges of the pulse envelope.

Pulse interval. The time interval between the 0.5A point on the leading edge of the first pulse and the 0.5A point on the leading edge of the second pulse.

Pulse rise time. The time between 0.1A and 0.9A on the leading edge of the pulse envelope.

Time intervals. Time intervals are referenced to:

a) the 0.5A point on the leading edge of a pulse;
b) the 0.5A point on the trailing edge of a pulse; or
c) the 90-degree point of a phase reversal.

Transponder sensitivity and power reference point. The antenna end of the transmission line of the transponder.

Note.— The 90-degree point of a phase reversal can be approximated by the minimum amplitude point on the envelope amplitude transient associated with the phase reversal and the phase reversal duration can be approximated by the time between the 0.8A points of the envelope amplitude transient.

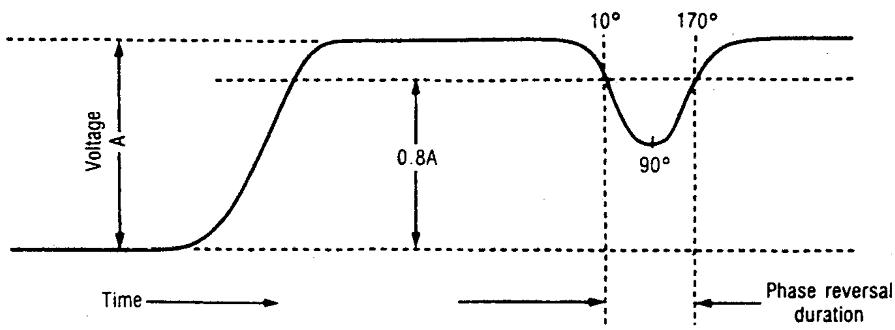


Figure 3-3. Definitions of secondary surveillance radar waveform shapes, intervals and the reference point for sensitivity and power

Note.— The intent of the lower limit of rise time (0.05 microsecond) is to reduce sideband radiation. Equipment will meet this requirement if the sideband radiation is no greater than that which, theoretically, would be produced by a trapezoidal wave having the stated rise time.

3.8.1.4.7 The decay time of pulses P_1, P_2 and P_3 shall be between 0.05 and 0.2 microsecond.

Note.— The intent of the lower limit of decay time (0.05 microsecond) is to reduce sideband radiation. Equipment will meet this requirement if the sideband radiation is no greater than that which, theoretically, would be produced by a trapezoidal wave having the stated decay time.

3.8.1.5 *Interrogator and control transmission characteristics (interrogation side-lobe suppression — signals-in-space)*

3.8.1.5.1 The radiated amplitude of P_2 at the antenna of the transponder shall be:

a) equal to or greater than the radiated amplitude of P_1 from the side-lobe transmissions of the antenna radiating P_1; and

b) at a level lower than 9 dB below the radiated amplitude of P_1, within the desired arc of interrogation.

3.8.1.5.2 Within the desired beamwidth of the directional interrogation (main lobe), the radiated amplitude of P_3 shall be within 1 dB of the radiated amplitude of P_1.

3.8.1.6 *Reply transmission characteristics (signals-in-space)*

3.8.1.6.1 *Framing pulses.* The reply function shall employ a signal comprising two framing pulses spaced 20.3 microseconds as the most elementary code.

3.8.1.6.2 *Information pulses.* Information pulses shall be spaced in increments of 1.45 microseconds from the first framing pulse. The designation and position of these information pulses shall be as follows:

Pulses	*Position (microseconds)*
C_1	1.45
A_1	2.90
C_2	4.35
A_2	5.80
C_4	7.25
A_4	8.70
X	10.15
B_1	11.60
D_1	13.05
B_2	14.50
D_2	15.95
B_4	17.40
D_4	18.85

Note.— The Standard relating to the use of these pulses is given in Part I, 2.5.4.1. However, the position of the "X" pulse is specified only as a technical standard to safeguard possible future use.

3.8.1.6.3 *Special position identification pulse (SPI).* In addition to the information pulses provided, a special position identification pulse shall be transmitted but only as a result of manual (pilot) selection. When transmitted, it shall be spaced at an interval of 4.35 microseconds following the last framing pulse of Mode A replies only.

3.8.1.6.4 *Reply pulse shape.* All reply pulses shall have a pulse duration of 0.45 plus or minus 0.1 microsecond, a pulse rise time between 0.05 and 0.1 microsecond and a pulse decay time between 0.05 and 0.2 microsecond. The pulse amplitude variation of one pulse with respect to any other pulse in a reply train shall not exceed 1 dB.

Note.— The intent of the lower limit of rise and decay times (0.05 microsecond) is to reduce sideband radiation. Equipment will meet this requirement if the sideband radiation is not greater than that which, theoretically, would be produced by a trapezoidal wave having the stated rise and decay times.

3.8.1.6.5 *Reply pulse position tolerances.* The pulse spacing tolerance for each pulse (including the last framing pulse) with respect to the first framing pulse of the reply group shall be plus or minus 0.10 microsecond. The pulse interval tolerance of the special position identification pulse with respect to the last framing pulse of the reply group shall be plus or minus 0.10 microsecond. The pulse spacing tolerance of any pulse in the reply group with respect to any other pulse (except the first framing pulse) shall not exceed plus or minus 0.15 microsecond.

3.8.1.6.6 *Code nomenclature.* The code designation shall consist of digits between 0 and 7 inclusive, and shall consist of the sum of the subscripts of the pulse numbers given in 3.8.1.6.2 above, employed as follows:

Digit	*Pulse Group*
First (*most significant*)	A
Second	B
Third	C
Fourth	D

3.8.1.7 *Technical characteristics of transponders with Mode A and Mode C capabilities only*

3.8.1.7.1 *Reply.* The transponder shall reply (not less than 90 per cent triggering) when all of the following conditions have been met:

a) the received amplitude of P_3 is in excess of a level 1 dB below the received amplitude of P_1 but no greater than 3 dB above the received amplitude of P_1;

b) either no pulse is received in the interval 1.3 microseconds to 2.7 microseconds after P_1, or P_1 exceeds by more than 9 dB any pulse received in this interval;

c) the received amplitude of a proper interrogation is more than 10 dB above the received amplitude of random pulses where the latter are not recognized by the transponder as P_1, P_2 or P_3.

3.8.1.7.2 The transponder shall not reply under the following conditions:

a) to interrogations when the interval between pulses P_1 and P_3 differs from those specified in 3.8.1.4.3 by more than plus or minus 1.0 microsecond;

b) upon receipt of any single pulse which has no amplitude variations approximating a normal interrogation condition.

3.8.1.7.3 *Dead time.* After recognition of a proper interrogation, the transponder shall not reply to any other interrogation, at least for the duration of the reply pulse train. This dead time shall end no later than 125 microseconds after the transmission of the last reply pulse of the group.

3.8.1.7.4 *Suppression*

Note.— This characteristic is used to prevent replies to interrogations received via the sidelobes of the interrogator *antenna, and to prevent Mode A/C transponders from replying to Mode S interrogations.*

3.8.1.7.4.1 The transponder shall be suppressed when the received amplitude of P_2 is equal to, or in excess of, the received amplitude of P_1 and spaced 2.0 plus or minus 0.15 microseconds. The detection of P_3 is not required as a prerequisite for initiation of suppression action.

3.8.1.7.4.2 The transponder suppression shall be for a period of 35 plus or minus 10 microseconds.

3.8.1.7.4.2.1 The suppression shall be capable of being reinitiated for the full duration within 2 microseconds after the end of any suppression period.

3.8.1.7.5 *Receiver sensitivity and dynamic range*

3.8.1.7.5.1 The minimum triggering level of the transponder shall be such that replies are generated to at least 90 per cent of the interrogation signals when:

a) the two pulses P_1 and P_3 constituting an interrogation are of equal amplitude and P_2 is not detected; and

b) the amplitude of these signals is nominally 71 dB below 1 mW, with limits between 69 dB and 77 dB below 1 mW.

3.8.1.7.5.2 The reply and suppression characteristics shall apply over a received amplitude of P_1 between minimum triggering level and 50 dB above that level.

3.8.1.7.5.3 The variation of the minimum triggering level between modes shall not exceed 1 dB for nominal pulse spacings and pulse widths.

3.8.1.7.6 *Pulse duration discrimination.* Signals of received amplitude between minimum triggering level and 6 dB above this level, and of a duration less than 0.3 microsecond, shall not cause the transponder to initiate reply or suppression action. With the exception of single pulses with amplitude variations approximating an interrogation, any single pulse of a duration more than 1.5 microseconds shall not cause the transponder to initiate reply or suppression action over the signal amplitude range of minimum triggering level (MTL) to 50 dB above that level.

3.8.1.7.7 *Echo suppression and recovery.* The transponder shall contain an echo suppression facility designed to permit normal operation in the presence of echoes of signals-in-space. The provision of this facility shall be compatible with the requirements for suppression of side lobes given in 3.8.1.7.4.1 above.

3.8.1.7.7.1 *Desensitization.* Upon receipt of any pulse more than 0.7 microsecond in duration, the receiver shall be desensitized by an amount that is within at least 9 dB of the amplitude of the desensitizing pulse but shall at no time exceed the amplitude of the desensitizing pulse, with the exception of possible overshoot during the first microsecond following the desensitizing pulse.

Note.— Single pulses of duration less than 0.7 microsecond are not required to cause the specified desensitization nor to cause desensitization of duration greater than permitted by 3.8.1.7.7.1 above and 3.8.1.7.7.2 below.

3.8.1.7.7.2 *Recovery.* Following desensitization, the receiver shall recover sensitivity (within 3 dB of minimum triggering level) within 15 microseconds after reception of a desensitizing pulse having a signal strength up to 50 dB above minimum triggering level. Recovery shall be at an average rate not exceeding 4.0 dB per microsecond.

3.8.1.7.8 *Random triggering rate.* In the absence of valid interrogation signals, Mode A/C transponders shall not generate more than 30 unwanted Mode A or Mode C replies per second as integrated over an interval equivalent to at least 300 random triggers, or 30 seconds, whichever is less. This random triggering rate shall not be exceeded when all possible interfering equipments installed in the same aircraft are operating at maximum interference levels.

3.8.1.7.9 *Reply rate*

3.8.1.7.9.1 The transponder shall be capable of at least 1 200 replies per second for a 15-pulse coded reply, except that, for transponder installations used solely below 4 500 m (15 000 ft), or below a lesser altitude established by the appropriate authority or by regional air navigation agreement, transponders capable of at least 1 000 replies per second for a 15-pulse coded reply shall be permitted.

3.8.1.7.9.2 *Reply rate limit control.* To protect the system from the effects of transponder over-interrogation by preventing response to weaker signals when a predetermined reply rate has been reached, a sensitivity reduction type reply limit control shall be incorporated in the equipment. The range of this control shall permit adjustment, as a minimum, to any value between 500 and 2 000 replies per second, or to the maximum reply rate capability if less than 2 000 replies per second, without regard to the number of pulses in each reply. Sensitivity reduction in excess of 3 dB shall not take effect until 90 per cent of the selected value is exceeded. Sensitivity reduction shall be at least 30 dB for rates in excess of 150 per cent of the selected value.

3.8.1.7.9.3 **Recommendation.—** *The reply rate limit should be set at 1 200 replies per second, or the maximum value below 1 200 replies per second of which the transponder is capable.*

3.8.1.7.10 *Reply delay and jitter.* The time delay between the arrival, at the transponder receiver, of the leading edge of P_3 and the transmission of the leading edge of the first pulse of the reply shall be 3 plus or minus 0.5 microseconds. The total jitter of the reply pulse-code group, with respect to P_3, shall not exceed 0.1 microsecond for receiver input levels between 3 dB and 50 dB above minimum triggering level. Delay variations between modes on which the transponder is capable of replying shall not exceed 0.2 microsecond.

3.8.1.7.11 *Transponder power output and duty cycle*

3.8.1.7.11.1 The peak pulse power available at the antenna end of the transmission line of the transponder shall be at least 21 dB and not more than 27 dB above 1 W, except that for transponder installations used solely below 4 500 m (15 000 ft), or below a lesser altitude established by the appropriate authority or by regional air navigation agreement, a peak pulse power available at the antenna end of the transmission line of the transponder of at least 18.5 dB and not more than 27 dB above 1 W shall be permitted.

3.8.1.7.11.2 **Recommendation.**— *The peak pulse power specified in 3.8.1.7.11.1 above should be maintained over a range of replies from code 0000 at a rate of 400 replies per second to a maximum pulse content at a rate of 1 200 replies per second or a maximum value below 1 200 replies per second of which the transponder is capable.*

3.8.1.7.12 *Reply codes*

3.8.1.7.12.1 *Identification.* The reply to a Mode A interrogation shall consist of the two framing pulses specified in 3.8.1.6.1 together with the information pulses (Mode A code) specified in 3.8.1.6.2.

Note.— The Mode A code designation is a sequence of four digits in accordance with 3.8.1.6.6.

3.8.1.7.12.1.1 The Mode A code shall be manually selected from the 4 096 codes available.

3.8.1.7.12.2 *Pressure-altitude transmission.* The reply to Mode C interrogation shall consist of the two framing pulses specified in 3.8.1.6.1 above. When digitized pressure-altitude information is available, the information pulses specified in 3.8.1.6.2 shall also be transmitted.

3.8.1.7.12.2.1 Transponders shall be provided with means to remove the information pulses but to retain the framing pulses when the provision of 3.8.1.7.12.2.4 below is not complied with in reply to Mode C interrogation.

3.8.1.7.12.2.2 The information pulses shall be automatically selected by an analog-to-digital converter connected to a pressure-altitude data source in the aircraft referenced to the standard pressure setting of 1 013.25 hectopascals.

Note.— The pressure setting of 1 013.25 hectopascals is equal to 29.92 inches of mercury.

3.8.1.7.12.2.3 Pressure-altitude shall be reported in 100-ft increments by selection of pulses as shown in Table B at the end of this chapter.

3.8.1.7.12.2.4 The digitizer code selected shall correspond to within plus or minus 38.1 m (125 ft), on a 95 per cent probability basis, with the pressure-altitude information (referenced to the standard pressure setting of 1 013.25 hectopascals), used on board the aircraft to adhere to the assigned flight profile.

3.8.1.7.13 *Transmission of the special position identification (SPI) pulse.* When required, this pulse shall be transmitted with Mode A replies, as specified in 3.8.1.6.3, for a period of between 15 and 30 seconds.

3.8.1.7.14 *Antenna*

3.8.1.7.14.1 The transponder antenna system, when installed on an aircraft, shall have a radiation pattern which is essentially omnidirectional in the horizontal plane.

3.8.1.7.14.2 **Recommendation.**— *The vertical radiation pattern should be nominally equivalent to that of a quarter-wave monopole on a ground plane.*

3.8.1.8 *Technical characteristics of ground interrogators with Mode A and Mode C capabilities only*

3.8.1.8.1 *Interrogation repetition frequency.* The maximum interrogation repetition frequency shall be 450 interrogations per second.

3.8.1.8.1.1 **Recommendation.**— *To minimize unnecessary transponder triggering and the resulting high density of mutual interference, all interrogators should use the lowest practicable interrogator repetition frequency that is consistent with the display characteristics, interrogator antenna beam width and antenna rotation speed employed.*

3.8.1.8.2 *Radiated power*

Recommendation.— *In order to minimize system interference the effective radiated power of interrogators should be reduced to the lowest value consistent with the operationally required range of each individual interrogator site.*

3.8.1.8.3 **Recommendation.**— *When Mode C information is to be used from aircraft flying below transition levels, the altimeter pressure reference datum should be taken into account.*

Note.— Use of Mode C below transition levels is in accordance with the philosophy that Mode C can usefully be employed in all environments.

3.8.1.9 *Interrogator radiated field pattern*

Recommendation.— *The beam width of the directional interrogator antenna radiating P_3 should not be wider than is operationally required. The side- and back-lobe radiation of the directional antenna should be at least 24 dB below the peak of the main-lobe radiation.*

3.8.1.10 *Interrogator monitor*

3.8.1.10.1 The range and azimuth accuracy of the ground interrogator shall be monitored at sufficiently frequent intervals to ensure system integrity.

Note.— Interrogators that are associated with and operated in conjunction with primary radar may use the primary radar as the monitoring device; alternatively, an electronic range and azimuth accuracy monitor would be required.

3.8.1.10.2 **Recommendation.**— *In addition to range and azimuth monitoring, provision should be made to monitor*

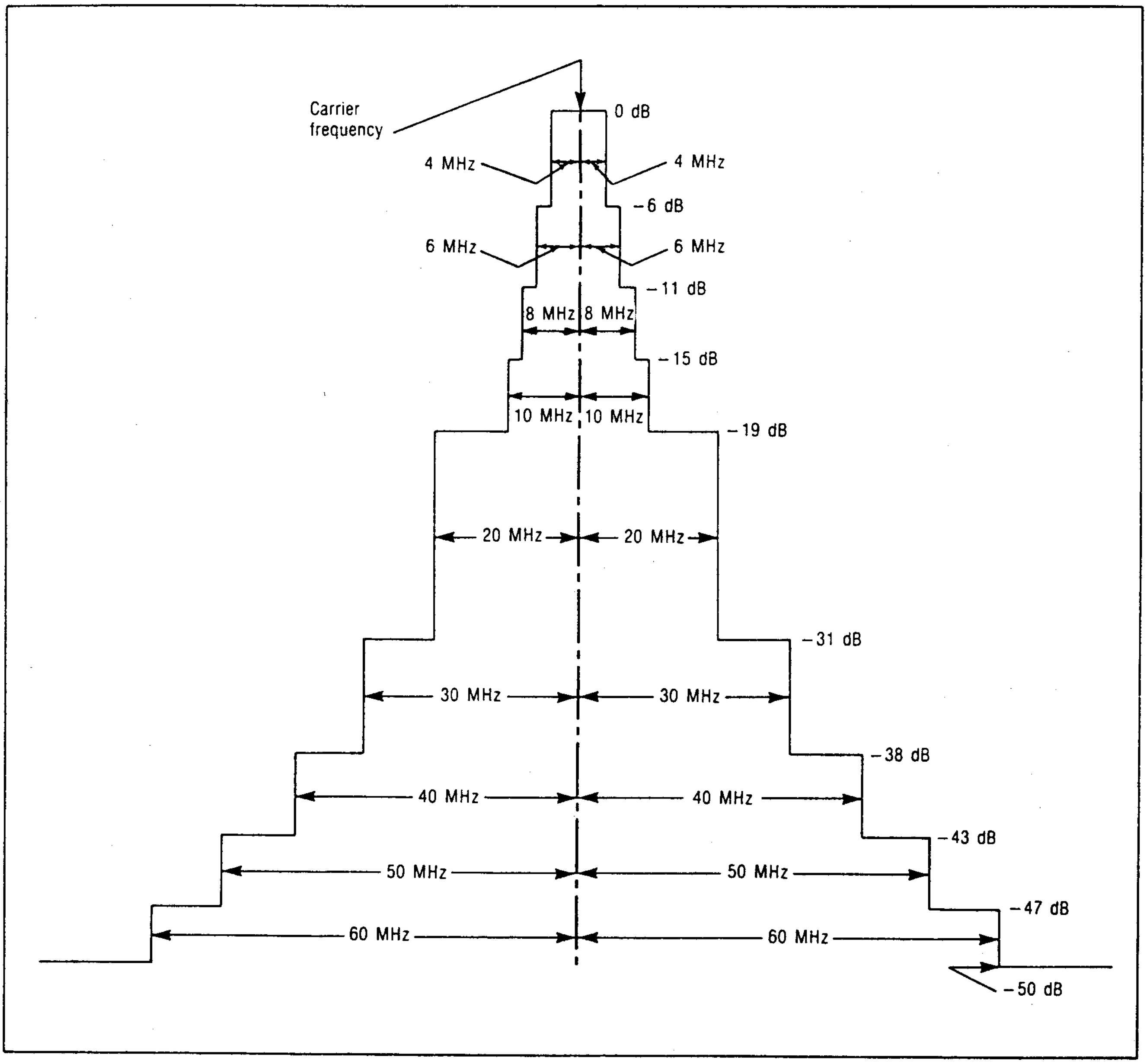


Figure 3-3.1. Required spectrum limits for interrogator transmitter

continuously the other critical parameters of the ground interrogator for any degradation of performance exceeding the allowable system tolerances and to provide an indication of any such occurrence.

3.8.1.11 *Spurious emissions and spurious responses*

3.8.1.11.1 *Spurious radiation*

Recommendation.— *CW radiation should not exceed 76 dB below 1 W for the interrogator and 70 dB below 1 W for the transponder.*

3.8.1.11.2 *Spurious responses*

Recommendation.— *The response of both airborne and ground equipment to signals not within the receiver pass band should be at least 60 dB below normal sensitivity.*

3.8.2 Systems having Mode S capabilities

3.8.2.1 *Interrogation signals-in-space characteristics.* The paragraphs herein describe the signals-in-space as they can be expected to appear at the antenna of the transponder.

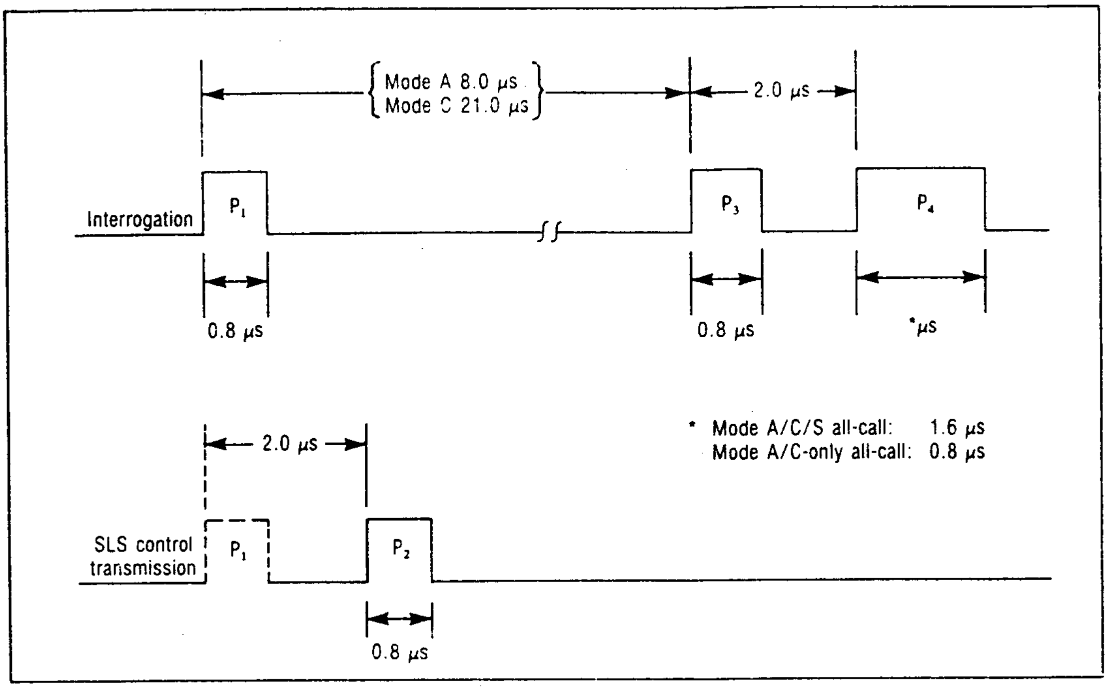


Figure 3-3.2. Intermode interrogation pulse sequence

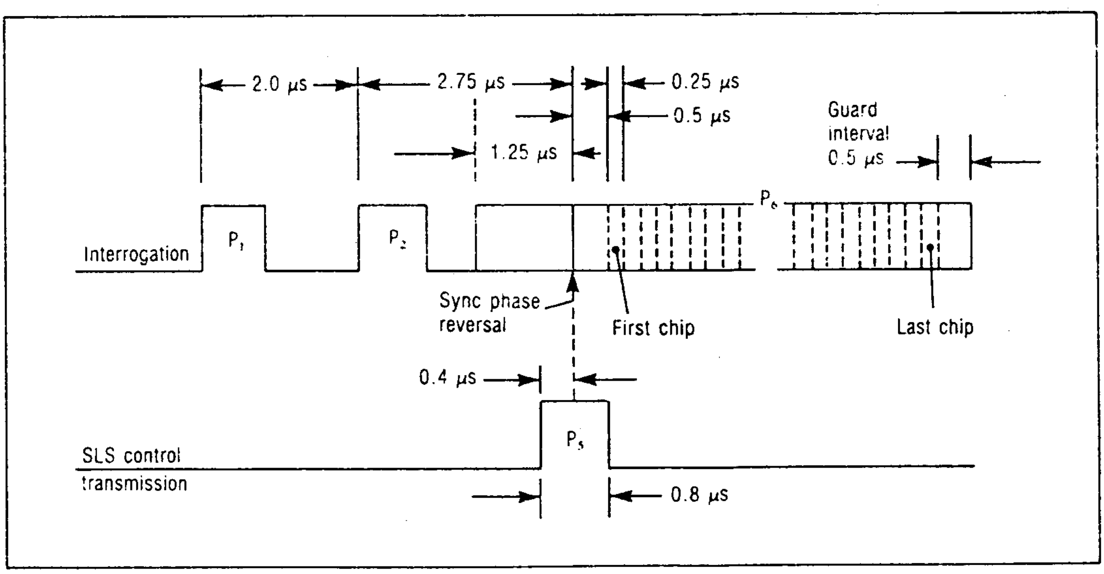


Figure 3-3.3. Mode S interrogation pulse sequence

Table 1. Pulse shapes — Mode S and intermode interrogations

Pulse	Duration	Duration tolerance	(Rise time) Min.	(Rise time) Max.	(Decay time) Min.	(Decay time) Max.
P_1, P_2, P_3, P_5	0.8	± 0.1	0.05	0.1	0.05	0.2
P_4 (short)	0.8	± 0.1	0.05	0.1	0.05	0.2
P_4 (long)	1.6	± 0.1	0.05	0.1	0.05	0.2
P_6 (short)	16.25	± 0.25	0.05	0.1	0.05	0.2
P_6 (long)	30.25	± 0.25	0.05	0.1	0.05	0.2

Note.— Because signals can be corrupted in propagation, certain interrogation pulse duration, pulse spacing and pulse amplitude tolerances are more stringent for interrogators as described in 3.8.2.11.4.

3.8.2.1.1 *Interrogation carrier frequency.* The carrier frequency of all interrogations (uplink transmissions) from ground facilities with Mode S capabilities shall be 1 030 plus or minus 0.01 MHz.

3.8.2.1.2 *Interrogation spectrum.* The spectrum of a Mode S interrogation about the carrier frequency shall not exceed the limits specified in Figure 3-3.1.

Note.— The Mode S interrogation spectrum is data dependent. The broadest spectrum is generated by an interrogation that contains all binary ONEs.

3.8.2.1.3 *Polarization.* Polarization of the interrogation and control transmissions shall be nominally vertical.

3.8.2.1.4 *Modulation.* For Mode S interrogations, the carrier frequency shall be pulse modulated. In addition, the data pulse, P_6, shall have internal phase modulation.

3.8.2.1.4.1 *Pulse modulation.* Intermode and Mode S interrogations shall consist of a sequence of pulses. The pulses which may be used to form a specific interrogation are designated P_1, P_2, P_3, P_4, P_5 and P_6. Pulse shapes shall be as defined in Table 1. All values are in microseconds.

Note.— The 0.8 microsecond pulses used in intermode and Mode S interrogations are identical in shape to those used in Modes A and C as defined in 3.8.1.4.

3.8.2.1.4.2 *Phase modulation.* The short (16.25-microsecond) and long (30.25-microsecond) P_6 pulses of 3.8.2.1.4.1 shall have internal binary differential phase modulation consisting of 180-degree phase reversals of the carrier at a 4 megabit per second rate.

3.8.2.1.4.2.1 *Phase reversal duration.* The duration of the phase reversal shall be less than 0.08 microsecond and the phase shall advance (or retard) monotonically throughout the transition region. There shall be no amplitude modulation applied during the phase transition.

Note.— The minimum duration of the phase reversal is not specified. Nonetheless, the spectrum requirements of 3.8.2.1.2 must be met.

3.8.2.1.4.2.2 *Phase relationship.* The tolerance on the 0 and 180-degree phase relationship between successive chips and on the sync phase reversal (3.8.2.1.5.2.2) within the P_6 pulse shall be plus or minus 5 degrees.

Note.— In Mode S a "chip" is the 0.25 microsecond carrier interval between possible data phase reversals.

3.8.2.1.5 *Pulse and phase reversal sequences.* Specific sequences of the pulses or phase reversals described in 3.8.2.1.4 shall constitute interrogations.

3.8.2.1.5.1 *Intermode interrogation*

3.8.2.1.5.1.1 *Mode A/C/S all-call interrogation.* This interrogation shall consist of three pulses: P_1, P_3, and the long P_4 as shown in Figure 3-3.2. One or two control pulses (P_2 alone, or P_1 and P_2) shall be transmitted using a separate antenna pattern to suppress responses from aircraft in the sidelobes of the interrogator antenna.

Note.— The Mode A/C/S all-call interrogation elicits a Mode A or Mode C reply (depending on the P_1-P_3 pulse spacing) from a Mode A/C transponder because it does not recognize the P_4 pulse. A Mode S transponder recognizes the long P_4 pulse and responds with a Mode S reply. This interrogation may be used to acquire Mode S-equipped aircraft as well as for surveillance of Mode A/C-equipped aircraft.

3.8.2.1.5.1.2 *Mode A/C-only all-call interrogation.* This interrogation shall be identical to that of the Mode A/C/S all-call interrogation except that the short P_4 pulse shall be used.

Note.— The Mode A/C-only all-call interrogation elicits a Mode A or Mode C reply from a Mode A/C transponder. A Mode S transponder recognizes the short P_4 pulse and does not reply to this interrogation.

3.8.2.1.5.1.3 *Pulse intervals.* The pulse intervals between P_1, P_2 and P_3 shall be as defined in 3.8.1.4.3 and 3.8.1.4.4. The pulse interval between P_3 and P_4 shall be 2 plus or minus 0.05 microsecond.

3.8.2.1.5.1.4 *Pulse amplitudes.* Relative amplitudes between pulses P_1, P_2 and P_3 shall be in accordance with 3.8.1.5. The amplitude of P_4 shall be within 1 dB of the amplitude of P_3.

3.8.2.1.5.2 *Mode S interrogation.* The Mode S interrogation shall consist of three pulses: P_1, P_2 and P_6 as shown in Figure 3-3.3.

Note.— P_6 is preceded by a P_1-P_2 pair which suppresses replies from Mode A/C transponders to avoid synchronous garble due to random triggering by the Mode S interrogation. The sync phase reversal within P_6 is the timing mark for demodulation of a series of time intervals (chips) of 0.25 microsecond duration. This series of chips starts 0.5 microsecond after the sync phase reversal and ends 0.5 microsecond before the trailing edge of P_6. A phase reversal may or may not precede each chip to encode its binary information value.

3.8.2.1.5.2.1 *Mode S sidelobe suppression.* The P_5 pulse shall be used with the Mode S-only all-call interrogation (UF = 11, 3.8.2.5.2) to prevent replies from aircraft in the side and back lobes of the antenna (3.8.2.1.5.2.5). When used, P_5 shall be transmitted using a separate antenna pattern.

Note 1.— The action of P_5 is automatic. Its presence, if of sufficient amplitude at the receiving location, masks the sync phase reversal of P_6.

Note 2.— The P_5 pulse may be used with other Mode S interrogations.

3.8.2.1.5.2.2 *Sync phase reversal.* The first phase reversal in the P_6 pulse shall be the sync phase reversal. It shall be the timing reference for subsequent transponder operations related to the interrogation.

3.8.2.1.5.2.3 *Data phase reversals.* Each data phase reversal shall occur only at a time interval (N times 0.25) plus or minus 0.02 microsecond (N equal to, or greater than 2) after the sync phase reversal. The 16.25-microsecond P_6 pulse shall contain at most 56 data phase reversals. The 30.25-microsecond P_6 pulse shall contain at most 112 data phase reversals. The last chip, that is the 0.25-microsecond time interval following the last data phase reversal position, shall be followed by a 0.5-microsecond guard interval.

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Note.— The 0.5-microsecond guard interval following the last chip prevents the trailing edge of P_6 from interfering with the demodulation process.

3.8.2.1.5.2.4 *Intervals.* The pulse interval between P_1 and P_2 shall be 2 plus or minus 0.05 microsecond. The interval between the leading edge of P_2 and the sync phase reversal of P_6 shall be 2.75 plus or minus 0.05 microsecond. The leading edge of P_6 shall occur 1.25 plus or minus 0.05 microsecond before the sync phase reversal. P_5, if transmitted, shall be centred over the sync phase reversal; the leading edge of P_5 shall occur 0.4 plus or minus 0.05 microsecond before the sync phase reversal.

3.8.2.1.5.2.5 *Pulse amplitudes.* The amplitude of P_2 and the amplitude of the first microsecond of P_6 shall be greater than the amplitude of P_1 minus 0.25 dB. Exclusive of the amplitude transients associated with phase reversals, the amplitude variation of P_6 shall be less than 1 dB and the amplitude variation between successive chips in P_6 shall be less than 0.25 dB. The radiated amplitude of P_5 at the antenna of the transponder shall be:

a) equal to or greater than the radiated amplitude of P_6 from the sidelobe transmissions of the antenna radiating P_6; and

b) at a level lower than 9 dB below the radiated amplitude of P_6 within the desired arc of interrogation.

3.8.2.2 *Reply signals-in-space characteristics*

3.8.2.2.1 *Reply carrier frequency.* The carrier frequency of all replies (downlink transmissions) from transponders with Mode S capabilities shall be 1 090 plus or minus 3 MHz for aircraft not capable of operating above 15 000 ft (4 572 m) and shall be 1 090 plus or minus 1 MHz for aircraft capable of operating above that level.

3.8.2.2.2 *Reply spectrum.* The spectrum of a Mode S reply about the carrier frequency shall not exceed the limits specified in Figure 3-3.4.

3.8.2.2.3 *Polarization.* Polarization of the reply transmissions shall be nominally vertical.

3.8.2.2.4 *Modulation.* The Mode S reply shall consist of a preamble and a data block. The preamble shall be a 4-pulse sequence and the data block shall be binary pulse-position modulated at a 1 megabit per second data rate.

3.8.2.2.4.1 *Pulse shapes.* Pulse shapes shall be as defined in Table 2. All values are in microseconds.

Table 2. Pulse shapes — Mode S replies

Pulse Duration	*Duration Tolerance*	*(Rise time) Min.*	*Max.*	*(Decay time) Min.*	*Max.*
0.5	±0.05	0.05	0.1	0.05	0.2
1.0	±0.05	0.05	0.1	0.05	0.2

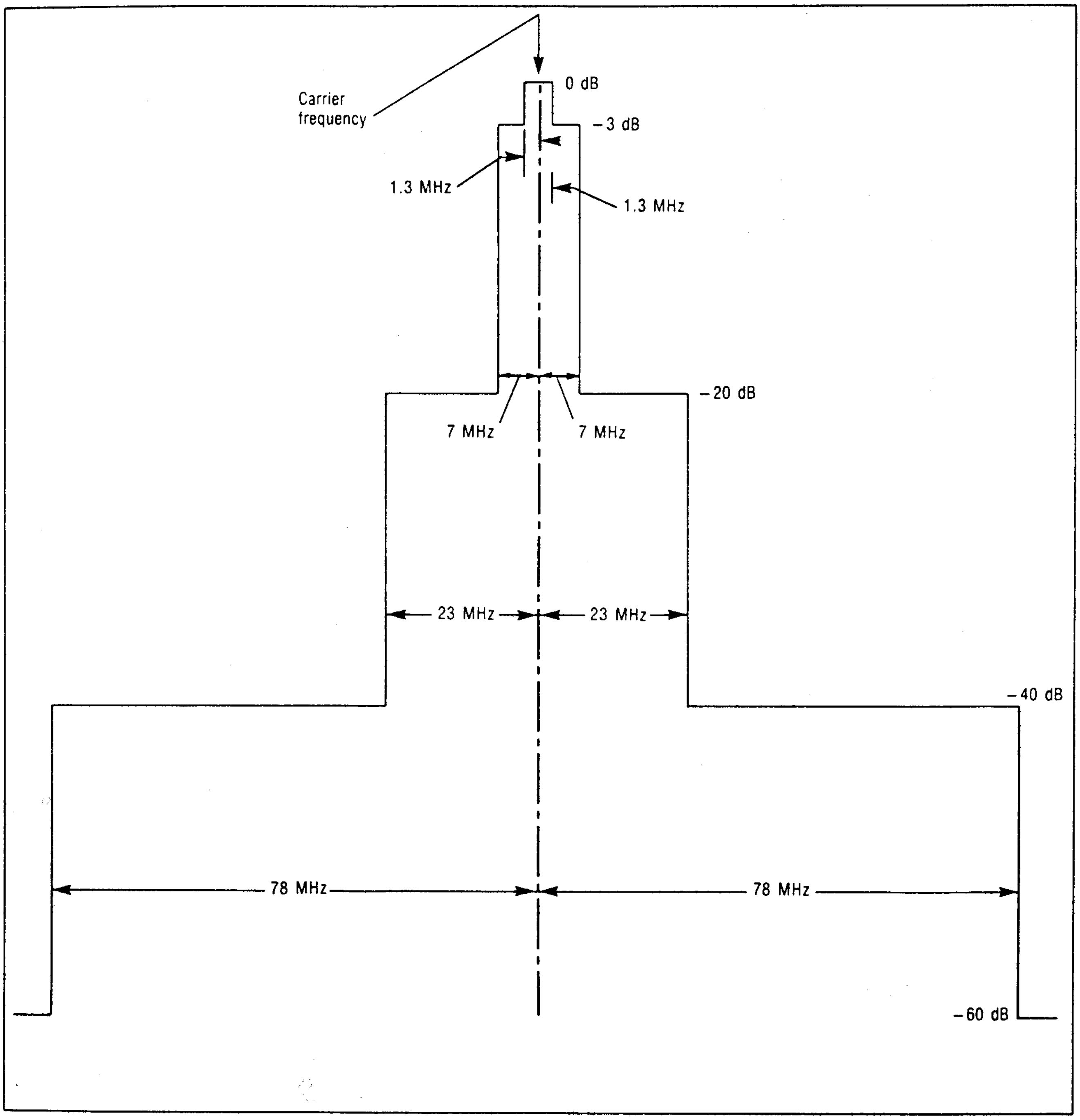

Figure 3-3.4. Required spectrum limits for transponder transmitter

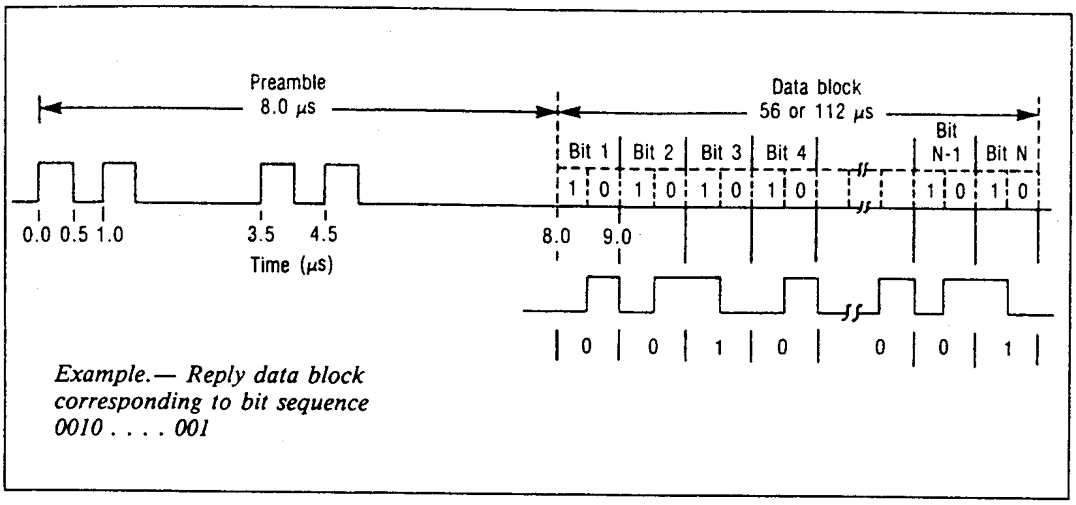

Figure 3-3.5. Mode S reply

3.8.2.2.5 *Mode S reply.* The Mode S reply shall be as shown in Figure 3-3.5. The data block in Mode S replies shall consist of either 56 or 112 information bits.

3.8.2.2.5.1 *Pulse intervals.* All reply pulses shall start at a defined multiple of 0.5 microsecond from the first transmitted pulse. The tolerance in all cases shall be plus or minus 0.05 microsecond.

3.8.2.2.5.1.1 *Reply preamble.* The preamble shall consist of four pulses, each with a duration of 0.5 microsecond. The pulse intervals from the first transmitted pulse to the second, third and fourth transmitted pulses shall be 1, 3.5 and 4.5 microseconds respectively.

3.8.2.2.5.1.2 *Reply data pulses.* The reply data block shall begin 8 microseconds after the leading edge of the first transmitted pulse. Either 56 or 112 one-microsecond bit intervals shall be assigned to each transmission. A 0.5-microsecond pulse shall be transmitted either in the first or in the second half of each interval. When a pulse transmitted in the second half of one interval is followed by another pulse transmitted in the first half of the next interval, the two pulses merge and a one-microsecond pulse shall be transmitted.

3.8.2.2.5.2 *Pulse amplitudes.* The pulse amplitude variation between one pulse and any other pulse in a Mode S reply shall not exceed 2 dB.

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3.8.2.3 *Mode S data structure*

3.8.2.3.1 *Data encoding*

3.8.2.3.1.1 *Interrogation data.* The interrogation data block shall consist of the sequence of 56 or 112 data chips positioned after the data phase reversals within P_6 (3.8.2.1.5.2.3). A 180-degree carrier phase reversal preceding a chip shall characterize that chip as a binary ONE. The absence of a preceding phase reversal shall denote a binary ZERO.

3.8.2.3.1.2 *Reply data.* The reply data block shall consist of 56 or 112 data bits formed by binary pulse position modulation encoding of the reply data as described in 3.8.2.2.5.1.2. A pulse transmitted in the first half of the interval shall represent a binary ONE whereas a pulse transmitted in the second half shall represent a binary ZERO.

3.8.2.3.1.3 *Bit numbering.* The bits shall be numbered in the order of their transmission, beginning with bit 1. Unless otherwise stated, numerical values encoded by groups (fields) of bits shall be encoded using positive binary notation and the first bit transmitted shall be the most significant bit (MSB). Information shall be coded in fields which consist of at least one bit.

Note.— In the description of Mode S formats the decimal equivalent of the binary code formed by the bit sequence within a field is used as the designator of the field function or command.

Table 3. Field definitions

Field		*Format*		*Reference*
Designator	*Function*	*UF*	*DF*	
AA	Address announced		11	3.8.2.5.2.2.2
AC	Altitude code		4, 20	3.8.2.6.5.4
AP	Address/parity	A11	0, 4, 5 20, 21 24	3.8.2.3.2.1.3
AQ	Acquisition	0		3.8.2.8.1.1
CA	Capability		11	3.8.2.5.2.2.1
DF	Downlink format		A11	3.8.2.3.2.1.2
DI	Designator identification	4, 5 20, 21		3.8.2.6.1.3
DR	Downlink request		4, 5 20, 21	3.8.2.6.5.2
FS	Flight status		4, 5 20, 21	3.8.2.6.5.1
ID	Identity		5, 21	3.8.2.6.7.1
II	Interrogator identifier	11		3.8.2.5.2.1.2
KE	Control, ELM		24	3.8.2.7.3.1
MA	Message, Comm-A	20, 21		3.8.2.6.2.1
MB	Message, Comm-B		20, 21	3.8.2.6.6.1
MC	Message, Comm-C	24		3.8.2.7.1.3
MD	Message, Comm-D		24	3.8.2.7.3.3
NC	Number of C-segment	24		3.8.2.7.1.2
ND	Number of D-segment		24	3.8.2.7.3.2
PC	Protocol	4, 5 20, 21		3.8.2.6.1.1
PI	Parity/interrogator identifier		11	3.8.2.3.2.1.4
PR	Probability of reply	11		3.8.2.5.2.1.1
RC	Reply control	24		3.8.2.7.1.1
RI	Reply information		0	3.8.2.8.2.2
RL	Reply length	0		3.8.2.8.1.2
RR	Reply request	4, 5 20, 21		3.8.2.6.1.2
SD	Special designator	4, 5 20, 21		3.8.2.6.1.4
UF	Uplink format	A11		3.8.2.3.2.1.1
UM	Utility message		4,5 20, 21	3.8.2.6.5.3
VS	Vertical status		0	3.8.2.8.2.1

Table 4. Subfield definitions

Subfield		*Field*	*Reference*
Designator	*Function*		
ACS	Comm-A capability subfield	MA	3.8.2.6.10.2.2.2
ADS	A-definition subfield	MA	3.8.2.6.2.1.1
AIS	Aircraft identification subfield	MB	3.8.2.9.1.1
BCS	Comm-B capability subfield	MB	3.8.2.6.10.2.2.2
BDS	B-definition subfield	MB	3.8.2.6.6.1.1
CDS	C-definition subfield	MC	3.8.2.7.1.3.1
CFS	Continuation subfield	MB	3.8.2.6.10.2.2.1
DDS	D-definition subfield	MD	3.8.2.7.3.3.1
ECS	ELM capability subfield	MB	3.8.2.6.10.2.2.2
IDS	Identifier designator subfield	UM	3.8.2.6.5.3.1
IIS	Interrogator identifier subfield	SD	3.8.2.6.1.4.1 a)
		UM	3.8.2.6.5.3.1
LOS	Lockout subfield	SD	3.8.2.6.1.4.1 d)
MBS	Multisite Comm-B subfield	SD	3.8.2.6.1.4.1 c)
MES	Multisite ELM subfield	SD	3.8.2.6.1.4.1 c)
RRS	Reply request subfield	SD	3.8.2.6.1.4.1 e)
RSS	Reservation status subfield	SD	3.8.2.6.1.4.1 c)
SRS	Segment request subfield	MC	3.8.2.7.6.2.1
TAS	Transmission acknowledgement subfield	MD	3.8.2.7.4.2.6
TMS	Tactical message subfield	SD	3.8.2.6.1.4.1 d)

3.8.2.3.2 *Formats of Mode S interrogations and replies*

Note.— A summary of all Mode S interrogation and reply formats is presented in Figures 3-3.6 and 3-3.7. A summary of all fields appearing in uplink and downlink formats is given in Table 3 and a summary of all subfields is given in Table 4.

3.8.2.3.2.1 *Essential fields.* Every Mode S transmission shall contain two essential fields. One is a descriptor which shall uniquely define the format of the transmission. This shall appear at the beginning of the transmission for all formats. The descriptors are designated by the UF (uplink format) or DF (downlink format) fields. The second essential field shall be a 24-bit field appearing at the end of each transmission and shall contain parity information. In all uplink and in currently defined downlink formats parity information shall be overlaid either on the Mode S address (3.8.2.4.1.2.3.1) or on the interrogator identifier according to 3.8.2.3.3.2. The designators are AP (address/parity) or PI (parity/interrogator identifier).

Note.— The remaining coding space is used to transmit the mission fields. For specific functions, a specific set of mission fields is prescribed. Mode S mission fields have two-letter designators. Subfields may appear within mission fields. Mode S subfields are labelled with three-letter designators.

3.8.2.3.2.1.1 *UF: Uplink format.* This uplink format field (5 bits long except in format 24 where it is 2 bits long) shall serve as the uplink format descriptor in all Mode S interrogations and shall be coded according to Figure 3-3.6.

3.8.2.3.2.1.2 *DF: Downlink format.* This downlink format field (5 bits long except in format 24 where it is 2 bits long) shall serve as the downlink format descriptor in all Mode S replies and shall be coded according to Figure 3-3.7.

3.8.2.3.2.1.3 *AP: Address/parity.* This 24-bit (33-56 or 89-112) field shall appear in all uplink and currently defined downlink formats except the Mode S-only all-call reply, DF = 11. The field shall contain parity overlaid on the Mode S address according to 3.8.2.3.3.2.

3.8.2.3.2.1.4 *PI: Parity/interrogator identifier.* This 24-bit (33-56) downlink field shall have parity overlaid on the interrogator's identity code according to 3.8.2.3.3.2 and shall appear in the Mode S all-call reply, DF = 11. If the reply is made in response to a Mode A/C/S all-call, or is an acquisition squitter (3.8.2.8.4), the interrogator identifier code shall be zero.

3.8.2.3.2.2 *Unassigned coding space.* Unassigned coding space shall contain all ZEROs as transmitted by interrogators and transponders.

Note.— Certain coding space indicated as unassigned in this section is reserved for other applications such as ACAS, data link, etc.

3.8.2.3.2.3 *Zero and unassigned codes.* A zero code assignment in all defined fields shall indicate that no action is required by the field. In addition, codes not assigned within the fields shall indicate that no action is required.

Note.— The provisions of 3.8.2.3.2.2 and 3.8.2.3.2.3 ensure that future assignments of previously unassigned coding space will not result in ambiguity. That is, Mode S equipment in which the new coding has not been implemented will clearly indicate that no information is being transmitted in newly assigned coding space.

3.8.2.3.3 *Error protection*

3.8.2.3.3.1 *Technique.* Parity check coding shall be used within Mode S interrogations and replies to provide protection against the occurrence of errors.

3.8.2.3.3.1.1 *Parity check sequence.* A sequence of 24 parity check bits shall be generated by the rule described in 3.8.2.3.3.1.2 and shall be incorporated into the field formed by the last 24 bits of all Mode S transmissions. The 24 parity check bits shall be combined with either the address coding or the interrogator identifier coding as described in 3.8.2.3.3.2. The resulting combination then forms either the AP (address/parity, 3.8.2.3.2.1.3) field or the PI (parity/interrogator identifier, 3.8.2.3.2.1.4) field.

3.8.2.3.3.1.2 *Parity check sequence generation.* The sequence of 24 parity bits ($p_1, p_2 \ldots p_{24}$) shall be generated from the sequence of information bits ($m_1, m_2 \ldots m_k$) where k is 32 or 88 for short or long transmissions respectively. This shall be done by means of a code generated by the polynomial:

$$G(x) = 1 + x^3 + x^{10} + x^{12} + x^{13} + x^{14} + x^{15} + x^{16} + x^{17} + x^{18} + x^{19} + x^{20} + x^{21} + x^{22} + x^{23} + x^{24}$$

When by the application of binary polynomial algebra, x^{24} [M(x)] is divided by G(x) where the information sequence M(x) is:

$$m_k + m_{k-1}x + m_{k-2}x^2 + \ldots + m_1x^{k-1}$$

the result is a quotient and a remainder R(x) of degree less than 24. The bit sequence formed by this remainder represents the parity check sequence. Parity bit p_i, for any i from 1 to 24, is the coefficient of x^{24-i} in R(x).

Note.— The effect of multiplying M(x) by x^{24} is to append 24 zero bits to the end of the sequence.

3.8.2.3.3.2 *AP and PI field generation.* Different address parity sequences shall be used for the uplink and downlink.

Note.— The uplink sequence is appropriate for a transponder decoder implementation. The downlink sequence facilitates the use of error correction in downlink decoding.

The code used in uplink AP field generation shall be formed as specified below from either the SSR Mode S address (3.8.2.4.1.2.3.1.1), the all-call address (3.8.2.4.1.2.3.1.2) or the broadcast address (3.8.2.4.1.2.3.1.3).

The code used in downlink AP field generation shall be formed directly from the sequence of 24 Mode S address bits ($a_1, a_2 \ldots a_{24}$), where a_i is the i-th bit transmitted in the aircraft address (AA) field of an all-call reply (3.8.2.5.2.2.2).

The code used in downlink PI field generation shall be formed by a sequence of 24 bits ($a_1, a_2 \ldots a_{24}$), where the first 20 bits are ZEROs and the last four bits are a replica of the interrogator identifier (II) field (3.8.2.5.2.1.2).

Note.— The PI code is not used in uplink transmissions.

A modified sequence ($b_1, b_2 \ldots b_{24}$) shall be used for uplink AP field generation. Bit b_i is the coefficient of x^{48-i} in the polynomial G(x)A(x), where:

$$A(x) = a_1x^{23} + a_2x^{22} + \ldots + a_{24}$$

and

G(x) is as defined in 3.8.2.3.3.1.2.

In the SSR Mode S address a_i shall be the i-th bit transmitted in the AA field of an all-call reply. In the all-call and broadcast addresses a_i shall equal one for all values of i.

3.8.2.3.3.2.1 *Uplink transmission order.* The sequence of bits transmitted in the uplink AP field is:

$$t_{k+1}, t_{k+2} \ldots t_{k+24}$$

where the bits are numbered in order of transmission, starting with k+1.

In uplink transmissions:

$$t_{k+i} = b_i \oplus p_i$$

where "⊕" prescribes modulo-2 addition: i equals 1 is the first bit transmitted in the AP field.

3.8.2.3.3.2.2 *Downlink transmission order.* The sequence of bits transmitted in the downlink AP and PI fields is:

$$t_{k+1}, t_{k+2} \ldots t_{k+24}$$

where the bits are numbered in order of transmission, starting with k+1. In downlink transmissions:

$$t_{k+i} = a_i \oplus p_i$$

where "⊕" prescribes modulo-2 addition: i equals 1 is the first bit transmitted in the AP of PI field.

3.8.2.4 *General interrogation-reply protocol*

3.8.2.4.1 *Transponder transaction cycle.* A transponder transaction cycle shall begin when the SSR Mode S transponder has recognized an interrogation. The transponder shall then evaluate the interrogation and determine whether it shall be accepted. If accepted, it shall then process the received interrogation and generate a reply, if appropriate. The transaction cycle shall end when:

a) any one of the necessary conditions for acceptance has not been met, or

b) an interrogation has been accepted and the transponder has either:

1) completed the processing of the accepted interrogation if no reply is required, or

2) completed the transmission of a reply.

A new transponder transaction cycle shall not begin until the previous cycle has ended.

3.8.2.4.1.1 *Interrogation recognition.* SSR Mode S transponders shall be capable of recognizing the following distinct types of interrogations:

a) Modes A and C;

b) intermode; and

c) Mode S.

Note.— The recognition process is dependent upon the signal input level and the specified dynamic range (3.8.2.10.1).

3.8.2.4.1.1.1 *Mode A and Mode C interrogation recognition.* A Mode A or Mode C interrogation shall be recognized when a P_1-P_3 pulse pair meeting the requirements of 3.8.1.4 has been received, and the leading edge of a P_4 pulse with an amplitude that is greater than a level 6 dB below the amplitude of P_3 is not received within the interval from 1.7 to 2.3 microseconds following the leading edge of P_3.

If a P_1-P_2 suppression pair and a Mode A or Mode C interrogation are recognized simultaneously, the transponder shall be suppressed. An interrogation shall not be recognized as Mode A or Mode C if the transponder is in suppression (3.8.2.4.2). If a Mode A and a Mode C interrogation are recognized simultaneously the transponder shall complete the transaction cycle as if only a Mode C interrogation had been recognized.

3.8.2.4.1.1.2 *Intermode interrogation recognition.* An intermode interrogation shall be recognized when a P_1-P_3-P_4 pulse triplet meeting the requirements of 3.8.2.1.5.1 is received. An interrogation shall not be recognized as an intermode interrogation if:

a) the received amplitude of the pulse in the P_4 position is smaller than 6 dB below the amplitude of P_3; or

b) the pulse interval between P_3 and P_4 is larger than 2.3 microseconds or shorter than 1.7 microseconds; or

c) the received amplitude of P_1 and P_3 is between MTL and −45 dBm and the pulse duration of P_1 or P_3 is less than 0.3 microsecond; or

d) the transponder is in suppression (3.8.2.4.2).

If a P_1-P_2 suppression pair and a Mode A or Mode C intermode interrogation are recognized simultaneously the transponder shall be suppressed.

3.8.2.4.1.1.3 *Mode S interrogation recognition.* A Mode S interrogation shall be recognized when a P_6 pulse is received with a sync phase reversal within the interval from 1.20 to 1.30 microseconds following the leading edge of P_6. A Mode S interrogation shall not be recognized if a sync phase reversal is not received within the interval from 1.05 to 1.45 microseconds following the leading edge of P_6.

3.8.2.4.1.2 *Interrogation acceptance.* Recognition according to 3.8.2.4.1 shall be a prerequisite for acceptance of any interrogation.

3.8.2.4.1.2.1 *Mode A and Mode C interrogation acceptance.* Mode A and Mode C interrogations shall be accepted when recognized (3.8.2.4.1.1.1).

3.8.2.4.1.2.2 *Intermode interrogation acceptance*

3.8.2.4.1.2.2.1 *Mode A/C/S all-call interrogation acceptance.* A Mode A/C/S all-call interrogation shall be accepted if the trailing edge of P_4 is received within 3.45 to 3.75 microseconds following the leading edge of P_3 and no lockout condition (3.8.2.6.9) prevents acceptance. A Mode A/C/S all-call shall not be accepted if the trailing edge of P_4 is received earlier than 3.3 or later than 4.2 microseconds following the leading edge of P_3, or if a lockout condition (3.8.2.6.9) prevents acceptance.

3.8.2.4.1.2.2.2 *Mode A/C-only all-call interrogation acceptance.* A Mode A/C-only all-call interrogation shall not be accepted by a Mode S transponder.

Note.— The technical condition for non-acceptance of a Mode A/C-only all-call is given in the preceding paragraph by the requirement for rejecting an intermode interrogation with a P_4 pulse having a trailing edge following the leading edge of P_3 by less than 3.3 microseconds.

3.8.2.4.1.2.3 *Mode S interrogation acceptance.* A Mode S interrogation shall only be accepted if:

a) the transponder is capable of processing the uplink format (UF) of the interrogation (3.8.2.3.2.1.1);

b) the address of the interrogation matches one of the addresses as defined in 3.8.2.4.1.2.3.1 implying that parity is established, as defined in 3.8.2.3.3;

c) no all-call lockout condition applies, as defined in 3.8.2.6.9; and

d) the transponder is capable of processing the uplinked data and presenting it at an output interface as prescribed in 3.8.2.10.5.2.2.1.

3.8.2.4.1.2.3.1 *Addresses.* Mode S interrogations shall contain either:

a) the Mode S address; or

Format No.	UF	Fields					
0	00000	3	RL:1	4	AQ:1	18	AP:24 ..... Short air-air surveillance (ACAS)
1	00001	27 or 83					AP:24
2	00010	27 or 83					AP:24
3	00011	27 or 83					AP:24
4	00100	PC:3	RR:5	DI:3	SD:16		AP:24 ..... Surveillance, altitude request
5	00101	PC:3	RR:5	DI:3	SD:16		AP:24 ..... Surveillance, identity request
6	00110	27 or 83					AP:24
7	00111	27 or 83					AP:24
8	01000	27 or 83					AP:24
9	01001	27 or 83					AP:24
10	01010	27 or 83					AP:24
11	01011	PR:4	II:4	19			AP:24 ..... Mode S only all-call
12	01100	27 or 83					AP:24
13	01101	27 or 83					AP:24
14	01110	27 or 83					AP:24
15	01111	27 or 83					AP:24
16	10000	3	RL:1	4	AQ:1	18	56 — AP:24 ..... Long air-air surveillance (ACAS)
17	10001	27 or 83					AP:24
18	10010	27 or 83					AP:24
19	10011	27 or 83					AP:24
20	10100	PC:3	RR:5	DI:3	SD:16	MA:56	AP:24 ..... Comm-A, altitude request
21	10101	PC:3	RR:5	DI:3	SD:16	MA:56	AP:24 ..... Comm-A, identity request
22	10110	27 or 83					AP:24
23	10111	27 or 83					AP:24
24	11	RC:2	NC:4	MC:80			AP:24 ..... Comm-C (ELM)

Notes.— 1. [XX:M] *denotes a field designated "XX" which is assigned M bits.*

2. [- N -] *denotes unassigned coding space with N available bits. These shall be coded as ZERO's for transmission.*

3. For uplink formats (UF) 0 to 23 the format number corresponds to the binary code in the first five bits of the interrogation. Format number 24 is defined as the format beginning with "11" in the first two bit positions while the following three bits vary with the interrogation content.

4. All formats are shown for completeness, although a number of them are unused. Those formats for which no application is presently defined remain undefined in length. Depending on future assignment they may be short (56 bits) or long (112 bits) formats. Specific formats associated with Mode S capability levels are described in later paragraphs.

Figure 3-3.6. Summary of Mode S interrogation or uplink formats

Format No.	DF	Fields	
0	00000	VS:1 · [7] · RI:4 · [2] · AC:13 · AP:24	Short air-air surveillance (ACAS)
1	00001	[27 or 83] · P:24	
2	00010	[27 or 83] · P:24	
3	00011	[27 or 83] · P:24	
4	00100	FS:3 · DR:5 · UM:6 · AC:13 · AP:24	Surveillance, altitude reply
5	00101	FS:3 · DR:5 · UM:6 · ID:13 · AP:24	Surveillance, identity reply
6	00110	[27 or 83] · P:24	
7	00111	[27 or 83] · P:24	
8	01000	[27 or 83] · P:24	
9	01001	[27 or 83] · P:24	
10	01010	[27 or 83] · P:24	
11	01011	CA:3 · AA:24 · PI:24	All-call reply
12	01100	[27 or 83] · P:24	
13	01101	[27 or 83] · P:24	
14	01110	[27 or 83] · P:24	
15	01111	[27 or 83] · P:24	
16	10000	VS:1 · [7] · RI:4 · [2] · AC:13 · 56 · AP:24	Long air-air surveillance (ACAS)
17	10001	[27 or 83] · P:24	
18	10010	[27 or 83] · P:24	
19	10011	[27 or 83] · P:24	
20	10100	FS:3 · DR:5 · UM:6 · AC:13 · MB:56 · AP:24	Comm-B, altitude reply
21	10101	FS:3 · DR:5 · UM:6 · ID:13 · MB:56 · AP:24	Comm-B, identity reply
22	10110	[27 or 83] · P:24	
23	10111	[27 or 83] · P:24	
24	11	1 · KE:1 · ND:4 · MD:80 · AP:24	Comm-D (ELM)

Notes.— 1. | *XX:M* | *denotes a field designated "XX" which is assigned M bits.*

| *P:24* | *denotes a 24-bit field reserved for parity information.*

2. [*N*] *denotes unassigned coding space with N available bits. These shall be coded as ZERO's for transmission.*

3. *For downlink formats (DF) 0 to 23 the format number corresponds to the binary code in the first five bits of the reply. Format number 24 is defined as the format beginning with "11" in the first two bit positions while the following three bits may vary with the reply content.*

4. *All formats are shown for completeness, although a number of them are unused. Those formats for which no application is presently defined remain undefined in length. Depending on future assignment they may be short (56 bits) or long (112 bits) formats. Specific formats associated with Mode S capability levels are described in later paragraphs.*

Figure 3-3.7. Summary of Mode S reply or downlink formats

b) the all-call address; or

c) the broadcast address.

3.8.2.4.1.2.3.1.1 *SSR Mode S address.* If the aircraft's Mode S address is identical to the address extracted from a received interrogation according to the procedure of 3.8.2.3.3.2 and 3.8.2.3.3.2.1, the extracted address shall be considered correct for purposes of Mode S interrogation acceptance.

3.8.2.4.1.2.3.1.2 *All-call address.* A Mode S-only all-call interrogation (uplink format UF = 11) shall contain an address, designated the all-call address, consisting of twenty-four consecutive ONEs. If the all-call address is extracted from a received interrogation with format UF = 11 according to the procedure of 3.8.2.3.3.2 and 3.8.2.3.3.2.1, the address shall be considered correct for Mode S-only all-call interrogation acceptance.

3.8.2.4.1.2.3.1.3 *Broadcast address.* To broadcast a message to all Mode S transponders within the interrogator beam, a Mode S interrogation uplink format 20 or 21 shall be used and an address of twenty-four consecutive ONEs shall be substituted for the aircraft Mode S address. If the UF code is 20 or 21 and this broadcast address is extracted from a received interrogation according to the procedure of 3.8.2.3.3.2 and 3.8.2.3.3.2.1, the address shall be considered correct for Mode S broadcast interrogation acceptance.

Note.— Transponders associated with airborne collision avoidance systems also accept a broadcast with UF = 16.

3.8.2.4.1.3 *Transponder replies.* Mode S transponders shall transmit the following reply types:

a) Mode A and Mode C replies; and

b) Mode S replies.

3.8.2.4.1.3.1 *Mode A and Mode C replies.* A Mode A (Mode C) reply shall be transmitted as specified in 3.8.1.6 when a Mode A (Mode C) interrogation has been accepted.

3.8.2.4.1.3.2 *Mode S replies.* Replies to other than Mode A and Mode C interrogations shall be Mode S replies.

3.8.2.4.1.3.2.1 *Replies to intermode interrogations.* A Mode S reply with downlink format 11 shall be transmitted in accordance with the provisions of 3.8.2.5.2.2 when a Mode A/C/S all-call interrogation has been accepted.

Note.— Since Mode S transponders do not accept Mode A/C-only all-call interrogations, no reply is generated.

3.8.2.4.1.3.2.2 *Replies to Mode S interrogations.* The information content of a Mode S reply shall reflect the conditions existing in the transponder after completion of all processing of the interrogation eliciting that reply. The correspondence between uplink and downlink formats shall be as summarized in Table 5.

Note.— Four categories of Mode S replies may be transmitted in response to Mode S interrogations:

a) Mode S all-call replies (DF = 11);

b) surveillance and standard-length communications replies (DF = 4, 5, 20 and 21);

c) extended length communications replies (DF = 24); and

d) short air-air surveillance replies (DF = 0).

3.8.2.4.1.3.2.2.1 *Replies to SSR Mode S-only all-call interrogations.* The downlink format of the reply to a Mode S-only all-call interrogation (if required) shall be DF = 11. The reply content and rules for determining the requirement to reply shall be as defined in 3.8.2.5.

Note.— A Mode S reply may or may not be transmitted when a Mode S interrogation with UF = 11 has been accepted.

3.8.2.4.1.3.2.2.2 *Replies to surveillance and standard length communications interrogations.* A Mode S reply shall be transmitted when a Mode S interrogation with UF = 4, 5, 20 or 21 and a unique Mode S address has been accepted. The contents of these interrogations and replies shall be as defined in 3.8.2.6.

Note.— If a Mode S interrogation with UF = 20 or 21 and a broadcast address is accepted, no reply is transmitted (3.8.2.4.1.2.3.1.3).

3.8.2.4.1.3.2.2.3 *Replies to extended length communications interrogations.* A series of Mode S replies ranging in number from 0 to 16 shall be transmitted when a Mode S interrogation with UF = 24 has been accepted. The downlink format of the reply (if any) shall be DF = 24. Protocols defining the number and content of the replies shall be as defined in 3.8.2.7.

3.8.2.4.1.3.2.2.4 *Replies to air-air surveillance interrogations.* A Mode S reply shall be transmitted when a Mode S interrogation with UF = 0 and a unique Mode S address has been accepted. The contents of these interrogations and replies shall be as defined in 3.8.2.8.

3.8.2.4.2 *Suppression*

3.8.2.4.2.1 *Effects of suppression.* A transponder in suppression (3.8.1.7.4) shall not recognize Mode A, Mode C or intermode interrogations if either the P_1 pulse alone or both the P_1 and P_3 pulses of the interrogation are received during the suppression interval. Suppression shall not affect the recognition of, acceptance of, or replies to Mode S interrogations.

3.8.2.4.2.2 *Suppression pairs.* The two-pulse Mode A/C suppression pair defined in 3.8.1.7.4.1 shall initiate suppression in a Mode S transponder regardless of the position of the pulse pair in a group of pulses, provided the transponder is not already suppressed or in a transaction cycle.

Note.— The P_3 - P_4 pair of the Mode A/C-only all-call interrogation both prevents a reply and initiates suppression. Likewise, the P_1 - P_2 preamble of a Mode S interrogation initiates suppression independently of the waveform that follows it.

3.8.2.5 *Intermode and Mode S all-call transactions*

3.8.2.5.1 *Intermode transactions*

Note.— Intermode transactions permit the surveillance of Mode A/C-only aircraft and the acquisition of Mode S aircraft. The Mode A/C/S all-call interrogation allows Mode A/C-only and Mode S transponders to be interrogated by the same transmissions. The Mode A/C-only all-call interrogation makes it possible to elicit replies only from Mode A/C transponders. In multisite scenarios, the interrogator must transmit its identifier code in the Mode S only all-call interrogation. Thus, a pair of Mode S-only and Mode A/C-only all-call interrogations are used. The intermode interrogations are defined in 3.8.2.1.5.1 and the corresponding interrogation-reply protocols are defined in 3.8.2.4.

3.8.2.5.2 *Mode S-only all-call transactions*

Note.— These transactions allow the ground to acquire Mode S aircraft by use of an interrogation addressed to all Mode S-equipped aircraft. The reply is via downlink format 11 which returns the aircraft address. The interrogation-reply protocols are defined in 3.8.2.4.

3.8.2.5.2.1 *Mode S-only all-call interrogation, uplink format 11*

1 – 5	6 – 9	10 – 13	14 – 32	33 – 56
UF	PR	II		AP

The format of this interrogation shall consist of these fields:

Field	*Reference*
UF uplink format	3.8.2.3.2.1.1
PR probability of reply	3.8.2.5.2.1.1
II interrogator	
identifier spare —	
19 bits	3.8.2.5.2.1.2
AP address/parity	3.8.2.3.2.1.3

3.8.2.5.2.1.1 *PR: Probability of reply.* This 4-bit (6-9) uplink field shall contain commands to the transponder specifying the probability of reply to that interrogation (3.8.2.5.4). Codes are as follows:

0 signifies reply with probability of 1
1 signifies reply with probability of 1/2
2 signifies reply with probability of 1/4
3 signifies reply with probability of 1/8
4 signifies reply with probability of 1/16
5, 6, 7 not assigned
8 signifies disregard lockout, reply with probability of 1
9 signifies disregard lockout, reply with probability of 1/2
10 signifies disregard lockout, reply with probability of 1/4
11 signifies disregard lockout, reply with probability of 1/8
12 signifies disregard lockout, reply with probability of 1/16
13, 14, 15 not assigned.

3.8.2.5.2.1.2 *II: Interrogator identifier.* This 4-bit (10-13) uplink field shall contain an interrogator identifier code. These II codes shall be assigned to interrogators in the range from 0 to 15. A II code value of zero shall not be used by interrogators which use the multisite lockout or communications protocols (3.8.2.6.9.1).

Note.— An interrogator may be assigned more than one identifier code and may use different codes in different interrogations.

3.8.2.5.2.2 *All-call reply, downlink format 11*

1 – 5	6 – 8	9 – 32	33 – 56
DF	CA	AA	PI

The reply to the Mode S-only all-call or the Mode A/C/S all-call interrogation shall be the Mode S all-call reply, downlink format 11. The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.8.2.3.2.1.2
CA capability	3.8.2.5.2.2.1
AA address announced	3.8.2.5.2.2.2
PI parity/interrogator	
identifier	3.8.2.3.2.1.4

3.8.2.5.2.2.1 *CA: Capability.* This 3-bit (6-8) downlink field shall contain an encoded definition of the communications capability of the transponder.

Coding:

0 signifies no communications capability (surveillance only), on the ground or airborne
transponder accepts UF = 0, 4, 5, 11
transponder transmits DF = 0, 4, 5, 11

1 signifies Comm-A and Comm-B capability, on the ground or airborne
transponder accepts UF = 0, 4, 5, 11, 20, 21
transponder transmits DF = 0, 4, 5, 11, 20, 21

2 signifies Comm-A, Comm-B and uplink extended length message (3.8.2.7) capability, on the ground or airborne
transponder accepts UF = 0, 4, 5, 11, 20, 21, 24
transponder transmits DF = 0, 4, 5, 11, 20, 21, 24

3 signifies Comm-A, Comm-B and uplink and downlink ELM capability, on the ground or airborne
transponder accepts UF = 0, 4, 5, 11, 20, 21, 24
transponder transmits DF = 0, 4, 5, 11, 20, 21, 24

4 to 7 not assigned in the all-call reply

Note.— See 3.8.2.8.4.1 for additional acquisition squitter capability codes.

Data link capability reports (3.8.2.6.10.2.2) shall be available for capability codes 1, 2 and 3.

Note.— Transponders associated with airborne collision avoidance systems also handle formats U = 16 and DF = 16.

Table 5. Interrogation — reply protocol summary

Interrogation UF	*Special conditions*	*Reply DF*
0	RL (3.8.2.8.1.2) equals zero	0
	RL (3.8.2.8.1.2) equals 1	No reply*
4	RR (3.8.2.6.1.2) less than 16	4
	RR (3.8.2.6.1.2) equal to or greater than 16	20
5	RR (3.8.2.6.1.2) less than 16	5
	RR (3.8.2.6.1.2) equal to or greater than 16	21
11	Transponder locked out to interrogator identifier, II (3.8.2.5.2.1.2)	No reply
	Stochastic reply test fails (3.8.2.5.4)	No reply
	Otherwise	11
20	RR (3.8.2.6.1.2) less than 16	4
	RR (3.8.2.6.1.2) equal to or greater than 16	20
	AP contains broadcast address (3.8.2.4.1.2.3.1.3)	No reply
21	RR (3.8.2.6.1.2) less than 16	5
	RR (3.8.2.6.1.2) equal to or greater than 16	21
	AP contains broadcast address (3.8.2.4.1.2.3.1.3)	No reply
24	RC (3.8.2.7.1.1) equals 0 or 1	No reply
	RC (3.8.2.7.1.1) equals 2 or 3	24

* A transponder associated with an ACAS would reply with DF = 16.

3.8.2.5.2.2.2 *AA: Address announced.* This 24-bit (9-32) downlink field shall contain the Mode S address which provides unambiguous identification of the aircraft.

3.8.2.5.3 *Lockout protocol.* The all-call lockout protocol defined in 3.8.2.6.9 shall be used by the interrogator with respect to an aircraft once the address of that specific aircraft has been acquired by an interrogator.

Note.— Following acquisition, a transponder is interrogated by discretely addressed interrogations as prescribed in 3.8.2.6, 3.8.2.7 and 3.8.2.8 and the all-call lockout protocol is used to inhibit replies to further all-call interrogations.

3.8.2.5.4 *Stochastic all-call protocol.* The transponder shall execute a random process upon acceptance of a Mode S-only all-call with a PR code equal to 1 to 4 or 9 to 12. A decision to reply shall be made in accordance with the probability specified in the interrogation. A transponder shall not reply if a PR code equal to 5, 6, 7, 13, 14 or 15 is received (3.8.2.5.2.1.1).

Note.— The random occurrence of replies makes it possible for the interrogator to acquire closely spaced aircraft, replies from which would otherwise synchronously garble each other.

3.8.2.6 *Addressed surveillance and standard length communication transactions*

Note 1.— The interrogations described in this section are addressed to specific aircraft. There are two basic interrogation and reply types, short and long. The short interrogations and replies are UF 4 and 5 and DF 4 and 5, while the long interrogations and replies are UF 20 and 21 and DF 20 and 21.

Note 2.— The communications protocols are given in 3.8.2.6.11. These protocols describe the control of the data exchange.

3.8.2.6.1 *Surveillance, altitude request, uplink format 4*

1	6	9	14	17	33
UF	PC	RR	DI	SD	AP
5	8	13	16	32	56

The format of this interrogation shall consist of these fields:

Field	*Reference*
UF uplink format	3.8.2.3.2.1.1
PC protocol	3.8.2.6.1.1
RR reply request	3.8.2.6.1.2
DI designator identification	3.8.2.6.1.3
SD special designator	3.8.2.6.1.4
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.1.1 *PC: Protocol.* This 3-bit, (6-8) uplink field shall contain operating commands to the transponder.

Coding:

0 signifies no action
1 signifies non-selective all-call lockout (3.8.2.6.9.2)
2 not assigned
3 not assigned
4 signifies close out Comm-B (3.8.2.6.11.3.2.3)
5 signifies close out uplink ELM (3.8.2.7.4.2.8)
6 signifies close out downlink ELM (3.8.2.7.6.3)
7 not assigned.

3.8.2.6.1.2 *RR: Reply request.* This 5-bit, (9-13) uplink field shall command the length and content of a requested reply.

The last four bits of the 5-bit RR code, transformed into their decimal equivalent, shall designate the BDS1 codes (3.8.2.6.11.2 or 3.8.2.6.11.3) of the requested Comm-B message if the most significant bit (MSB) of the RR code is ONE (RR is equal to or greater than 16).

Coding:

RR = 0-15 shall be used to request a reply with surveillance format (DF equals 4 or 5);

RR = 16-31 shall be used to request a reply with Comm-B format (DF equals 20 or 21);

RR = 16 shall be used to request transmission of an air-initiated Comm-B according to 3.8.2.6.11.3;

RR = 17 shall be used to request a data link capability report according to 3.8.2.6.10.2.2;

RR = 18 shall be used to request aircraft identification according to 3.8.2.9;

19-31 are not assigned in section 3.8.

Note.— Codes 19-31 are reserved for applications such as data link communications, airborne collision avoidance systems (ACAS), etc.

3.8.2.6.1.3 *DI: Designator identification.* This 3-bit (14-16) uplink field shall identify the structure of the SD field (3.8.2.6.1.4).

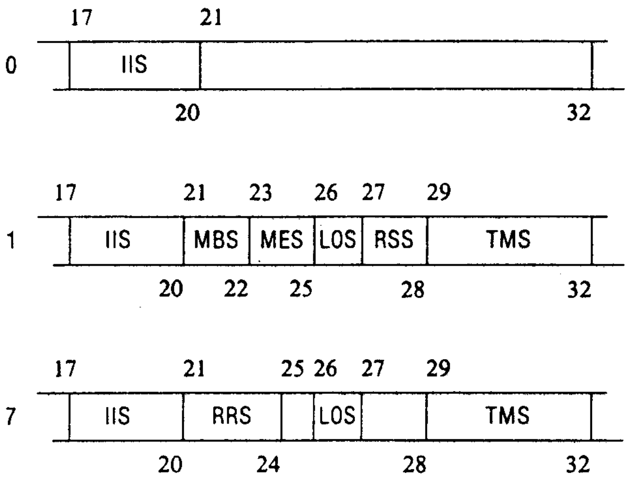
Coding:

0 signifies SD not assigned except for IIS
1 signifies SD contains multisite and communications control information
2-6 signifies SD not assigned
7 signifies SD contains extended data readout request, multisite and communications control information.

3.8.2.6.1.4 *SD: Special designator.* This 16-bit (17-32) uplink field shall contain control codes which depend on the coding in the DI field.

Note.— The special designator (SD) field is provided to accomplish the transfer of multisite, lockout and communications control information from the ground station to the transponder.

DI CODE *SD FIELD STRUCTURE*



3.8.2.6.1.4.1 *Subfields in SD.* The SD field shall contain information as follows:

a) If the DI code = 0, 1 or 7:

IIS, the 4-bit (17-20) interrogator identifier subfield shall contain an assigned identifier code of the interrogator (3.8.2.5.2.1.2).

b) If the DI code = 0:

bits 21-32 are not assigned.

c) If the DI code = 1:

MBS, the 2-bit (21, 22) multisite Comm-B subfield shall have the following codes:

0 signifies no Comm-B action
1 signifies air-initiated Comm-B reservation request (3.8.2.6.11.3.1)
2 signifies Comm-B closeout (3.8.2.6.11.3.2.3)
3 not assigned.

MES, the 3-bit (23-25) multisite ELM subfield shall contain reservation and closeout commands for ELM as follows:

0 signifies no ELM action
1 signifies uplink ELM reservation request (3.8.2.7.4.1)
2 signifies uplink ELM closeout (3.8.2.7.4.2.8)
3 signifies downlink ELM reservation request (3.8.2.7.6.1.1)
4 signifies downlink ELM closeout (3.8.2.7.6.3)
5 signifies uplink ELM reservation request and downlink ELM closeout
6 signifies uplink ELM closeout and downlink ELM reservation request
7 signifies uplink ELM and downlink ELM closeouts.

RSS, the 2-bit (27, 28) reservation status subfield shall request the transponder to report its reservation status in the UM field. The following codes have been assigned:

0 signifies no request
1 signifies report Comm-B reservation status in UM
2 signifies report uplink ELM reservation status in UM
3 signifies report downlink ELM reservation status in UM

d) If the DI code = 1 or 7:

LOS, the 1-bit (26) lockout subfield, if set to ONE, shall signify a multisite lockout command from the interrogator indicated in IIS. LOS set to ZERO, shall be used to signify that no change in lockout state is commanded.

TMS, the 4-bit (29-32) tactical message subfield shall contain communications control information used by the data link avionics.

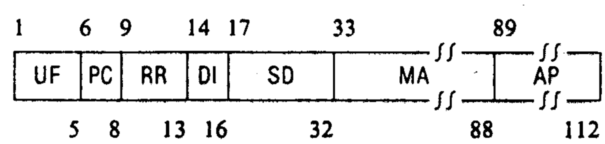
e) If the DI code = 7:

RRS, the 4-bit (21-24) reply request subfield in SD shall give the BDS2 code of a requested Comm-B reply.

Bits 25, 27 and 28 are not assigned.

3.8.2.6.1.5 *PC and SD field processing.* When DI = 1, PC field processing shall be completed before processing the SD field.

3.8.2.6.2 *Comm-A altitude request, uplink format 20*



The format of this interrogation shall consist of these fields:

Field	*Reference*
UF uplink format	3.8.2.3.2.1.1
PC protocol	3.8.2.6.1.1
RR reply request	3.8.2.6.1.2
DI designator identification	3.8.2.6.1.3
SD special designator	3.8.2.6.1.4
MA message, Comm-A	3.8.2.6.2.1
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.2.1 *MA: Message, Comm-A.* This 56-bit (33-88) field shall contain a data link message to the aircraft, and shall contain the 8-bit ADS (Comm-A, definition) subfield.

3.8.2.6.2.1.1 *Subfield in MA: ADS, A-definition subfield.* This 8-bit (33-40) subfield shall label the data contained in MA.

Note.— For convenience in coding, ADS is expressed in two groups of 4 bits each, ADS1 and ADS2.

3.8.2.6.3 *Surveillance identity request, uplink format 5*

1	6	9	14	17	33
UF	PC	RR	DI	SD	AP
5	8	13	16	32	56

The format of this interrogation shall consist of these fields:

Field	*Reference*
UF uplink format	3.8.2.3.2.1.1
PC protocol	3.8.2.6.1.1
RR reply request	3.8.2.6.1.2
DI designator identification	3.8.2.6.1.3
SD special designator	3.8.2.6.1.4
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.4 *Comm-A identity request, uplink format 21*

1	6	9	14	17	33	89
UF	PC	RR	DI	SD	MA	AP
5	8	13	16	32	88	112

The format of this interrogation shall consist of these fields:

Field	*Reference*
UF uplink format	3.8.2.3.2.1.1
PC protocol	3.8.2.6.1.1
RR reply request	3.8.2.6.1.2
DI designator identification	3.8.2.6.1.3
SD special designator	3.8.2.6.1.4
MA message, Comm-A	3.8.2.6.2.1
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.5 *Surveillance altitude reply, downlink format 4*

1	6	9	14	20	33
DF	FS	DR	UM	AC	AP
5	8	13	19	32	56

This reply shall be generated in response to an interrogation UF 4 or 20 with an RR field value less than 16.

The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.8.2.3.2.1.2
FS flight status	3.8.2.6.5.1
DR downlink request	3.8.2.6.5.2
UM utility message	3.8.2.6.5.3
AC altitude code	3.8.2.6.5.4
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.5.1 *FS: Flight status.* This 3-bit (6-8) downlink field shall contain the following information:

Coding:

0	signifies no alert and no SPI, aircraft is airborne
1	signifies no alert and no SPI, aircraft is on the ground
2	signifies alert, no SPI, aircraft is airborne
3	signifies alert, no SPI, aircraft is on the ground
4	signifies alert and SPI, aircraft is airborne or on the ground
5	signifies no alert and SPI, aircraft is airborne or on the ground
6	not assigned
7	not assigned

Note.— The conditions which cause an alert are given in 3.8.2.6.10.1.1.

3.8.2.6.5.2 *DR: Downlink request.* This 5-bit (9-13) downlink field shall contain requests to downlink information.

Coding:

0	signifies no downlink request
1	signifies request to send Comm-B message
2	reserved for ACAS
3	reserved for ACAS
4	signifies Comm-B broadcast message 1 available
5	signifies Comm-B broadcast message 2 available
6	reserved for ACAS
7	reserved for ACAS
8-15	not assigned
16-31	see downlink ELM protocol (3.8.2.7.6.1)

Codes 1-15 shall take precedence over codes 16-31.

Note.— Giving precedence to codes 1-15 permits the announcement of a Comm-B message to interrupt the announcement of a downlink ELM. This gives priority to the announcement of the shorter message.

3.8.2.6.5.3 *UM: Utility message.* This 6-bit (14-19) downlink field shall contain transponder communications status information as specified in 3.8.2.6.1.4.1 and 3.8.2.6.5.3.1.

3.8.2.6.5.3.1 *Subfields in UM for multisite protocols*

UM FIELD STRUCTURE

14	18
IIS	IDS
17	19

The following subfields shall be inserted by the transponder into the UM field of the reply if a surveillance or Comm-A interrogation (UF equals 4, 5, 20, 21) contains DI = 1 and RSS other than zero:

IIS: The 4-bit (14-17) interrogator identifier subfield reports the identifier of the interrogator that is reserved for multisite communications.

IDS: The 2-bit (18, 19) identifier designator subfield reports the type of reservation made by the interrogator identified in IIS.

Assigned coding is:

0 signifies no information
1 signifies IIS contains Comm-B II code
2 signifies IIS contains Comm-C II code
3 signifies IIS contains Comm-D II code.

3.8.2.6.5.3.2 *Multisite reservation status.* The interrogator identifier of the ground station currently reserved for multisite Comm-B delivery (3.8.2.6.11.3.1) shall be transmitted in the IIS subfield together with Code 1 in the IDS subfield if the UM content is not specified by the interrogation (when DI = 0 or 7, or when DI = 1 and RSS = 0).

The interrogator identifier of the ground station currently reserved for downlink ELM delivery (3.8.2.7.6.1), if any, shall be transmitted in the IIS subfield together with Code 3 in the IDS subfield if the UM content is not specified by the interrogation and there is no current Comm-B reservation.

3.8.2.6.5.4 *AC: Altitude code.* This 13-bit (20-32) field shall contain altitude coded as follows:

a) Bit 26 is designated as the M bit, and shall be ZERO if the altitude is reported in feet. M equals ONE shall be reserved for possible future use to indicate that the altitude reporting is in metric units.

Note.— Future use of units other than the foot is dependent upon world-wide agreement on a new standard of vertical measurement.

b) If M equals ZERO, then bit 28 is designated as the Q bit. Q equals ZERO shall be used to indicate that the altitude is reported in 100-foot increments. Q equals ONE shall be used to indicate that the altitude is reported in 25-foot increments.

c) If the M bit (bit 26) and the Q bit (bit 28) equal ZERO, the altitude shall be coded according to the pattern for Mode C replies of 3.8.1.7.12.2.3. Starting with bit 20 the sequence shall be C1, A1, C2, A2, C4, A4, ZERO, B1, ZERO, B2, D2, B4, D4.

d) If the M bit equals ZERO and the Q bit equals ONE, the 11-bit field represented by bits 20 to 25, 27 and 29 to 32 shall represent a binary coded field with a least significant bit (LSB) of 25 ft. The binary value of the positive decimal integer "N" shall be encoded to report pressure-altitudes in the range [(25 N) — 1.000 plus or minus 12.5 ft]. The coding of 3.8.1.7.12.2.3 shall be used to report pressure-altitude above 50 187.5 ft.

Note 1.— This coding method is only able to provide values between minus 1 000 ft and plus 50 175 ft.

Note 2.— The most significant bit (MSB) of this field is bit 20 as required by 3.8.2.3.1.3.

e) If the M bit equals ONE, the 12-bit field represented by bits 20 to 25 and 27 to 31 shall be reserved for possible future use for encoding altitude in metric units.

f) ZERO shall be transmitted in each of the 13 bits of the AC field if altitude information is not available.

3.8.2.6.6 *Comm-B altitude reply, downlink format 20*

DF	FS	DR	UM	AC	MB	AP
1–5	6–8	9–13	14–19	20–32	33–88	89–112

This reply shall be generated in response to an interrogation UF 4 or 20 with an RR field value greater than 15. The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.8.2.3.2.1.2
FS flight status	3.8.2.6.5.1
DR downlink request	3.8.2.6.5.2
UM utility message	3.8.2.6.5.3
AC altitude code	3.8.2.6.5.4
MB message, Comm-B	3.8.2.6.6.1
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.6.1 *MB: Message, Comm-B.* This 56-bit (33-88) downlink field shall be used to transmit data link messages to the ground and shall contain the 8-bit BDS (Comm-B definition) subfield.

3.8.2.6.6.1.1 *Subfield in MB: BDS, B-definition subfield.* This 8-bit (33-40) subfield of MB shall label the data contained in MB.

Note.— For convenience in coding, BDS is expressed in two groups of 4 bits each, BDS1 and BDS2. The only BDS codes defined in this section are those for aircraft identification (3.8.2.9.1.2) and for data link capability reporting (3.8.2.6.10.2.2.2).

3.8.2.6.7 *Surveillance identity reply, downlink format 5*

DF	FS	DR	UM	ID	AP
1–5	6–8	9–13	14–19	20–32	33–56

This reply shall be generated in response to an interrogation UF 5 or 21 with an RR field value less than 16. The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.8.2.3.2.1.2
FS flight status	3.8.2.6.5.1
DR downlink request	3.8.2.6.5.2
UM utility message	3.8.2.6.5.3
ID identity	3.8.2.6.7.1
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.7.1 *ID: Identity (Mode A code).* This 13-bit (20-32) field shall contain aircraft identity code, in accordance with the pattern for Mode A replies in 3.8.1.6. Starting with bit 20, the sequence shall be C1, A1, C2, A2, C4, A4, ZERO, B1, D1, B2, D2, B4, D4.

3.8.2.6.8 *Comm-B identity reply, downlink format 21*

1	6	9	14	20	33	89
DF	FS	DR	UM	ID	MB	AP
5	8	13	19	32	88	112

This reply shall be generated in response to an interrogation UF 5 or 21 with an RR field value greater than 15. The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.8.2.3.2.1.2
FS flight status	3.8.2.6.5.1
DR downlink request	3.8.2.6.5.2
UM utility message	3.8.2.6.5.3
ID identity	3.8.2.6.7.1
MB message, Comm-B	3.8.2.6.6.1
AP address/parity	3.8.2.3.2.1.3

3.8.2.6.9 *Lockout protocols*

3.8.2.6.9.1 *Multisite all-call lockout*

Note.— The multisite lockout protocol prevents transponder acquisition from being denied one ground station by lockout commands from an adjacent ground station that has overlapping coverage.

The multisite lockout command shall be transmitted in the SD field (3.8.2.6.1.4.1) with DI = 1 or DI = 7. The command shall be indicated by LOS code equals 1 and the presence of a non-zero interrogator identifier in the IIS subfield of SD. After a transponder has accepted an interrogation containing a multisite lockout command, that transponder shall commence to lock out (i.e. not accept) any Mode S-only all-call interrogation which includes the identifier of the interrogator that commanded the lockout. The lockout shall persist for an interval T_L (3.8.2.10.3.9) after the last acceptance of an interrogation containing the multisite lockout command. Multisite lockout shall not prevent acceptance of a Mode S-only all-call interrogation containing PR codes 8 to 12. If a lockout command (LOS = 1) is received together with IIS = 0, it shall be interpreted as a non-selective all-call lockout (3.8.2.6.9.2).

Note 1.— Fifteen interrogators can send independent multisite lockout commands. Each of these commands must be timed separately.

Note 2.— Multisite lockout does not affect the response of the transponder to Mode S-only all-call interrogations containing II equals 0 or to Mode A/C/S all-call interrogations.

3.8.2.6.9.2 *Non-selective all-call lockout*

Note.— In cases where the multisite lockout protocol is not required (e.g. there is no overlapping coverage or there is ground station co-ordination via ground-to-ground communications) the non-selective lockout protocol may be used.

On acceptance of an interrogation containing code 1 in the PC field, a transponder shall commence to lock out (i.e. not accept) two types of all-call interrogations:

a) the Mode S-only all-call (UF = 11), with II equals 0; and

b) the Mode A/C/S all-call of 3.8.2.1.5.1.1.

This lockout condition shall persist for an interval T_D (3.8.2.10.3.9) after the last receipt of the command. Non-selective lockout shall not prevent acceptance of a Mode S-only all-call interrogation containing PR codes 8 to 12.

Note.— Non-selective lockout does not affect the response of the transponder to Mode S-only all-call interrogations containing II not equal to 0.

3.8.2.6.10 *Basic data protocols*

3.8.2.6.10.1 *Flight status protocol.* Flight status shall be reported in the FS field (3.8.2.6.5.1).

3.8.2.6.10.1.1 *Alert.* An alert condition shall be reported in the FS field if the Mode A identity code transmitted in Mode A replies and in downlink formats DF equals 5 and DF equals 21 are changed by the pilot.

3.8.2.6.10.1.1.1 *Permanent alert condition.* The alert condition shall be maintained if the Mode A identity code is changed to 7500, 7600 or 7700.

3.8.2.6.10.1.1.2 *Temporary alert condition.* The alert condition shall be temporary and shall cancel itself after T_C seconds if the Mode A identity code is changed to a value other than those listed in 3.8.2.6.10.1.1.1.

Note.— The value of T_C is given in 3.8.2.10.3.9.

3.8.2.6.10.1.1.3 *Termination of the permanent alert condition.* The permanent alert condition shall be terminated and replaced by a temporary alert condition when the Mode A identity code is set to a value other than 7500, 7600 or 7700.

3.8.2.6.10.1.2 *Ground report.* The on-the-ground status of the aircraft shall be reported in the FS field and the VS field (3.8.2.8.2.1). If a means for indicating the on-the-ground condition is not available at the transponder data interface (3.8.2.10.5.1.3), the FS and VS codes shall indicate that the aircraft is airborne.

3.8.2.6.10.1.3 *Special position identification (SPI).* An equivalent of the SPI pulse shall be transmitted by Mode S transponders in the FS field when manually activated. This pulse shall be transmitted for T_1 seconds after initiation (3.8.1.6.3 and 3.8.1.7.13).

Note.— The value of T_1 is given in 3.8.2.10.3.9.

3.8.2.6.10.2 *Capability reporting protocol*

Note.— A Mode S installation in an aircraft may be capable of handling a number of aircraft separation assurance or data link services. Aircraft capability is reported in special fields as defined in the following paragraphs.

3.8.2.6.10.2.1 *Capability report.* The 3-bit CA field, contained in the all-call reply, DF equals 11, shall report the basic capability of the Mode S transponder as described in 3.8.2.5.2.2.1.

3.8.2.6.10.2.2 *Data link capability report.* The data link capability report shall provide the interrogator with a description of the data link capability of the Mode S installation. The report shall be obtained by a ground-initiated Comm-B reply in response to an interrogation containing RR equals 17 and DI is not equal to 7 or DI equals 7 and RRS equals zero (3.8.2.6.11.2).

3.8.2.6.10.2.2.1 *Subfields in MB for data link capability report.* The subfields within the MB field of all data link capability reports shall be:

BDS1 BDS1 = 1 shall be inserted in this 4-bit (33-36) subfield for all data link capability reports.

BDS2 The initial report shall use BDS2 = 0 in this 4-bit (37-40) subfield. Additional data link capabilities shall subsequently be reported using BDS2 codes other than ZERO.

CFS This 4-bit (41-44) continuation subfield shall contain the BDS2 value of the next additional data link capability report available from this installation. If there is no additional data link capability report, CFS shall equal zero.

3.8.2.6.10.2.2.2 *Coding of the data link capability report*

BDS1: 1 = data link capability report

BDS2: 0 = initial report
1 = additional report
2-15 = not assigned

CFS: see 3.8.2.6.10.2.2.1

For BDS2 = 0 or 1 the data link capability field shall contain the following subfields:

ACS: This 20-bit (45-64) Comm-A capability subfield shall report the labels of the Comm-A messages supported by this installation.

Note.— If all the bits are ZERO, no Comm-A data link services are supported.

BCS: This 16-bit (65-80) Comm-B capability subfield shall report the labels of the Comm-B messages that can be accessed by the ground for transmission via a ground-initiated Comm-B.

Note 1.— If all the bits are ZERO, no data is accessible by a ground-initiated Comm-B.

Note 2.— The BCS bit assigned for aircraft identification reporting is provided in 3.8.2.9.1.3.

ECS: This 8-bit (81-88) ELM capability subfield shall report the ELM capability of the installation.

Note.— If all the bits are ZERO, no ELM data link services are supported.

3.8.2.6.10.2.2.3 *Updating of the data link capability report.* The transponder shall, at intervals not exceeding four seconds, compare the current data link capability status with that last reported and shall, if a difference is noted, initiate a revised data link capability report by Comm-B broadcast (3.8.2.6.11.4) for BDS1 = 1 and BDS 2 = value as required. The transponder shall initiate, generate and transmit the revised capability report even if the aircraft data link capability is degraded or lost. The transponder shall set the BDS subfield for the data link capability report.

Note.— The setting of the BDS code by the transponder ensures that a broadcast change of capability report will contain the BDS code for all cases of data link failure (e.g. the loss of the transponder data link interface).

3.8.2.6.11 *Standard length communications protocols*

Note 1.— The two types of standard length communications protocols are Comm-A and Comm-B; messages using these protocols are transferred under the control of the interrogator. Comm-A messages are sent directly to the transponder and are completed within one transaction. A Comm-B message is used to transfer information from air to ground and can be initiated either by the interrogator or the transponder. In the case of ground-initiated Comm-B transfers, the interrogator requests data to be read out from the transponder, which delivers the message in the same transaction. In the case of air-initiated Comm-B transfers, the transponder announces the intention to transmit a message; in a subsequent transaction an interrogator will extract the message.

Note 2.— In a non-selective air-initiated Comm-B protocol all transactions necessary can be controlled by any interrogator.

Note 3.— In some areas of overlapping interrogator coverage there may be no means for co-ordinating interrogator activities via ground communications. Air-initiated Comm-B communications protocols require more than one transaction for completion. Thus, co-ordination is necessary to ensure that a Comm-B message is not inadvertently closed out by the wrong interrogator. The multisite communications protocol is used for this co-ordination in areas where no other means are available. In a multisite scenario, air-initiated Comm-B messages can either be directed to a specific interrogator or be announced for recovery by any interrogator.

Note 4.— The multisite and the non-selective communications protocols cannot be used simultaneously in a region of overlapping interrogator coverage unless the interrogators co-ordinate their communications activities via ground communications.

Note 5.— The multisite communications protocol is independent of the multisite lockout protocol. That is, the multisite communications protocol may be used with the non-selective lockout protocol and vice versa. The choice of lockout and communications protocols to be used depends upon the network management technique being used.

Note 6.— The broadcast Comm-B protocol can be used to make a message available to all active interrogators.

3.8.2.6.11.1 *Comm-A.* The interrogator shall deliver a Comm-A message in the MA field of an interrogation UF = 20 or 21.

3.8.2.6.11.1.1 *Comm-A technical acknowledgement.* Acceptance of a Comm-A interrogation shall be automatically technically acknowledged by the transponder, by the transmission of the requested reply (3.8.2.10.5.2.2.1).

Note.— The receipt of a reply from the transponder according to the rules of 3.8.2.4.1.2.3 d) and 3.8.2.4.1.3.2.2.2 is the acknowledgement to the interrogator that the message has been received and stored by the transponder. If either uplink or downlink fail, this reply will be missing and the interrogator will normally send the message again. In the case of downlink failure the transponder may receive the message more than once.

3.8.2.6.11.1.2 *Comm-A broadcast.* If a Comm-A broadcast interrogation is accepted (3.8.2.4.1.2.3.1.3) information transfer shall be handled according to 3.8.2.10.5.2.1.1 but other transponder functions shall not be affected and a reply shall not be transmitted.

Note.— There is no technical acknowledgement to a Comm-A broadcast message.

3.8.2.6.11.2 *Ground-initiated Comm-B.* The interrogator shall request data to be sent down in the MB field by specifying the BDS1 and BDS2 codes of the desired data. The BDS1 code shall be as defined in the RR field of a surveillance or Comm-A interrogation.

The BDS2 code shall be defined in the RRS subfield of SD (3.8.2.6.1.4.1) when DI = 7. If no BDS2 code is specified (i.e. DI is not equal to 7) it shall signify that BDS2 = 0. On receipt of such a request, the reply shall be transmitted containing the data corresponding to the request. The transponder shall deliver a Comm-B message of all ZEROs in response to a request for data that is not available.

3.8.2.6.11.3 *Air-initiated Comm-B*

3.8.2.6.11.3.1 *General protocol.* The transponder shall announce the presence of an air-initiated Comm-B message with the insertion of code 1 in the DR field. To extract an air-initiated Comm-B message, the interrogator shall transmit a request for a Comm-B message reply in a subsequent interrogation with RR equal to 16 and, if DI equals 7, RRS must be equal to zero (3.8.2.6.11.3.2.1 and 3.8.2.6.11.3.3.1). Receipt of this request code shall cause the transponder to transmit the air-initiated Comm-B message. If a command to transmit an air-initiated Comm-B message is received while no message is waiting to be transmitted, the reply shall contain all ZEROs in the MB field.

The reply that delivers the message shall continue to contain code 1 in the DR field. After a Comm-B closeout has been accomplished, the message shall be cancelled and the DR code belonging to this message immediately removed. If another air-initiated Comm-B message is waiting to be transmitted, the transponder shall set the DR code to 1, so that the reply contains the announcement of this next message.

Note.— The announcement and cancellation protocol ensures that an air-initiated message will not be lost due to uplink or downlink failures that occur during the delivery process.

3.8.2.6.11.3.2 *Additional protocol for multisite air-initiated Comm-B*

Note.— The announcement of an air-initiated Comm-B message waiting to be delivered may be accompanied by a multisite reservation status report in the UM field (3.8.2.6.5.3.2).

Recommendation.— *An interrogator should not attempt to extract a message if it has determined that it is not the reserved site.*

3.8.2.6.11.3.2.1 *Message transfer.* An interrogator shall request a Comm-B reservation and extract an air-initiated Comm-B message by transmitting a surveillance or Comm-A interrogation UF equals 4, 5, 20 or 21 containing.

RR equals 16
DI equals 1
IIS equals assigned interrogator identifier
MBS equals 1 (Comm-B reservation request)

Note.— A Comm-B multisite reservation request is normally accompanied by a Comm-B reservation status request (RSS = 1). This causes the interrogator identifier of the reserved site to be inserted in the UM field of the reply.

Protocol procedure in response to this interrogation shall depend upon the state of the B-timer which indicates if a Comm-B reservation is active. This timer shall run for T_R seconds.

Note.— The value of T_R is given in 3.8.2.10.3.9.

a) If the B-timer is not running, the transponder shall grant a reservation to the requesting interrogator by:

   1) storing the IIS of the interrogation as the Comm-B II; and

   2) starting the B-timer.

   A multisite Comm-B reservation shall not be granted by the transponder unless an air-initiated Comm-B message is waiting to be transmitted and the requesting interrogation contains RR equals 16, DI equals 1, MBS equals 1 and IIS is not zero.

b) If the B-timer is running and the IIS of the interrogation equals the Comm-B II, the transponder shall restart the B-timer.

c) If the B-timer is running and the IIS of the interrogation does not equal the Comm-B II, then there shall be no change to the Comm-B II or the B-timer.

Note.— In case c) the reservation request has been denied.

In each case the transponder shall reply with the Comm-B message in the MB field.

An interrogator shall determine if it is the reserved site for this message through coding in the UM field. If it is the reserved site it shall attempt to close out the message in a subsequent interrogation. If it is not the reserved site it shall not attempt to close out the message.

3.8.2.6.11.3.2.2 *Multisite-directed Comm-B transmissions.* To direct an air-initiated Comm-B message to a specific interrogator, the multisite Comm-B protocol shall be used. When the B-timer is not running, the interrogator identifier of the desired destination shall be stored as the Comm-B II. Simultaneously the B-timer shall be started and the code DR equals 1 shall be set. For a multisite-directed Comm-B message, the B-timer shall not automatically time out but shall continue to run until:

a) the message is read and closed out by the reserved site; or

b) the message is cancelled (3.8.2.10.5.4) by the data link avionics.

Note.— The protocols of 3.8.2.6.5.3 and 3.8.2.6.11.3.2.1 should then result in delivery of the message to the reserved site. The data link avionics may cancel the message if delivery to the reserved site cannot be accomplished.

3.8.2.6.11.3.2.3 *Multisite Comm-B closeout.* The interrogator shall close out a multisite air-initiated Comm-B by transmitting either a surveillance or a Comm-A interrogation containing:

either DI equals 1
IIS equals assigned interrogator identifier
MBS equals 2 (Comm-B closeout)

or DI equals 0, 1 or 7
IIS equals assigned interrogator identifier
PC equals 4 (Comm-B closeout)

The transponder shall compare the IIS of the interrogation to the Comm-B II and if the interrogator identifiers do not match, the message shall not be cleared and the status of the Comm-B II, B-timer, and DR code shall not be changed. If the interrogator identifiers match, the transponder shall set the Comm-B II to zero, reset the B-timer, clear the DR code for this message and clear the message itself. The transponder shall not close out a multisite air-initiated Comm-B message unless it has been read out at least once by the reserved site.

3.8.2.6.11.3.2.4 *Automatic expiration of Comm-B reservation.* If the B-timer period expires before a multisite closeout has been accomplished, the Comm-B II shall be set to zero and the B-timer reset. The Comm-B message and the DR field shall not be cleared by the transponder.

Note.— This makes it possible for another site to read and clear this message.

3.8.2.6.11.3.3 *Additional protocol for non-selective air-initiated Comm-B*

Note.— In cases where the multisite protocols are not required (i.e. no overlapping coverage or sensor co-ordination via ground-to-ground communication), the non-selective air-initiated Comm-B protocol may be used.

3.8.2.6.11.3.3.1 *Message transfer.* The interrogator shall extract the message by transmitting either RR equals 16 and DI is not equal to 7, or RR equals 16, DI equals 7 and RRS equals zero in a surveillance or Comm-A interrogation.

3.8.2.6.11.3.3.2 *Comm-B closeout.* The interrogator shall close out a non-selective air-initiated Comm-B message by transmitting PC equals 4 (Comm-B closeout). On receipt of this command, the transponder shall perform closeout, unless the B-timer is running. If the B-timer is running, indicating that a multisite reservation is in effect, closeout shall be accomplished as per 3.8.2.6.11.3.2.3. The transponder shall not close out a non-selective air-initiated Comm-B message unless it has been read out at least once by an interrogation using non-selective protocols.

3.8.2.6.11.4 *Comm-B broadcast*

Note 1.— A Comm-B message may be broadcast to all active interrogators within range. Messages are alternately numbered 1 and 2 and are self-cancelling after 18 seconds. Interrogators have no means to cancel Comm-B broadcast messages.

Note 2.— Use of the Comm-B broadcast is restricted to transmission of information which does not require a subsequent ground-initiated uplink response.

Note 3.— The timer used for the Comm-B broadcast cycle is the same as that used for the Comm-B multisite protocol.

3.8.2.6.11.4.1 *Initiation.* A Comm-B broadcast cycle shall not be initiated when an air-initiated Comm-B is waiting to be transmitted. A Comm-B broadcast cycle shall begin with:

a) the insertion of DR code 4 or 5, (3.8.2.6.5.2) into replies with DF 4, 5, 20 or 21; and

b) the starting of the B-timer.

3.8.2.6.11.4.2 *Extraction.* To extract the broadcast message, an interrogator shall transmit RR equals 16 and DI not equal to 7 or RR equals 16 and DI equals 7 with RRS equals zero in a subsequent interrogation.

3.8.2.6.11.4.3 *Expiration.* When the B-timer period expires, the transponder shall clear the DR code for this message, discard the present broadcast message and change the broadcast message number (from 1 to 2 or 2 to 1) in preparation for a subsequent Comm-B broadcast.

3.8.2.6.11.4.4 *Interruption.* In order to prevent a Comm-B broadcast cycle from delaying the delivery of an air-initiated Comm-B message, provision shall be made for an air-initiated Comm-B to interrupt a Comm-B broadcast cycle. If a broadcast cycle is interrupted, the B-timer shall be reset, the interrupted broadcast message shall be retained and the message number shall not be changed. Delivery of the interrupted broadcast message shall recommence when no air-initiated Comm-B transaction is in effect. The message shall then be broadcast for the full duration of the B-timer.

3.8.2.7 *Extended length communication transactions*

Note 1.— Long messages, either on the uplink or the downlink, can be transferred by the extended length message (ELM) protocols through the use of Comm-C (UF = 24) and Comm-D (DF = 24) formats respectively. The ELM uplink protocol provides for the transmission on the uplink of up to sixteen 80-bit message segments before requiring a reply from the transponder. They also allow a corresponding procedure on the downlink.

Note 2.— In some areas of overlapping interrogator coverage there may be no means for co-ordinating interrogator activities via ground communications. However, the ELM communication protocols require more than one transaction for completion; co-ordination is thus necessary to ensure that segments from different messages are not interleaved and that transactions are not inadvertently closed out by the wrong interrogator. The multisite communications protocol is used for this co-ordination in areas where no other means are available.

Note 3.— Downlink extended length messages are transmitted only after authorization by the interrogator. The segments to be transmitted are contained in Comm-D replies. As with air-initiated Comm-B messages, downlink ELMs are either announced to all interrogators or directed to a specific interrogator. In the former case an individual interrogator can use the multisite protocol to reserve for itself the ability to close out the downlink ELM transaction. A transponder can be instructed to identify the interrogator that has reserved the transponder for an ELM transaction. Only that interrogator can close out the ELM transaction and reservation.

Note 4.— The multisite protocol and the non-selective protocol cannot be used simultaneously in a region of overlapping interrogator coverage unless the interrogators co-ordinate their communications activities via ground communications.

3.8.2.7.1 *Comm-C, uplink format 24*

1	3	5	9	89
UF	RC	NC	MC	AP
2	4	8	88	112

The format of this interrogation shall consist of these fields:

Field	*Reference*
UF uplink format	3.8.2.3.2.1.1
RC reply control	3.8.2.7.1.1
NC number of C-segment	3.8.2.7.1.2
MC message, Comm-C	3.8.2.7.1.3
AP address/parity	3.8.2.3.2.1.3

3.8.2.7.1.1 *RC: Reply control.* This 2-bit (3-4) uplink field shall designate segment significance and reply decision.

Coding:

RC = 0 signifies uplink ELM initial segment in MC
= 1 signifies uplink ELM intermediate segment in MC
= 2 signifies uplink ELM final segment in MC
= 3 signifies a request for downlink ELM delivery (3.8.2.7.6.2)

3.8.2.7.1.2 *NC: Number of C-segment.* This 4-bit (5-8) uplink field shall designate the number of the message segment contained in MC (3.8.2.7.4.2.1). NC shall be coded as a binary number.

3.8.2.7.1.3 *MC: Message, Comm-C.* This 80-bit (9-88) uplink field shall contain:

a) one of the segments of a sequence used to transmit an uplink ELM to the transponder; or

b) control codes for a downlink ELM.

Note.— Message content and codes are not included in this chapter except for 3.8.2.7.6.2.1.

3.8.2.7.1.3.1 *Subfield in MC: CDS, C-definition subfield.* This 8-bit (9-16) uplink subfield in MC shall contain the message label, and is used in segment zero of an uplink ELM.

Note.— For convenience in coding, CDS is expressed in two groups of 4 bits each, CDS1 and CDS2.

3.8.2.7.2 *Interrogation-reply protocol for UF24*

Note.— Interrogation-reply co-ordination for the above format follows the protocol outlined in Table 5 (3.8.2.4.1.3.2.2).

3.8.2.7.3 *Comm-D, downlink format 24*

1		4 5	9	89
DF		KE	ND	MD	AP
2			8	88	112

The format of this reply shall consist of these fields:

Field	Reference
DF downlink format Spare — 1 bit	3.8.2.3.2.1.2
KE control, ELM	3.8.2.7.3.1
ND number of D-segment	3.8.2.7.3.2
MD message, Comm-D	3.8.2.7.3.3
AP address/parity	3.8.2.3.2.1.3

3.8.2.7.3.1 *KE: Control, ELM.* This 1-bit (4) downlink field shall define the content of the ND and MD fields.

Coding:

KE = 0 signifies downlink ELM transmission
1 signifies uplink ELM acknowledgement

3.8.2.7.3.2 *ND: Number of D-segment.* This 4-bit (5-8) downlink field shall designate the number of the message segment contained in MD (3.8.2.7.6.2). ND shall be coded as a binary number.

3.8.2.7.3.3 *MD: Message, Comm-D.* This 80-bit (9-88) downlink field shall contain:

a) one of the segments of a sequence used to transmit a downlink ELM to the interrogator; or

b) control codes for an uplink ELM.

3.8.2.7.3.3.1 *Subfield in MD: DDS, D-definition subfield.* This 8-bit (9-16) downlink subfield in MD shall contain the message label and is used in segment zero of a downlink ELM.

Note.— For convenience in coding, DDS is expressed in two groups of 4 bits each, DDS1 and DDS2.

3.8.2.7.4 *Multisite uplink ELM protocol*

3.8.2.7.4.1 *Multisite uplink ELM reservation.* An interrogator shall request a reservation for an uplink ELM by transmitting a surveillance or Comm-A interrogation containing:

DI equals 1
IIS equals assigned interrogator identifier
MES equals 1 or 5 (uplink ELM reservation request)

Note.— A multisite uplink ELM reservation request is normally accompanied by an uplink ELM reservation status request (RSS = 2). This causes the interrogator identifier of the reserved site to be inserted in the UM field of the reply.

Protocol procedure in response to this interrogation shall depend upon the state of the C-timer which indicates if an uplink ELM reservation is active. This timer shall run for T_R seconds.

Note.— The value of T_R is given in 3.8.2.10.3.9.

a) If the C-timer is not running the transponder shall grant a reservation to the requesting interrogator by:

   1) storing the IIS of the interrogation as the Comm-C II and,

   2) starting the C-timer.

b) If the C-timer is running and the IIS of the interrogation equals the Comm-C II, the transponder shall restart the C-timer.

c) If the C-timer is running and the IIS of the interrogation does not equal the Comm-C II, there shall be no change to the Comm-C II or the C-timer.

Note.— In case c) the reservation request has been denied.

An interrogator shall not start ELM activity unless, during the same scan, having requested an uplink ELM status report, it has received its own interrogator identifier as the reserved interrogator for uplink ELM in the UM field.

Note.— If ELM activity is not started during the same scan as the reservation, a new reservation request may be made during the next scan.

If uplink ELM delivery is not completed on the current scan, the interrogator shall ensure that it still has a reservation before delivering additional segments on a subsequent scan.

3.8.2.7.4.2 *Multisite uplink ELM delivery.* The minimum length of an uplink ELM shall be two segments, the maximum length shall be 16 segments.

3.8.2.7.4.2.1 *Initial segment transfer.* The interrogator shall begin the ELM uplink delivery for an n-segment message (NC values from 0 to n-1) by a Comm-C transmission containing RC equals zero. The message segment transmitted in the MC field shall be the last segment of the message and shall carry NC equals n-1.

On receipt of an initializing segment (RC equals zero) the transponder shall establish a "setup" defined as:

a) clearing the number and content of previous segment storage registers and the associated TAS field;

b) assigning storage space for the number of segments announced in NC of this interrogation; and

c) storing the MC field of the segment received.

The transponder shall not reply to this interrogation.

Receipt of another initializing segment shall result in a new setup within the transponder.

3.8.2.7.4.2.2 *Transmission acknowledgement.* The transponder shall use the TAS subfield to report the segments received so far in an uplink ELM sequence. The information contained in the TAS subfield shall be continually updated by the transponder as segments are received.

Note.— Segments lost in uplink transmission are noted by their absence in the TAS report and are retransmitted by the interrogator which will then send further final segments to assess the extent of message completion.

3.8.2.7.4.2.2.1 *TAS, transmission acknowledgement subfield in MD.* This 16-bit (17-32) downlink subfield in MD reports the segment numbers received so far in an uplink ELM sequence. Starting with bit 17, which denotes segment number zero, each of the following bits shall be set to one if the corresponding segment of the sequence has been received. TAS shall appear in MD if KE equals one in the same reply.

3.8.2.7.4.2.3 *Intermediate segment transfer.* The interrogator shall transfer intermediate segments by transmitting Comm-C interrogations with RC equals 1. The transponder shall store the segments and update TAS only if the setup of 3.8.2.7.4.2.1 is in effect and if the received NC is smaller than the value stored at receipt of the initial segment. No reply shall be generated on receipt of an intermediate segment.

Note.— Intermediate segments may be transmitted in any order.

3.8.2.7.4.2.4 *Final segment transfer.* The interrogator shall transfer a final segment by transmitting a Comm-C interrogation with RC equals 2. This interrogation may contain any message segment. The transponder shall store the content of the MC field and update TAS if the setup of 3.8.2.7.4.2.1 is in effect and if the received NC is smaller than the value of the initial segment NC. The transponder shall reply under all circumstances as per 3.8.2.7.4.2.5.

Note.— RC equals 2 is transmitted any time that the interrogator wants to receive the TAS subfield in the reply. Therefore, more than one "final" segment may be transferred during the delivery of an uplink ELM.

3.8.2.7.4.2.5 *Acknowledgement reply.* On receipt of a final segment, the transponder shall transmit a Comm-D reply (DF = 24), with KE equals 1 and with the TAS subfield in the MD field. This reply shall be transmitted at 128 microseconds plus or minus 0.25 microseconds following the sync phase reversal of the interrogation delivering the final segment.

3.8.2.7.4.2.6 *Completed message.* The transponder shall deem the message complete if all segments announced by NC in the initializing segment have been received. If the message is complete, the message content shall be delivered to the outside via the ELM interface of 3.8.2.10.5.2.1.3 and cleared. No later-arriving segments shall be stored. The TAS content shall remain unchanged until either a new setup is called for (3.8.2.7.4.2.1) or until closeout (3.8.2.7.4.2.8).

3.8.2.7.4.2.7 *C-timer restart.* The C-timer shall be restarted each time that a received segment is stored and the Comm-C II is not ZERO.

Note.— The requirement for the Comm-C II to be non-zero prevents the C-timer from being restarted during a non-selective uplink ELM transaction.

3.8.2.7.4.2.8 *Multisite uplink ELM closeout.* The interrogator shall close out a multisite uplink ELM by transmitting either a surveillance or a Comm-A interrogation containing:

either DI equals 1
IIS equals assigned interrogator identifier
MES equals 2, 6 or 7 (uplink ELM closeout)

or DI equals 0, 1 or 7
IIS equals assigned interrogator identifier
PC equals 5 (uplink ELM closeout)

The transponder shall compare the IIS of the interrogation to the Comm-C II and if the interrogator identifiers do not match, the state of the ELM uplink process shall not be changed.

If the interrogator identifiers match, the transponder shall set the Comm-C II to ZERO, reset the C-timer, clear the stored TAS and discard any stored segments of an incomplete message.

3.8.2.7.4.2.9 *Automatic multisite uplink ELM closeout.* If the C-timer period expires before a multisite closeout has been accomplished the closeout actions described in 3.8.2.7.4.2.8 shall be initiated automatically by the transponder.

3.8.2.7.5 *Non-selective uplink ELM*

Note.— In cases where the multisite protocols are not required (for example, no overlapping coverage or sensor co-ordination via ground-to-ground communication), the non-selective uplink ELM protocol may be used.

Non-selective uplink ELM delivery shall take place as for multisite uplink ELMs described in 3.8.2.7.4.2. The interrogator shall close out an uplink ELM by transmitting PC equals 5 (uplink ELM closeout) in a surveillance or Comm-A interrogation. On receipt of this command, the transponder shall perform closeout, unless the C-timer is running. If the C-timer is running, indicating that a multisite reservation is in effect, the closeout shall be accomplished as per 3.8.2.7.4.2.8. An uncompleted message, present when the closeout is accepted, shall be cancelled.

3.8.2.7.6 *Multisite downlink ELM protocol*

3.8.2.7.6.1 *Initialization.* The transponder shall announce the presence of a downlink ELM of n segments by making the binary code corresponding to the decimal value 15 + n available for insertion in the DR field of a surveillance or Comm-B reply, DF equals 4, 5, 20, 21. This announcement shall remain active until the ELM is closed out (3.8.2.7.6.3, 3.8.2.7.7.1).

3.8.2.7.6.1.1 *Multisite downlink ELM reservation.* An interrogator shall request a reservation for extraction of a downlink ELM by transmitting a surveillance or Comm-A interrogation containing:

DI equals 1
IIS equals assigned interrogator identifier
MES equals 3 or 6 (downlink ELM reservation request)

Note.— A multisite downlink ELM reservation request is normally accompanied by a downlink ELM reservation status request (RSS = 3). This causes the interrogator identifier of the reserved interrogator to be inserted in the UM field of the reply.

3.8.2.7.6.1.1.1 Protocol procedure in response to this interrogation shall depend upon the state of the D-timer which indicates if a downlink ELM reservation is active. This timer shall run for T_R seconds.

Note.— The value of T_R is given in 3.8.2.10.3.9.

a) if the D-timer is not running, the transponder shall grant a reservation to the requesting interrogator by:

1) storing the IIS of the interrogation as the Comm-D II; and

2) starting the D-timer.

A multisite downlink ELM reservation shall not be granted by the transponder unless a downlink ELM is waiting to be transmitted.

b) if the D-timer is running and the IIS of the interrogation equals the Comm-D II, the transponder shall restart the D-timer; and

c) if the D-timer is running and the IIS of the interrogation does not equal the Comm-D II, there shall be no change to the Comm-D II or D-timer.

Note.— In case c) the reservation request has been denied.

3.8.2.7.6.1.1.2 An interrogator shall determine if it is the reserved site through coding in the UM field and, if so, it may proceed to request delivery of the downlink ELM. Otherwise, ELM activity shall not be started during this scan and a new reservation request may be made during the next scan.

3.8.2.7.6.1.1.3 If downlink ELM activity is not completed on the current scan, the interrogator shall ensure that it still has a reservation before requesting additional segments on a subsequent scan.

3.8.2.7.6.1.2 *Multisite directed downlink ELM transmissions.* To direct a downlink ELM message to a specific interrogator, the multisite downlink ELM protocol shall be used. When the D-timer is not running, the interrogator identifier of the desired destination shall be stored as the Comm-D II. Simultaneously, the D-timer shall be started and the DR code (3.8.7.6.1) shall be set. For a multisite directed downlink ELM, the D-timer shall not automatically time out but shall continue to run until:

a) the message is read and closed out by the reserved site; or

b) the message is cancelled (3.8.2.10.5.4) by the data link avionics.

Note.— The protocols of 3.8.2.7.6.1 should then result in the delivery of the message to the reserved site. The data link avionics may cancel the message if delivery to the reserved site cannot be accomplished.

3.8.2.7.6.2 *Delivery of downlink ELMs.* The interrogator shall extract a downlink ELM by transmitting a Comm-C interrogation with RC equals 3. This interrogation shall carry the SRS subfield which specifies the segments to be transmitted. On receipt of this request, the transponder shall transfer the requested segments by means of Comm-D replies with KE equals zero and ND corresponding to the number of the segment in MD. The first segment shall be transmitted 128 microseconds plus or minus 0.25 microseconds following the sync phase reversal of the interrogation requesting delivery and subsequent segments shall be transmitted at a rate of one every 136 microseconds plus or minus 1 microsecond.

Note 1.— The requested segments may be transmitted in any order.

Note 2.— Segments lost in downlink transmissions will be requested again by the interrogator on a subsequent interrogation carrying the SRS subfield. This process is repeated until all segments have been transferred.

If a request is received to transmit downlink ELM segments and no message is waiting, each reply segment shall contain all ZEROs in the MD field.

3.8.2.7.6.2.1 *SRS, segment request subfield in MC.* This 16-bit (9-24) uplink subfield in MC shall request the transponder to transfer downlink ELM segments. Starting with bit 9, which denotes segment number ZERO, each of the following bits shall be set to ONE if the transmission of the corresponding segment is requested. SRS shall appear in MC if RC equals 3 in the same interrogation.

3.8.2.7.6.2.2 *D-timer restart.* The D-timer shall be restarted each time that a request for Comm-D segments is received if the Comm-D II is non-zero.

Note.— The requirement for the Comm-D II to be non-zero prevents the D-timer from being restarted during a non-selective downlink ELM transaction.

3.8.2.7.6.3 *Multisite downlink ELM closeout.* The interrogator shall close out a multisite downlink ELM by transmitting either a surveillance or a Comm-A interrogation containing:

either DI equals 1
IIS equals assigned interrogator identifier
MES equals 4, 5 or 7 (downlink ELM closeout)

or DI equals 0, 1 or 7
IIS equals assigned interrogator identifier
PC equals 6 (downlink ELM closeout).

The transponder shall compare the IIS of the interrogation to the Comm-D II and if the interrogator identifiers do not match, the state of the downlink process shall not be changed.

If the interrogator identifiers match, and if a request for transmission has been complied with at least once, the transponder shall set the Comm-D II to zero, reset the D-timer, clear the DR code for this message and clear the message itself.

If another downlink ELM is waiting to be transmitted, the transponder shall set the DR code (if no Comm-B message is waiting to be delivered) so that the reply contains the announcement of the next message.

3.8.2.7.6.4 *Automatic expiration of downlink ELM reservation.* If the D-timer period expires before a multisite closeout has been accomplished, the Comm-D II shall be set to ZERO, and the D-timer reset. The message and DR code shall not be cleared.

Note.— This makes it possible for another site to read and clear this message.

3.8.2.7.7 *Non-selective downlink ELM.*

Note.— In cases where the multisite protocols are not required (i.e. no overlapping coverage or sensor co-ordination via ground-to-ground communication), the non-selective downlink ELM protocol may be used.

Non-selective downlink ELM delivery shall take place as described in 3.8.2.7.6.2.

3.8.2.7.7.1 *Non-selective downlink ELM closeout.* The interrogator shall close out a non-selective downlink ELM by transmitting PC equals 6 (downlink ELM closeout) in a surveillance or Comm-A interrogation. On receipt of this command, and if a request for transmission has been complied with at least once, the transponder shall perform closeout unless the D-timer is running. If the D-timer is running, indicating that a multisite reservation is in effect, the closeout shall be accomplished as per 3.8.2.7.6.3.

3.8.2.8 *Air-air service transactions*

Note.— Airborne collision avoidance system (ACAS) equipment uses the formats UF and DF equals zero for air-air surveillance.

3.8.2.8.1 *Short air-air surveillance, uplink format 0*

1 9 14 33

UF		RL		AQ		AP

5 56

The format of this interrogation shall consist of these fields:

Field	*Reference*
UF uplink format spare — 3 bits	3.8.2.3.2.1.1
RL reply length spare — 4 bits	3.8.2.8.1.2
AQ acquisition spare — 18 bits	3.8.2.8.1.1
AP address/parity	3.8.2.3.2.1.3

3.8.2.8.1.1 *AQ: Acquisition.* This 1-bit (14) uplink field shall contain a code which controls the content of the RI field.

3.8.2.8.1.2 *RL: Reply length.* This 1-bit (9) uplink field shall command the format to be used for the reply.

Coding:

0 signifies a reply with DF = 0
1 signifies no reply

Note.— A transponder associated with airborne collision avoidance equipment would reply with DF equals 16 in response to an interrogation with RL equals 1.

3.8.2.8.2 *Short air-air surveillance, downlink format 0*

1 6 14 20 33

DF	VS		RI		AC	AP

5 17 32 56

This reply shall be sent in response to an interrogation with UF equals zero and RL equals zero. The format of this reply shall consist of these fields:

Field	*Reference*
DF downlink format	3.8.2.3.2.1.2
VS vertical status spare — 7 bits	3.8.2.8.2.1
RI reply information spare — 2 bits	3.8.2.8.2.2
AC altitude code	3.8.2.6.5.4
AP address/parity	3.8.2.3.2.1.3

3.8.2.8.2.1 *VS: Vertical status:* This 1-bit (6) downlink field shall indicate the status of the aircraft (3.8.2.6.10.1.2).

Coding:

0 signifies that the aircraft is airborne
1 signifies that the aircraft is on the ground

3.8.2.8.2.2 *RI: Reply information, air-air.* This 4-bit (14-17) downlink field shall report the aircraft's maximum cruising true airspeed capability and type of reply to interrogating aircraft. The coding shall be as follows:

0 signifies a reply to an air-air interrogation UF = 0 with AQ = 0
1-7 reserved for ACAS
8-15 signifies a reply to an air-air interrogation UF = 0 with AQ = 1 and that the maximum airspeed is as follows:
- 8 no maximum airspeed data available
- 9 maximum airspeed is .LE. 140 km/h (75 kt)
- 10 maximum airspeed is .GT. 140 and .LE. 280 km/h (75 and 150 kt)
- 11 maximum airspeed is .GT. 280 and .LE. 560 km/h (150 and 300 kt)
- 12 maximum airspeed is .GT. 560 and .LE. 1 110 km/h (300 and 600 kt)
- 13 maximum airspeed is .GT. 1 110 and .LE. 2 220 km/h (600 and 1 200 kt)
- 14 maximum airspeed is more than 2 220 km/h (1 200 kt)
- 15 not assigned.

Note.— ".LE." means "less than or equal to" and ".GT." means "greater than".

3.8.2.8.3 *Air-air transaction protocol*

Note.— Interrogation-reply co-ordination for the air-air formats follows the protocol outlined in Table 5 (3.8.2.4.1.3.2.2).

The most significant bit (bit 14) of the RI field of an air-air reply shall replicate the value of the AQ field (bit 14) received in an interrogation with UF equals 0.

If AQ equals 0 in the interrogation, the RI field of the reply shall contain the zero code.

If AQ equals 1 in the interrogation, the RI field of the reply shall contain the maximum cruising true airspeed capability of the aircraft as defined in 3.8.2.8.2.2.

3.8.2.8.4 *Acquisition squitter*

Note.— SSR Mode S transponders transmit acquisition squitters (unsolicited downlink transmissions) to permit passive acquisition by interrogators with broad antenna beams, where active acquisition may be hindered by all-call synchronous garble. Examples of such interrogators are an airborne collision avoidance system and an airport surface surveillance system.

3.8.2.8.4.1 *Acquisition squitter format.* The format used for acquisition squitter transmissions shall be the all-call reply, DF equals 11 with interrogator identifier equal to zero, but the 3-bit CA field in the acquisition squitter shall contain an encoded definition of the communication capability as well as the message waiting and "on the ground" indication.

Coding:

0 signifies Level 1, on the ground or airborne (3.8.2.5.2.2.1)
1 signifies Level 2, no ability to set Code 7, on the ground or airborne (3.8.2.5.2.2.1)
2 signifies Level 3, no ability to set Code 7, on the ground or airborne (3.8.2.5.2.2.1)
3 signifies Level 4, no ability to set Code 7, on the ground or airborne (3.8.2.5.2.2.1)
4 signifies Level 2, 3 or 4, ability to set Code 7, on the ground
5 signifies Level 2, 3 or 4, ability to set Code 7, airborne
6 signifies Level 2, 3 or 4, ability to set Code 7, on the ground or airborne
7 signifies DR ≠ 0 or FS = 3, 4, 5 on the ground or airborne (3.8.2.6.5.1, 3.8.2.6.5.2 and 3.8.2.6.5.3)

Installations that have the ability to set Code 7 but do not have automatic means to set "on the ground" condition shall use Code 6. Aircraft with automatic "on the ground" determination shall use Codes 4 and 5. Data link capability reports (3.8.2.6.10.2.2) shall be available for capability codes 1, 2, 3, 4, 5 and 6.

3.8.2.8.4.2 *Acquisition squitter rate.* Acquisition squitter transmissions shall be emitted at random intervals that are uniformly distributed over the range from 0.8 to 1.2 seconds, with the following exceptions:

a) the scheduled acquisition squitter shall be delayed if the transponder is in a transaction cycle (3.8.2.4.1); and

b) the scheduled acquisition squitter shall be delayed if a mutual suppression interface is active (see note below).

An acquisition squitter shall not be interrupted by link transactions or mutual suppression activity after the squitter transmission has begun.

Note.— A mutual suppression system may be used to connect onboard equipment operating in the same frequency band in order to prevent mutual interference. Acquisition squitter action resumes as soon as practical after a mutual suppression interval.

3.8.2.8.4.3 *Acquisition squitter antenna selection.* Transponders operating with antenna diversity (3.8.2.10.4) shall transmit squitters alternately from the two antennas.

3.8.2.9 *Aircraft identification protocol*

3.8.2.9.1 *Aircraft identification reporting.* A ground-initiated Comm-B request (3.8.2.6.11.2) containing RR equals 18 and either DI does not equal 7 or DI equals 7 and RRS equals zero shall cause the resulting reply to contain the aircraft identification in its MB field.

3.8.2.9.1.1 *AIS, aircraft identification subfield in MB.* The transponder shall report the aircraft identification in the 48-bit (41-88) AIS subfield of MB. The aircraft identification transmitted shall be that employed in the flight plan. When no flight plan is available, the registration marking of the aircraft shall be inserted in this subfield.

Note.— When the registration marking of the aircraft is used, it is classified as "fixed direct data" (3.8.2.10.5.1.1). When another type of aircraft identification is used, it is classified as "variable direct data" (3.8.2.10.5.1.3).

3.8.2.9.1.2 *Coding of the AIS subfield.* The AIS subfield shall be coded as follows:

33	41	47	53	59	65	71	77	83
BDS	Char. 1	Char. 2	Char. 3	Char. 4	Char. 5	Char. 6	Char. 7	Char. 8
40	46	52	58	64	70	76	82	88

Note.— Aircraft identification coding provides up to eight characters.

The BDS code for the aircraft identification message shall be BDS1 equals 2 and BDS2 equals 0 as a result of the RR coding in 3.8.2.6.1.2.

Each character shall be coded as a 6-bit subset of the International Alphabet Number 5 (IA-5) as illustrated in Table 6. The character code shall be transmitted with the high order unit (b6) first and the reported aircraft identification shall be transmitted with its left-most character first. Characters shall be coded consecutively without intervening SPACE code. Any unused character spaces at the end of the subfield shall contain a SPACE character code.

3.8.2.9.1.3 *Aircraft identification capability report.* Transponders which respond to a ground-initiated request for aircraft identification shall report this capability in the data link capability report (3.8.2.6.10.2.2) by setting bit 65 of the BCS subfield to ONE.

3.8.2.9.1.4 *Change of aircraft identification.* If the aircraft identification reported in the AIS subfield is changed in flight, the transponder shall report the new identification to the ground by use of the Comm-B broadcast message protocol of 3.8.2.6.11.4.

3.8.2.10 *Essential system characteristics of the SSR Mode S transponder*

3.8.2.10.1 *Transponder sensitivity and dynamic range.* Transponder sensitivity shall be defined in terms of a given interrogation signal input level and a given percentage of corresponding replies. Only correct replies containing the required bit pattern for the interrogation received shall be counted. Given an interrogation that requires a reply according to 3.8.2.4, the minimum triggering level, MTL, shall be defined as the minimum input power level for 90 per cent reply-to-interrogation ratio. The MTL shall be −74 dBm ±3 dB. The reply-to-interrogation ratio of a Mode S transponder shall be:

a) at least 99 per cent for signal input levels between 3 dB above MTL and −21 dBm; and

b) no more than 10 per cent at signal input levels below −81 dBm.

Note.— Transponder sensitivity and output power are described in this section in terms of signal level at the terminals of the antenna. This gives the designer freedom to arrange the installation, optimizing cable length and receiver-transmitter design, and does not exclude receiver and/or transmitter components from becoming an integral part of the antenna subassembly.

3.8.2.10.1.1 *Reply ratio in the presence of interference*

Note.— The following paragraphs present measures of the performance of the Mode S transponder in the presence of interfering Mode A/C interrogation pulses.

3.8.2.10.1.1.1 *Reply ratio in the presence of an interfering pulse.* Given a Mode S interrogation which requires a reply (3.8.2.4), the reply ratio of a transponder shall be at least 95 per cent in the presence of an interfering Mode A/C interrogation pulse if the level of the interfering pulse is 6 dB or more below the signal level for Mode S input signal levels between −68 dBm and −21 dBm and the interfering pulse overlaps the P_6 pulse of the Mode S interrogation anywhere after the sync phase reversal.

Table 6. Character coding for transmission of aircraft identification by data link
(subset of IA-5 — see 3.8.2.9.1.2)

				b_6	0	0	1	1
				b_5	0	1	0	1
b_4	b_3	b_2	b_1					
0	0	0	0			P	SP	0
0	0	0	1		A	Q		1
0	0	1	0		B	R		2
0	0	1	1		C	S		3
0	1	0	0		D	T		4
0	1	0	1		E	U		5
0	1	1	0		F	V		6
0	1	1	1		G	W		7
1	0	0	0		H	X		8
1	0	0	1		I	Y		9
1	0	1	0		J	Z		
1	0	1	1		K			
1	1	0	0		L			
1	1	0	1		M			
1	1	1	0		N			
1	1	1	1		O			

Under the same conditions, the reply ratio shall be at least 50 per cent if the interference pulse level is 3 dB or more below the signal level.

3.8.2.10.1.1.2 *Reply ratio in the presence of pulse pair interference.* Given an interrogation which requires a reply (3.8.2.4), the reply ratio of a transponder shall be at least 90 per cent in the presence of an interfering P_1 - P_2 pulse pair if the level of the interfering pulse pair is 9 dB or more below signal level for input signal levels between −68 dBm and −21 dBm and the P_1 pulse of the interfering pair occurs no earlier than the P_1 pulse of the Mode S signal.

3.8.2.10.1.1.3 *Reply ratio in the presence of low level asynchronous interference.* For all received signals between −65 dBm and −21 dBm and given a Mode S interrogation that requires a reply according to 3.8.2.4 and if no lockout condition is in effect, the transponder shall reply correctly with at least 95 per cent reply ratio in the presence of asynchronous interference. Asynchronous interference shall be taken to be a single Mode A/C interrogation pulse occurring at all repetition rates up to 10 000 Hz at a level 12 dB or more below the level of the Mode S signal.

Note.— Such pulses may combine with the P_1 and P_2 pulses of the Mode S interrogation to form a valid Mode A/C-only all-call interrogation. The Mode S transponder does not respond to Mode A/C-only all-call interrogations. A preceding pulse may also combine with the P_2 of the Mode S interrogation to form a valid Mode A or Mode C interrogation. However, the P_1 - P_2 pair of the Mode S preamble takes precedence (3.8.2.4.1.1.1). The Mode S decoding process is independent of the Mode A/Mode C decoding process and the Mode S interrogation is accepted.

3.8.2.10.1.1.4 *Spurious response*

Recommendation.— *The response to signals not within the receiver pass band should be at least 60 dB below normal sensitivity.*

3.8.2.10.2 *Transponder peak pulse power.* The peak power of each pulse of a reply shall:

a) not be less than 18.5 dBW for aircraft not capable of operating at altitudes exceeding 4 570 m (15 000 ft);

b) not be less than 21.0 dBW for aircraft capable of operating above 4 570 m (15 000 ft);

c) not be less than 21.0 dBW for aircraft with maximum cruising speed exceeding 324 km/h (175 kt); and

d) not exceed 27.0 dBW.

3.8.2.10.2.1 *Inactive state transponder output power.* When the transponder is in the inactive state the peak pulse power at 1 090 MHz plus or minus 3 MHz shall not exceed −50 dBm. The inactive state is defined to include the entire period between transmissions less 10-microsecond transition periods preceding the first pulse and following the last pulse of the transmission.

Note.— Inactive state transponder power is constrained in this way to ensure that an aircraft, when located as near as 185 m (0.1 NM) to a Mode A/C or Mode S interrogator, does not cause interference to that installation. In certain applications of Mode S, airborne collision avoidance for example, where a 1 090 MHz transmitter and receiver are in the same aircraft, it may be necessary to further constrain the inactive state transponder power.

3.8.2.10.2.2 *Spurious emission radiation.*

Recommendation.— *CW radiation should not exceed 70 dB below 1 watt.*

3.8.2.10.3 *Special characteristics*

3.8.2.10.3.1 *Mode S side-lobe suppression*

Note.— Side-lobe suppression for Mode S formats occurs when a P_5 pulse overlays the location of the sync phase reversal of P_6, causing the transponder to fail to recognize the interrogation (3.8.2.4.1.1.3).

Given a Mode S interrogation that requires a reply, the transponder shall:

a) at all signal levels between MTL +3 dB and −21 dBm, have a reply ratio of less than 10 per cent if the received amplitude of P_5 exceeds the received amplitude of P_6 by 3 dB or more;

b) at all signal levels between MTL +3 dB and −21 dBm, have a reply ratio of at least 99 per cent if the received amplitude of P_6 exceeds the received amplitude of P_5 by 12 dB or more.

3.8.2.10.3.2 *Mode S dead time.* Dead time shall be defined as the time interval beginning at the end of a reply transmission and ending when the transponder has regained sensitivity to within 3 dB of MTL. Mode S transponders shall not have more than 125 microseconds' dead time.

3.8.2.10.3.3 *Mode S receiver densensitization.* The transponder's receiver shall be desensitized according to 3.8.1.7.7.1 on receipt of any pulse of more than 0.7 microsecond's duration.

3.8.2.10.3.3.1 *Recovery from desensitization.* Recovery from desensitization shall begin at the trailing edge of each pulse of a received signal and shall occur at the rate prescribed in 3.8.1.7.7.2, provided that no reply or data transfer is made in response to the received signal.

3.8.2.10.3.4 *Recovery after Mode S interrogations that do not elicit replies*

3.8.2.10.3.4.1 *Recovery after a single Mode S interrogation.* The transponder shall recover sensitivity to within 3 dB of MTL no later than 128 microseconds after receipt of the sync phase reversal following a Mode S interrogation that is not accepted (3.8.2.4.1.2) or that is accepted but requires no reply.

3.8.2.10.3.4.2 *Recovery after a Mode S Comm-C interrogation.* A Mode S transponder with Comm-C capability shall recover sensitivity to within 3 dB of MTL no later than 45 microseconds after receipt of the sync phase reversal following acceptance of a Comm-C interrogation for which no reply is required.

3.8.2.10.3.5 *Unwanted Mode S replies.* Mode S transponders shall not generate unwanted Mode S replies more often than once in 10 seconds. Installation in the aircraft shall be made in such a manner that this standard shall be achieved when all possible interfering equipments installed in the same aircraft are operating at maximum interference levels.

3.8.2.10.3.6 *Reply rate limiting*

Note.— Reply rate limiting is prescribed separately for Modes A and C and for Mode S.

3.8.2.10.3.6.1 *Mode S reply rate limiting.* Reply rate limiting is not required for the Mode S formats of a transponder. If such limiting is incorporated for circuit protection, it shall permit the minimum reply rates required in 3.8.2.10.3.7.2 and 3.8.2.10.3.7.3.

3.8.2.10.3.6.2 *Modes A and C reply rate limiting.* Reply rate limiting for Modes A and C shall be effected according to 3.8.1.7.9.1. The prescribed sensitivity reduction (3.8.1.7.9.2) shall not affect the Mode S performance of the transponder.

3.8.2.10.3.7 *Minimum reply rate capability, Modes A, C and S*

3.8.2.10.3.7.1 *Minimum reply rate capability, Modes A and C.* The minimum reply rate capability for Modes A and C shall be in accordance with 3.8.1.7.9.

3.8.2.10.3.7.2 *Minimum reply rate capability, Mode S.* A transponder capable of transmitting only short Mode S replies shall be able to generate replies at the following rates:

50 Mode S replies in any 1-second interval
18 Mode S replies in a 100-millisecond interval
8 Mode S replies in a 25-millisecond interval
4 Mode S replies in a 1.6-millisecond interval

A transponder transmitting short and long replies but not transmitting downlink ELMs shall be able to generate as long replies at least:

16 of 50 Mode S replies in any 1-second interval
6 of 18 Mode S replies in a 100-millisecond interval
4 of 8 Mode S replies in a 25-millisecond interval
2 of 4 Mode S replies in a 1.6-millisecond interval

3.8.2.10.3.7.3 *Minimum Mode S ELM peak reply rate*

Note.— When a downlink ELM is initialized (3.8.2.7.6.1), the Mode S transponder announces the length (in segments) of the waiting message. The transponder must be able to transmit this number of segments, plus an additional margin to make up for missed replies, during the beam dwell of the ground interrogator.

At least once every four seconds a Mode S transponder equipped for ELM downlink operation shall be capable of transmitting in a 25-millisecond interval, at least 25 per cent more segments than have been announced in the initialization (3.8.2.7.6.1).

Note.— A transponder capable of handling the maximum length downlink ELM (16 segments) is therefore required to be able to transmit 20 long replies under the above conditions. Transponders may be built which handle less than the maximum message length. These transponders cannot initialize a message length that exceeds their transmitter capability. For example, a transponder that can transmit at most 10 long replies under the above conditions can never announce a message of more than 8 segments.

3.8.2.10.3.8 *Reply delay and jitter*

Note.— After an interrogation has been accepted and if a reply is required, this reply transmission begins after a fixed delay needed to carry out the protocols. Different values for this delay are assigned for Modes A and C, for Mode S and for Modes A/C/S all-call replies.

3.8.2.10.3.8.1 *Reply delay and jitter for Modes A and C.* The reply delay and jitter for Modes A and C transactions shall be as prescribed in 3.8.1.7.10.

3.8.2.10.3.8.2 *Reply delay and jitter for Mode S.* For all input signal levels between MTL and −21 dBm, the leading edge of the first preamble pulse of the reply (3.8.2.2.5.1.1) shall occur 128 plus or minus 0.25 microsecond after the sync phase reversal (3.8.2.1.5.2.2) of the received P_6. The jitter of the reply delay shall not exceed 0.08 microsecond, peak (99.9 percentile).

3.8.2.10.3.8.3 *Reply delay and jitter for Modes A/C/S all call.* For all input signal levels between MTL +3 dB and −21 dBm the leading edge of the first preamble pulse of the reply (3.8.2.2.5.1.1) shall occur 128 plus or minus 0.5 microsecond after the leading edge of the P_4 pulse of the interrogation (3.8.2.1.5.1.1). Jitter shall not exceed 0.1 microsecond, peak (99.9 percentile).

Note.— A peak jitter of 0.1 microsecond is consistent with the jitter prescribed in 3.8.1.7.10.

3.8.2.10.3.9 *Timers.* Duration and features of timers shall be as shown in Table 7.

All timers shall be capable of being restarted. On receipt of any start command, they shall run for their specified times. This shall occur regardless of whether they are in the running or the non-running state at the time that the start command is received. A command to reset a timer shall cause the timer to stop running and to return to its initial state in preparation for a subsequent start command.

Table 7. Timer characteristics

Timer Name	Number	Reference	Symbol	Duration s	Tolerance s	Resettable
Non-selective lock-out	1	3.8.2.6.9.2	T_D	18	± 1	no
Temporary alert	1	3.8.2.6.10.1.1.2	T_C	18	± 1	no
SPI	1	3.8.2.6.10.1.3	T_I	18	± 1	no
Reservations B, C, D	3*	3.8.2.6.11.3.1	T_R	18	± 1	yes
Multisite lockout	15	3.8.2.6.9.1	T_L	18	± 1	no

* As required.

3.8.2.10.3.10 *Inhibition of replies.* Replies to Mode A/C/S all-call and Mode S-only all-call interrogations shall always be inhibited when the aircraft is on the ground. It shall not be possible to inhibit replies to discretely addressed Mode S interrogations, or acquisition squitter transmissions, regardless of whether the aircraft is airborne or on the ground.

Note.— In some installations Mode A/C replies may be inhibited when the aircraft is on the ground to prevent interference when in close proximity to an interrogator or other aircraft. Mode S discretely addressed interrogations do not give rise to such interference and may be required for data link communications with aircraft on the airport surface. Acquisition squitter transmissions may be used for passive surveillance of aircraft on the airport surface.

3.8.2.10.4 *Transponder antenna system and diversity operation.* Mode S transponders equipped for diversity operation shall have two RF ports for operation with two antennas, one antenna on the top and the other on the bottom of the aircraft's fuselage. The received signal from one of the antennas shall be selected for acceptance and the reply shall be transmitted from the selected antenna only.

3.8.2.10.4.1 *Radiation pattern.* The radiation pattern of Mode S antennas when installed on an aircraft shall be nominally equivalent to that of a quarter-wave monopole on a ground plane.

Note.— Transponder antennas designed to increase gain at the expense of vertical beamwidth are undesirable because of their poor performance during turns.

3.8.2.10.4.2 *Antenna location.* The horizontal distance between the top and the bottom antennas shall not be greater than 7.6 m. Both antennas shall be mounted as near as possible to the centre line of the fuselage. Antennas shall be located so as to minimize obstruction to their fields in the horizontal plane.

Note.— The antenna spacing is specified in order to control apparent range jitter from reply to reply due to antenna diversity switching.

3.8.2.10.4.3 *Antenna selection.* Mode S transponders equipped for diversity operation shall have the capability to evaluate a pulse sequence simultaneously received on both antenna channels to determine individually for each channel if the P_1 pulse and the P_2 pulse of a Mode S interrogation preamble meet the requirements for a Mode S interrogation as defined in 3.8.2.1 and if the P_1 pulse and the P_3 pulse of a Mode A, Mode C or intermode interrogation meet the requirements for Mode A and Mode C interrogations as defined in 3.8.1.

Note.— Transponders equipped for diversity operation may optionally have the capability to evaluate additional characteristics of the received pulses of the interrogations in making a diversity channel selection. The transponder may as an option evaluate a complete Mode S interrogation simultaneously received on both channels to determine individually for each channel if the interrogation meets the requirements for Mode S interrogation acceptance as defined in 3.8.2.4.1.2.3.

If the two channels simultaneously receive at least a P_1 - P_2 pulse pair that meets the requirements for a Mode S interrogation, or a P_1 - P_3 pulse pair that meets the requirements for a Mode A or Mode C interrogation, or if the two channels simultaneously accept a complete interrogation, the antenna at which the signal strength is greater shall be selected for the reception of the remainder (if any) of the interrogation and for the transmission of the reply.

If only one channel receives a pulse pair that meets the requirements for an interrogation, or if only one channel accepts an interrogation, the antenna associated with that channel shall be selected regardless of received signal strength.

3.8.2.10.4.3.1 *Selection threshold.* If antenna selection is based on signal level, it shall be carried out at all signal levels between MTL and −21 dBm.

Note.— Either antenna may be selected if the difference in signal level is less than 3 dB.

3.8.2.10.4.3.2 *Received signal delay tolerance.* If an interrogation is received at one antenna 0.125 microsecond or less in advance of reception at the other antenna, the interrogations shall be considered to be simultaneous interrogations, and the above antenna selection criteria applied. If an accepted interrogation is received at either antenna 0.375 microsecond or more in advance of reception at the other antenna, the antenna selected for the reply shall be that which received the earlier interrogation. If the relative time of receipt is between 0.125 and 0.375 microsecond, the transponder shall select the antenna for reply either on the basis of the simultaneous interrogation criteria or on the basis of the earlier time of arrival.

3.8.2.10.4.4 *Diversity transmission channel isolation.* The peak RF power transmitted from the selected antenna shall exceed the power transmitted from the non-selected antenna by at least 20 dB.

3.8.2.10.4.5 *Reply delay of diversity transponders.* The total difference in mean reply delay between the two antenna channels (including the transponder-to-antenna cables) shall not exceed 0.08 microsecond for interrogations of equal amplitude. This requirement shall hold for interrogation signal strengths between MTL +3 dB and −21 dBm.

Note.— This requirement limits apparent jitter caused by antenna switching and by cable delay differences. The jitter requirements on each individual channel remain as specified for non-diversity transponders. Apparent jitter caused by antenna location is controlled by the requirements of 3.8.2.10.4.2.

3.8.2.10.5 *Data processing and interfaces*

3.8.2.10.5.1 *Direct data.* Direct data shall be those which are required for the surveillance protocol of the Mode S system.

3.8.2.10.5.1.1 *Fixed direct data.* Fixed direct data are data from the aircraft which do not change in flight and shall be:

a) the Mode S address (3.8.2.4.1.2.3.1.1 and 3.8.2.5.2.2.2);

b) the maximum airspeed (3.8.2.8.2.2); and

c) the registration marking if used for flight identification (3.8.2.9.1.1).

3.8.2.10.5.1.2 *Interfaces for fixed direct data*

Recommendation.— *Interfaces from the transponder to the aircraft should be designed such that the values of the fixed direct data become a function of the aircraft installation rather than of the transponder configuration.*

Note.— The intent of this recommendation is to encourage an interface technique which permits transponder exchange without manipulation of the transponder itself for setting the fixed direct data.

3.8.2.10.5.1.3 *Variable direct data.* Variable direct data are data from the aircraft which may change in flight and shall be:

a) the Mode C altitude (3.8.2.6.5.4);

b) the Mode A identity code (3.8.2.6.7.1);

c) the on-the-ground condition (3.8.2.6.5.1 and 3.8.2.8.2.1);

d) the aircraft identification if different from the registration marking (3.8.2.9.1.1); and

e) the SPI condition (3.8.2.6.10.1.3).

3.8.2.10.5.1.4 *Interfaces for variable direct data.* It shall be possible for the Mode A identity code, the SPI condition and, if necessary, the variable aircraft identification to be inserted by the pilot.

Interfaces shall be included to accept the pressure altitude and on-the-ground coding.

Note.— A specific interface design for the variable direct data is not prescribed.

3.8.2.10.5.2 *Indirect data*

Note.— Indirect data are those which pass through the transponder in either direction but which do not affect the surveillance function.

If origins and/or destinations of indirect data are not within the transponder's enclosure, interfaces shall be used for the necessary connexions.

3.8.2.10.5.2.1 *The function of interfaces*

Note.— Indirect data interfaces for standard transactions serve interrogations which require a reply and the broadcast function. Indirect data interfaces for ELM serve that system and require buffering and protocol circuitry within the transponder. Interface ports can be separate for each direction and for each service or can be combined in any manner.

3.8.2.10.5.2.1.1 *Uplink standard length transaction interface.* The uplink standard length transaction interface shall transfer all bits, with the possible exception of the AP field.

Note.— AP can also be transferred to aid in integrity implementation.

3.8.2.10.5.2.1.2 *Downlink standard length transaction interface.* A transponder which transmits information originating in a peripheral device shall be able to receive bits or bit patterns for insertion at appropriate locations within the transmission. These locations shall not include those into which bit patterns generated internally by the transponder are inserted, not the AP field of the reply.

A transponder which transmits information using the Comm-B format shall have immediate access to requested data in the sense that the transponder shall respond to an interrogation with data requested by that interrogation.

Note.— This requirement may be met in two ways:

a) the transponder may have provisions for internal data and protocol buffering;

b) the transponder may employ a "real time" interface which operates such that uplink data leave the transponder before the corresponding reply is generated and downlink data enter the transponder in time to be incorporated in the reply.

3.8.2.10.5.2.1.3 *Extended length message interface*

Note.— The ELM interface extracts from, and enters into, the transponder the data exchanged between air and ground by means of the ELM protocol (3.8.2.7).

3.8.2.10.5.2.2 *Indirect data transaction rates*

3.8.2.10.5.2.2.1 *Standard length transactions.* A transponder equipped for information transfer to and from external devices shall be capable of processing the data of at least as many replies as prescribed for minimum reply rates in 3.8.2.10.3.7.2 and uplink data from interrogations being delivered at a rate of at least:

50 long interrogations in any 1-second interval
18 long interrogations in a 100-millisecond interval
8 long interrogations in a 25-millisecond interval
4 long interrogations in a 1.6-millisecond interval.

Note 1.— A transponder capable of reply rates higher than the minimum of 3.8.2.10.3.7.2 need not accept long interrogations after reaching the uplink data processing limits above.

Note 2.— The Mode S reply is the sole means of acknowledging receipt of the data content of a Mode S interrogation. Thus, if the transponder is capable of replying to an interrogation, the Mode S installation must be capable of accepting the data contained in that interrogation regardless of the timing between it and other accepted interrogations. Overlapping Mode S beams from several interrogators could lead to the requirement for considerable data processing and buffering. The minimum described here reduces data processing to a realistic level and the non-acceptance provision provides for notification to the interrogator that data will temporarily not be accepted.

3.8.2.10.5.2.2.2 *Extended length transactions.* A transponder equipped for ground-to-air ELM operation shall be capable of processing at least four complete 16-segment ELMs (3.8.2.7.4) in 4 seconds and the content of any uplink ELM shall be available for transfer across the output interface no later than 1 second after it was received. A transponder equipped for air-to-ground ELM operation shall be able to transmit at least four air-to-ground ELM segments (3.8.2.7.6 and 3.8.2.10.3.7.3) in a 4-second period.

3.8.2.10.5.3 *Integrity of data content transfer.* A transponder which employs data interfaces shall include sufficient protection to ensure error rates of less than one error in 10^3 messages and less than one undetected error in 10^7 112-bit transmissions in both directions between the antenna and each interface port.

3.8.2.10.5.4 *Message cancellation.* The downlink standard length transaction interface and the extended length message interface shall include the capability to cancel a message sent to the transponder for delivery to the ground, but whose delivery cycle has not been completed (i.e. a closeout has not been accomplished by a ground interrogator).

Note.— One example of the need for this capability is to cancel a message if delivery is attempted when the aircraft is not within coverage of a Mode S ground station. The message must then be cancelled to prevent it from being read and interpreted as a current message when the aircraft re-enters Mode S airspace.

3.8.2.10.5.5 *Air-directed messages.* The transfer of this type of message requires all of the actions indicated in 3.8.2.10.5.4 plus the transfer to the transponder of the interrogator identifier of the site that is to receive the message.

3.8.2.11 *Essential system characteristics of the ground interrogator*

Note.— To ensure that Mode S interrogator action is not detrimental to Mode A/C interrogators, performance limits exist for Mode S interrogators.

3.8.2.11.1 *Interrogation repetition rates.* Mode S interrogators shall use the lowest practicable interrogation repetition rates for all interrogation modes.

Note.— Accurate azimuth data at low interrogation rates can be obtained with monopulse techniques.

3.8.2.11.1.1 *All-call interrogation repetition rate.* The interrogation repetition rate for the Mode A/C/S all-call, used for acquisition, shall be less than 250 per second. This rate shall also apply to the paired Mode S-only and Mode A/C-only all-call interrogations used for acquisition in the multisite mode.

3.8.2.11.1.2 *Interrogation repetition rate to a single aircraft*

3.8.2.11.1.2.1 *Interrogations requiring a reply.* Mode S interrogations requiring a reply shall not be transmitted to a single aircraft at intervals shorter than 400 microseconds.

3.8.2.11.1.2.2 *Uplink ELM interrogations.* The minimum time between the beginning of successive Comm-C interrogations shall be 50 microseconds.

3.8.2.11.1.3 *Repetition rate for selective interrogations.* The interrogation rate for Mode S selective interrogations shall be:

a) less than 1 200 per second averaged over a 4-second interval;

b) less than 1 800 per second averaged over a 1-second interval; and

c) less than 2 400 per second averaged over a 40-millisecond interval.

Table 8. Transmitted signal tolerances

Reference	Function	Tolerance
3.8.2.1.4.1	Pulse duration P_1, P_2, P_3, P_4, P_5 Pulse duration P_6	± 0.09 microsecond ± 0.20 microsecond
3.8.1.4	Pulse position $P_1 - P_3$ Pulse position $P_1 - P_2$	± 0.18 microsecond ± 0.10 microsecond
3.8.2.1.5.1.3	Pulse position $P_3 - P_4$	± 0.04 microsecond
3.8.2.1.5.2.4	Pulse position $P_1 - P_2$ Pulse position P_2 − sync phase reversal Pulse position P_6 − sync phase reversal Pulse position P_5 − sync phase reversal	± 0.04 microsecond ± 0.04 microsecond ± 0.04 microsecond ± 0.05 microsecond
3.8.1.5	Pulse amplitude P_3	P_1 ± 0.5 dB
3.8.2.1.5.1.4	Pulse amplitude P_4	P_3 ± 0.5 dB
3.8.2.1.5.2.5	Pulse amplitude P_6	Equal to or greater than P_2 −0.25 dB
3.8.2.1.4.1	Pulse rise times	0.05 microsecond minimum, 0.1 microsecond maximum
3.8.2.1.4.1	Pulse decay times	0.05 microsecond minimum 0.2 microsecond maximum

3.8.2.11.2 *Interrogator-effective radiated power*

Recommendation.— *The effective radiated power of all interrogation pulses should be minimized as described in 3.8.1.8.2.*

3.8.2.11.3 *Inactive-state interrogator output power.* When the interrogator transmitter is not transmitting an interrogation, its output shall not exceed −5 dBm effective radiated power at any frequency between 960 MHz and 1 215 MHz.

Note.— This constraint ensures that aircraft flying near the interrogator (as close as 1.85 km (1 NM)) shall not receive interference that would prevent them from being tracked by another interrogator. In certain instances even smaller interrogator-to-aircraft distances are of significance, for example if Mode S surveillance on the airport surface is used. In such cases a further restraint on inactive state interrogator output power may be necessary.

3.8.2.11.3.1 *Spurious emission radiation*

Recommendation.— *CW radiation should not exceed 76 dB below 1 watt.*

3.8.2.11.4 *Tolerances on transmitted signals.* In order that the signal-in-space be received by the transponder as described in 3.8.2.1, the tolerances on the transmitted signal shall be as summarized in Table 8.

3.8.2.11.5 *Spurious response*

Recommendation.— *The response to signals not within the passband shall be at least 60 dB below normal sensitivity.*

3.9 System characteristics of airborne ADF receiving systems

3.9.1 Accuracy of bearing indication

3.9.1.1 The bearing given by the ADF system shall not be in error by more than plus or minus 5 degrees with a radio signal from any direction having a field strength of 70 microvolts per metre or more radiated from an LF/MF NDB or locator operating within the tolerances permitted by this Annex and in the presence also of an unwanted signal from a direction 90 degrees from the wanted signal and:

1) on the same frequency and 15 dB weaker; or

2) plus or minus 2 kHz away and 4 dB weaker; or

3) plus or minus 6 kHz or more away and 55 dB stronger.

Note.— The above bearing error is exclusive of aircraft magnetic compass error.

3.10 Loran-A system characteristics

3.10.1 General

3.10.1.1 The Loran-A system shall provide accurately timed pulses of radio frequency energy from pairs of associated stations such that measurements in an aircraft of the difference of time of arrival of the pulses from each pair determine the hyperbolic line of position of the aircraft. Two such intersecting lines determine the position of the aircraft.

3.10.1.2 The system shall be comprised of a master station transmitting pulses received directly by the aircraft, and effectively triggering other slave stations of the system. When triggered by the master station, slave stations transmit synchronized pulses for reception by the same aircraft.

3.10.2 System characteristics

3.10.2.1 The Loran-A pulse shall have a nominal rise time of 21 microseconds plus or minus 1 microsecond and a nominal pulse width of 40 microseconds plus or minus 1 microsecond.

3.10.2.2 *Pulse spectrum.* The peaks of the sideband energy on either side of the carrier frequency shall be down from the carrier frequency in amplitude, as follows:

Frequency	*Attenuation*
± 25 kHz	−20 dB or lower
± 50 kHz	−40 dB or lower
± 120 kHz	−70 dB or lower

3.10.2.3 The Loran-A pulse repetition period shall be assigned a value from the table of 3.10.3.3 below between 29 300 and 50 000 microseconds for identification. The assigned period shall be maintained within 0.01 microsecond.

3.10.2.4 A pair shall be comprised of a master station transmitting accurately timed pulses and a slave station transmitting pulses accurately delayed from the master pulse by the time distance between the stations plus one-half the pulse repetition period, plus an additional coding delay, usually 1 000 microseconds with an over-all tolerance of plus or minus 2 microseconds.

Note 1.— Accuracy of signal-in-space for a 2-microsecond timing tolerance. *Within 80 per cent of the Loran-A coverage areas involved, ground wave line-of-position is accurate to approximately 2.8 km (1.5 NM), and sky wave line-of-position is accurate to within 13 km (7 NM).*

Note 2.— The limits of accuracy in relation to the geometric configuration of ground stations are defined by a circle drawn through each station of the pair, and having its centre located on the perpendicular bisector of the base line with a radius equal to six times the base line length.

Note 3.— Coverage. *At sea level, ground wave coverage may be expected to at least 1 112 km (600 NM) over water, and sky wave coverage to over 1 853 km (1 000 NM) over either land or water.*

3.10.3 Identification

3.10.3.1 A Loran-A pair shall be identified by the channel number, and the basic rate and specific rate of the pulse repetition period.

3.10.3.2 *Loran-A channel frequencies.*

Channel No.	*Frequency*
1	1 950 kHz
2	1 850 kHz
3	1 900 kHz

3.10.3.3 *Loran-A specific pulse repetition periods:*

	Basic rate (period in microseconds)		
Specific rate	*S*	*L*	*H*
0	50 000	40 000	30 000
1	49 900	39 900	29 900
2	49 800	39 800	29 800
3	49 700	39 700	29 700
4	49 600	39 600	29 600
5	49 500	39 500	29 500
6	49 400	39 400	29 400
7	49 300	39 300	29 300

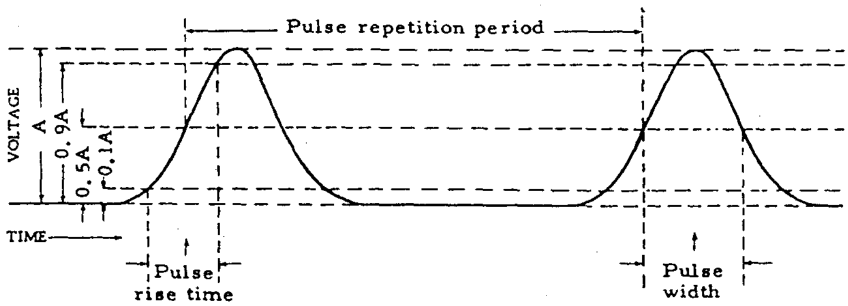
Example: Loran pair 2L4 designates Channel 2, 1 850 kHz basic rate L and specific rate 39 600 microseconds.

3.10.4 Siting

3.10.4.1 **Recommendation.—** *The distance between the master and its slave station should be as great as practicable, having regard for the necessity of continuous reception of the master pulses by the slave station for synchronization and the reception of pulses from both stations by aircraft in the required service area.*

3.10.5 Monitoring

3.10.5.1 **Recommendation.—** *Monitoring of operation should normally be conducted at the master station by electronic observation and recording of the difference of time of arrival between master and slave pulses and visual observation of the characteristics of the pulses transmitted from the master and slave stations.*



DEFINITIONS

Pulse amplitude A. The peak voltage of the pulse envelope.

Pulse width. The time interval (microseconds) between 0.5A points on leading and trailing edges of the pulse envelope.

Pulse repetition period (PRP). The time interval (microseconds) between the 0.5A point on the leading edge of the first pulse and the 0.5A point on the leading edge of the following pulse from the same station.

Pulse rise time. The time interval (microseconds) between 0.1A point and 0.9A point on the leading edge of the pulse envelope.

Loran pair. A synchronized master station and slave station operating on the same radio frequency with the same pulse repetition period and serving a particular geographic area.

Loran chain. A group of two or more co-ordinated Loran pairs covering the same general geographic area.

Figure 3-4. Loran-A pulse shape and spacing definitions

3.10.5.2 **Recommendation.**— *When the difference of time of arrival of the monitored signals varies from normal by more than 2 microseconds, the user should be notified of the unusable condition by a shifting of the relative position of the master or slave pulses, at 1-second intervals. This "blink" signal may be produced by regularly shifting the time position of the master or slave pulses, or both, back and forth approximately 1 000 microseconds.*

3.11 Microwave landing system (MLS) characteristics

3.11.1 Definitions

Auxiliary data. Data, transmitted in addition to basic data, that provide ground equipment siting information for use in refining airborne position calculations and other supplementary information.

Basic data. Data transmitted by the ground equipment that are associated directly with the operation of the landing guidance system.

Beam centre. The midpoint between the two minus 3-dB points on the leading and trailing edges of the scanning beam main lobe.

Beamwidth. The width of the scanning beam main lobe measured at the minus 3-dB points and defined in angular units on the boresight, in the horizontal plane for the azimuth function and in the vertical plane for the elevation function.

Clearance guidance sector. The volume of airspace, inside the coverage sector, within which the azimuth guidance information provided is not proportional to the angular displacement of the aircraft, but is a constant left or right indication of which side the aircraft is with respect to the proportional guidance sector.

Control motion noise (CMN). That portion of the guidance signal error which causes control surface, wheel and column motion and could affect aircraft attitude angle during coupled flight, but does not cause aircraft displacement from the desired course and/or glide path. (See 3.5 above.)

Co-ordinate system — conical. A function is said to use conical co-ordinates when the decoded guidance angle varies as the minimum angle between the surface of a cone containing the receiver antenna, and a plane perpendicular to the axis of the cone and passing through its apex. The apex of the cone is at the antenna phase centre. For approach azimuth or back azimuth functions, the plane is the vertical plane containing the runway centre line. For elevation functions, the plane is horizontal.

Co-ordinate system — planar. A function is said to use planar co-ordinates when the decoded guidance angle varies as the angle between the plane containing the receiver antenna and a reference plane. For azimuth functions, the reference plane is the vertical plane containing the runway centre line and the plane containing the receiver antenna is a vertical plane passing through the antenna phase centre.

Coverage sector. A volume of airspace within which service is provided by a particular function and in which the signal power density is equal to or greater than the specified minimum.

DME/P. The distance measuring element of the MLS, where the "P" stands for precise distance measuring. The spectrum characteristics are those of DME/N.

Function. A particular service provided by the MLS, e.g. approach azimuth guidance, back azimuth guidance or basic data, etc.

Mean course error. The mean value of the azimuth error along the runway extended centre line.

Mean glide path error. The mean value of the elevation error along the glide path of an elevation function.

Minimum glide path. The lowest angle of descent along the zero degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.

Note.— This is the lowest elevation angle which has been approved and promulgated for the instrument runway.

MLS approach reference datum. A point at a specified height above the intersection of the runway centre line and the threshold.

MLS back azimuth reference datum. A point at a specified height above the runway centre line at the runway midpoint.

MLS datum point. The point on the runway centre line closest to the phase centre of the approach elevation antenna. (See 3.5 above.)

Out-of-coverage indication signal. A signal radiated into areas outside the intended coverage sector where required to specifically prevent invalid removal of an airborne warning indication in the presence of misleading guidance information.

Path following error (PFE). That portion of the guidance signal error which could cause aircraft displacement from the desired course and/or glide path. (See 3.5 above.)

Path following noise (PFN). That portion of the guidance signal error which could cause aircraft displacement from the mean course line or mean glide path as appropriate.

Proportional guidance sector. The volume of airspace within which the angular guidance information provided by a function is directly proportional to the angular displacement of the airborne antenna with respect to the zero angle reference.

3.11.2 General

3.11.2.1 MLS is a precision approach and landing guidance system which provides position information and various ground to air data. The position information is provided in a wide coverage sector and is determined by an azimuth angle measurement, an elevation angle measurement and a range (distance) measurement.

Note.— Unless specifically indicated as the MLS airborne equipment, the text in 3.11 above refers to the MLS ground equipment.

3.11.3 MLS configurations

3.11.3.1 *Basic MLS.* The basic configuration of the MLS shall be composed of the following:

a) approach azimuth equipment, associated monitor, remote control and indicator equipment;

b) approach elevation equipment, associated monitor, remote control and indicator equipment;

c) a means for the encoding and transmission of essential data words, associated monitor, remote control and indicator equipment;

Note.— The essential data are those basic and auxiliary data words specified in 3.11.5.4.

d) DME, associated monitor, remote control and indicator equipment.

3.11.3.2 **Recommendation.—** *In order to provide precise ranging information throughout the azimuth coverage sector, the DME should be DME/P, conforming to the Standards of Part I, 3.5. Where for operational reasons precision range is not required, it should be permissible to install DME/N, conforming to the Standards of 3.5 above in place of DME/P.*

Note.— DME is the MLS ranging element and is expected to be installed as soon as possible. However, during the stage of transition from ILS to MLS, marker beacons installed for ILS may be used temporarily but in no case beyond the ILS protection date.

3.11.3.3 *Expanded MLS configurations.* It shall be permissible to derive expanded configurations from the basic MLS, by addition of one or more of the following functions or characteristic improvements:

a) back azimuth equipment, associated monitor, remote control and indicator equipment;

b) flare elevation equipment, associated monitor, remote control and indicator equipment;

c) DME/P, associated monitor, remote control and indicator equipment;

d) a means for the encoding and transmission of additional auxiliary data words, associated monitor, remote control and indicator equipment;

e) a wider proportional guidance sector exceeding the minimum specified in 3.11.5 below.

Note.— The MLS signal format allows further system growth to include additional functions, such as 360 degrees azimuth.

3.11.4 Signal-in-space characteristics — Angle and data functions

3.11.4.1 *Channelling*

3.11.4.1.1 *Channel arrangement.* The MLS angle and data functions shall operate on any one of the 200 channels shown in Table A.

3.11.4.1.2 *Channel pairing with DME.* The channel pairing of the angle and data channel with the channel of the ranging function shall be taken in accordance with the provisions of Table A.

3.11.4.1.3 *Frequency tolerance.* The operating radio frequency of the ground equipment shall not vary more than plus or minus 10 kHz from the assigned frequency. The frequency stability shall be such that there is no more than a plus or minus 50 Hz deviation from the nominal frequency when measured over a one-second interval.

3.11.4.1.4 *Radio frequency signal spectrum.* The transmitted signal shall be such that, during the transmission time, the mean power density above a height of 600 m (2 000 ft) shall not exceed -100.5 dBW/m^2 for angle guidance and -95.5 dBW/m^2 for data, as measured in a 150 kHz bandwidth centred 840 kHz or more from the nominal frequency.

3.11.4.2 *Polarization.* The radio frequency transmissions from all ground equipment shall be nominally vertically polarized. The effect of any horizontally polarized component shall not cause the guidance information to change by more than 40 per cent of the PFE allowed at that location with the airborne antenna rotated 30 degrees from the vertical position or cause the PFE limit to be exceeded.

3.11.4.3 *Time-division-multiplex (TDM) organization*

3.11.4.3.1 Both angle information and data shall be transmitted by TDM on a single radio frequency channel.

3.11.4.3.2 *Synchronization.* The transmissions from the various angle and data ground equipments serving a particular runway shall be time synchronized to assure interference-free operations on the common radio frequency channel of operation.

3.11.4.3.3 *Function rates.* Each function transmitted shall be repeated at the rates shown in the following table:

Function	*Average rate (Hz) measured over any 10-second period*
Approach azimuth guidance	13 ± 0.5
High rate approach azimuth guidance	39 ± 1.5
Back azimuth guidance	6.5 ± 0.25
Approach elevation guidance	39 ± 1.5
Flare elevation guidance	39 ± 1.5
Basic data	see Part I, Appendix A, Table A-7
Auxiliary data	see Part I, Appendix A, Table A-10

3.11.4.3.3.1 **Recommendation.—** *When the proportional guidance sector is not greater than plus or minus 40 degrees and a need for flare elevation or other growth functions at that facility is not anticipated, the high rate approach azimuth function should be used.*

Note.— Application information is contained in Attachment G to Part I, 2.3.3.

3.11.4.3.4 *Function timing.* Timing standards for each angle and data function shall be as specified in Appendix A to Part I, Tables A-1 through A-6 and A-8. The ground equipment internal timing accuracy of each listed event including jitter shall be the specified nominal value plus or minus 2 microseconds. The timing jitter shall be less than 1 microsecond route mean square (RMS).

Note 1.— The timing of each listed event indicates the beginning of the event time slot and the end of the previous event time slot. The characteristics and timing of the actual transmissions are as specified in the applicable paragraphs.

Note 2.— Information on the measurement of the timing accuracy is contained in Attachment G to Part I, 2.2.2.

3.11.4.3.5 *Function sequence.* The time interval between repetitive transmissions of any one function shall be varied in a manner which provides protection from synchronous interference.

Note 1.— Each function transmission is an independent entity which can occur in any position in the TDM sequence (with the exception that back azimuth must be preceded by basic data word No. 2).

Note 2.— Some sequences which have demonstrated protection from synchronous interference are illustrated in Attachment G to Part I, 2.1.4.

3.11.4.4 *Preamble*

3.11.4.4.1 A preamble signal shall be transmitted throughout the applicable coverage sector to identify the particular function to follow. The preamble shall consist of a radio frequency carrier acquisition period, a receiver reference time code, and a function identification code. The timing of the preamble transmissions shall be as specified in Appendix A to Part I, Table A-1.

3.11.4.4.2 *Carrier acquisition.* The preamble transmission shall begin with a period of unmodulated radio frequency carrier as specified in Appendix A to Part I, Table A-1.

3.11.4.4.3 *Modulation and coding*

3.11.4.4.3.1 *Differential phase shift keying (DPSK).* The preamble codes and the basic and auxiliary data signals specified in 3.11.4.8 below shall be transmitted by DPSK of the radio frequency carrier. A "zero" shall be represented by a 0 degrees plus or minus 10 degrees phase shift and a "one" shall be represented by a 180 degrees plus or minus 10 degrees phase shift. The modulation rate shall be 15 625 bauds. The internal timing accuracy of the DPSK transition shall be as specified in 3.11.4.3.4 above. There shall be no amplitude modulation applied during the phase transition. The transition time shall not exceed 10 microseconds, and the phase shall advance or retard monotonically throughout the transition region.

3.11.4.4.3.2 *Receiver reference time.* All preambles shall contain the receiver reference time code, 11101 (bits I_1 to I_5). The time of the last phase transition midpoint in the code shall be the receiver reference time. The receiver reference time code shall be validated by decoding a valid function identification immediately following the receiver reference time code.

3.11.4.4.3.3 *Function identification.* A code for function identification shall follow the receiver reference time code. This code shall consist of the five information bits (I_6 to I_{10}) allowing identification of 31 different functions, plus two parity bits (I_{11} and I_{12}) as shown in the following table:

Function	*Code* I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}
Approach azimuth	0	0	1	1	0	0	1
High rate approach azimuth	0	0	1	0	1	0	0
Approach elevation	1	1	0	0	0	0	1
Flare elevation	0	1	1	0	0	0	1
Back azimuth	1	0	0	1	0	0	1
360° azimuth	0	1	0	0	1	0	1
Basic data 1	0	1	0	1	0	0	0
Basic data 2	0	1	1	1	1	0	0
Basic data 3	1	0	1	0	0	0	0
Basic data 4	1	0	0	0	1	0	0
Basic data 5	1	1	0	1	1	0	0
Basic data 6	0	0	0	1	1	0	1
Auxiliary data A	1	1	1	0	0	1	0
Auxiliary data B	1	0	1	0	1	1	1
Auxiliary data C	1	1	1	1	0	0	0

Note.— The function identification codes have been chosen so that parity bits I_{11} and I_{12} satisfy the equations:

$$I_6 + I_7 + I_8 + I_9 + I_{10} + I_{11} = \text{EVEN}$$

$$I_6 + I_8 + I_{10} + I_{12} = \text{EVEN}$$

3.11.4.5 *Angle guidance parameters.* Angle guidance information shall be encoded by the amount of time separation between the centres of the received TO and FRO scanning beam main lobes. The coding shall be interpreted in the airborne equipment as a linear function of time as follows:

$$\theta = (T_0 - t)\ V/2$$

where:

θ = Azimuth or elevation guidance angle in degrees

t = Time separation in microseconds between TO and FRO beam centres

T_0 = Time separation in microseconds between TO and FRO beam centres corresponding to zero degrees

V = Scan velocity scaling constant in degrees per microsecond.

3.11.4.5.1 The values of the angle guidance parameters shall be as shown in the following table:

Function	*Maximum scan angle (degrees)*	*Value of t for maximum scan angle (µs)*	T_0 *(µs)*	*V (degrees/µs)*
Approach azimuth	−62 to +62	13 000	6 800	0.020
High rate approach azimuth	−42 to +42	9 000	4 800	0.020
Back azimuth	−42 to +42	9 000	4 800	−0.020
Approach elevation	−1.5 to +29.5	3 500	3 350	0.020
Flare elevation	−2 to +10	3 200	2 800	0.010

Note.— Between the end of the TO scan and the beginning of the FRO scan there is a pause time of no radiation of appropriate duration. Additional information is provided in Attachment G to Part I, 2.2.1.

3.11.4.5.2 The tolerances on the ground equipment scanning beam velocity and the time separation between TO and FRO pulses corresponding to zero degrees shall be sufficient to satisfy the accuracy requirements specified in 3.11.4.9 below.

3.11.4.5.3 The TO and FRO scan transmissions shall be symmetrically disposed about the mid-scan point listed in each of Tables A-2 through A-5 of Appendix A to Part I. The mid-scan point and the centre of the time interval between the TO and FRO scan transmissions shall coincide with a tolerance of plus or minus 10 microseconds.

3.11.4.6 *Azimuth guidance functions*

3.11.4.6.1 Each transmission of a guidance angle shall consist of a clockwise TO scan followed by a counter-clockwise FRO scan as viewed from above the antenna. For approach azimuth functions, increasing angle values shall be in the direction of the TO scan. For the back azimuth functions, increasing angle values shall be in the direction of the FRO scan.

Note.— A diagram illustrating the scanning conventions is provided in Attachment G to Part I, 2.3.1.

3.11.4.6.2 *Sector signals.* The transmission format of any azimuth function shall include time slots for airborne antenna selection, out-of-coverage indication, and test pulses as specified in Appendix A to Part I, Tables A-2 and A-3. The internal timing accuracy of the sector signals shall conform to the internal timing accuracy of the DPSK transitions specified in 3.11.4.3.4 above.

3.11.4.6.2.1 *Ground equipment identification.* The MLS providing services for a particular runway shall be identified by a four-character alphabetic designator starting with the letter M. This designator less the first letter shall be transmitted as a digital word as listed in Appendix A to Part I, Table A-7.

3.11.4.6.2.1.1 The signal shall be transmitted on the data channel into the approach and back azimuth coverage regions.

3.11.4.6.2.1.2 The code bit in the time slot previously allocated for the alternate (Morse code) ground equipment identification following the azimuth preamble shall be fixed in the "ZERO" state.

3.11.4.6.2.2 *Airborne antenna selection signal.* A signal for airborne antenna selection shall be transmitted as a "zero" DPSK signal lasting for a six-bit period. The signal shall be available throughout the coverage sector in which approach or back azimuth guidance is provided.

Note.— The signal provides an opportunity for the selection of the most appropriate antenna in a multiple antenna airborne installation.

3.11.4.6.2.3 *Azimuth out-of-coverage indication pulses.* Where out-of-coverage indication pulses are used, they shall be:

1) greater than any guidance signal in the out-of-coverage sector;

2) at least 5 dB less than the fly-left (fly-right) clearance level within the fly-left (fly-right) clearance sector; and

3) at least 5 dB less than the scanning beam level within the proportional coverage region.

The duration of each pulse measured at the half amplitude point shall be at least 100 microseconds, and the rise and fall times shall be less than 10 microseconds.

3.11.4.6.2.3.1 If desired, it shall be permissible to sequentially transmit two pulses in each out-of-coverage indication time slot. Where the pulse pairs are used, the duration of each pulse shall be at least 50 microseconds and the rise and fall times shall be less than 10 microseconds.

3.11.4.6.2.3.2 The transmissions of out-of-coverage indication pulses radiated from antennas with overlapping coverage patterns shall be separated by at least 10 microseconds.

3.11.4.6.2.4 *Ground radiated test signals.*

Note.— Time has been reserved in the azimuth angle guidance signal formats for the future use of a ground radiated test signal.

3.11.4.6.2.5 *Clearance guidance.* Where the proportional guidance sector provided is less than the minimum coverage specified in 3.11.5.2.2.1.1 a) and 3.11.5.2.2.2 a) below, clearance guidance shall be provided to supplement the coverage sector by the transmission of fly-left/fly-right clearance pulses in the formats for the approach azimuth, high rate approach azimuth and back azimuth functions. Alternatively, it shall be permissible to provide clearance guidance by permitting the scanning beam to scan beyond the designated proportional guidance sector to provide fly-left or fly-right clearance information as appropriate when the decoded angle exceeds the designated limits of proportional guidance coverage.

3.11.4.6.2.5.1 Clearance guidance information shall be provided by transmitting pairs of pulses within the angle scan time slots. One pair shall consist of one pulse adjacent to the start time of the scanning beam TO scan and one pulse adjacent to the stop time of the FRO scan. A second pair shall consist of one pulse adjacent to the stop time of the scanning beam TO scan, and one pulse adjacent to the start time of the FRO scan. The fly-right clearance pulses shall represent positive angles and the fly-left clearance pulses shall represent negative angles. The duration of each clearance pulse shall be 50 microseconds with a tolerance of plus or minus 5 microseconds. The transmitter switching time between the clearance pulses and the scanning beam transmissions shall not exceed 10 microseconds. The rise time at the edge of each clearance pulse not adjacent to the scanning beam shall be less than 10 microseconds.

3.11.4.6.2.5.2 The signal-in-space characteristics of the clearance guidance pulses shall be as follows:

a) within the fly-right clearance guidance sector, the fly-right clearance guidance signal shall exceed the scanning beam sidelobes and all other guidance and out-of-coverage indication signals by at least 5 dB;

b) within the fly-left clearance guidance sector, the fly-left clearance guidance signal shall exceed the scanning beam sidelobes and all other guidance and out-of-coverage indication signals by at least 5 dB;

c) within the proportional guidance sector, the clearance guidance signals shall be at least 5 dB below the scanning beam main lobe.

3.11.4.6.2.5.3 The power density of the clearance signal shall be as required in 3.11.4.10.1 below.

Note 1.— Attachment G to Part I, 2.3.4 contains guidance information on the following:

a) clearance and scanning beam timing arrangements;

b) pulse envelopes in the transition regions between clearance and scanning beam signals;

c) clearance (fly-right/fly-left) convention changes.

Note 2.— The proportional coverage limits are transmitted in basic data as specified in 3.11.4.8.2 below.

3.11.4.7 *Elevation guidance functions*

3.11.4.7.1 *Scanning conventions.* For the approach elevation and flare elevation functions, increasing elevation guidance angles shall be in the upward direction. Zero elevation angle shall coincide with a horizontal plane through the respective antenna phase centre. Each guidance angle transmission shall consist of a TO scan followed by a FRO scan. The TO scan shall be in the direction of increasing angle values.

3.11.4.7.2 *Sector signal.* Provision for transmission of one out-of-coverage indication pulse shall be made in the format for the approach elevation function. Where an out-of-coverage indication pulse is used, it shall be: (1) greater than any guidance signal in the out-of-coverage indication sector and (2) at least 5 dB less than the guidance signals within the guidance sector. The elevation out-of-coverage indication timing shall be as shown in Appendix A to Part I, Table A-4. The duration of each pulse measured at the half amplitude points shall be at least 100 microseconds, and the rise and fall times shall be less than 10 microseconds.

3.11.4.7.2.1 If desired, it shall be permissible to sequentially transmit two pulses in each obstacle clearance indication time slot. Where pulse pairs are used, the duration of each pulse shall be at least 50 microseconds, and the rise and fall times shall be less than 10 microseconds.

3.11.4.8 *Data functions.* Provision shall be made in the MLS signal format for the transmission of basic data and auxiliary data.

Note.— Ground equipment data transmission requirements are specified in 3.11.5.4 below.

3.11.4.8.1 *Data transmission.* Data shall be transmitted as specified in 3.11.4.4.3.1 above.

3.11.4.8.2 *Basic data structure and timing.* Basic data shall be encoded as 32-bit words consisting of a function preamble (12 bits) specified in 3.11.4.4 above, and data content as specified in Appendix A to Part I, Table A-7. The timing of the basic data words shall be as specified in Appendix A to Part I, Table A-6. The content, maximum interval between transmission of the same word and organization of the words shall be as specified in Appendix A to Part I, Table A-7. Data containing digital information shall be transmitted with the least significant bit first. The smallest binary number shall represent the lower absolute range limit with increments in binary steps to the upper absolute range limit specified in Appendix A to Part I, Table A-7.

3.11.4.8.2.1 *Basic data contents.* The data items specified in Appendix A, Part I, Table A-7 shall be defined as follows:

a) *Approach azimuth antenna to threshold distance* shall represent the minimum distance between the approach azimuth antenna phase centre to the vertical plane perpendicular to the centre line which contains the runway threshold.

b) *Approach azimuth proportional coverage limit* shall represent the limit of the sector in which proportional approach azimuth guidance is transmitted.

c) *Clearance signal type* shall indicate the method of providing the azimuth clearance signal.

d) *Minimum glide path* shall represent the lowest angle of descent along the zero-degree azimuth as defined in 3.11.1.

e) *Back azimuth status* shall represent the operational status of the back azimuth equipment.

f) *DME status* shall represent the operational status of the DME equipment.

g) *Approach azimuth status* shall represent the operational status of the approach azimuth equipment.

h) *Approach elevation status* shall represent the operational status of the approach elevation equipment.

i) *Beamwidth* shall represent, for a particular function, the antenna beamwidth as defined in 3.11.1.

j) *DME distance* shall represent the minimum distance between the DME antenna phase centre and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

k) *Approach azimuth magnetic orientation* shall represent the angle measured in the horizontal plane clockwise from Magnetic North to the zero-degree approach azimuth guidance radial, originating from the approach azimuth antenna. The vertex of the measured angle shall be the approach azimuth antenna phase centre.

l) *Back azimuth magnetic orientation* shall represent the angle measured in the horizontal plane clockwise from Magnetic North to the zero-degree back azimuth guidance radial, originating from the back azimuth antenna. The vertex of the measured angle shall be the back azimuth antenna phase centre.

m) *Back azimuth proportional coverage limit* shall represent the limit of the sector in which proportional back azimuth guidance is transmitted.

n) *MLS ground equipment identification* shall represent the last three characters of the system identification specified in 3.11.4.6.2.1. The characters shall be encoded in accordance with International Telegraph Alphabet No. 5 using B_1 through B_6.

Note.— Bit B_7 of this code may be reconstructed in the airborne receiver by taking the complement of bit B_6.

3.11.4.8.3 *Auxiliary data organization and timing.* Auxiliary data shall be organized into 76-bit words consisting of the function preamble (12 bits) as specified in 3.11.4.4, the address (8 bits) as specified in Appendix A to Part I, Table A-9, and data content and parity (56 bits) as specified in Appendix A to Part I, Table A-10. Three function identification codes are reserved to indicate transmission of auxiliary data A, auxiliary data B and auxiliary data C. The timing of the auxiliary data function shall be as specified in Appendix A to Part I, Table A-8. Two auxiliary data word formats shall be provided, one for digital data and one for alphanumeric character data. Data containing digital information shall be transmitted with the least significant bit first. Alphanumeric data characters shall be encoded in accordance with International Alphabet No. 5 (IA-5) in Part I, 4.12.1.2 using seven information bits, plus one even parity bit added to each character. Alphanumeric data shall be transmitted in the order in which they are to be read. The serial transmission of a character shall be with the lower order bit transmitted first and the parity bit transmitted last.

Note.— Auxiliary data A contents are specified in 3.11.4.8.3.1 below. Auxiliary data B contents are reserved for future use, and auxiliary data C contents are reserved for national use.

3.11.4.8.3.1 *Auxiliary data A content.* The data items specified in Appendix A, Part I, Table A-10 shall be defined as follows:

a) *Approach azimuth antenna offset* shall represent the minimum distance between the approach azimuth antenna phase centre and a vertical plane containing the runway centre line.

b) *Approach azimuth antenna to MLS datum point distance* shall represent the minimum distance between the approach azimuth antenna phase centre and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

c) *Approach azimuth alignment with runway centre line* shall represent the minimum angle between the zero-degree approach azimuth guidance radial and the runway centre line.

d) *Approach azimuth antenna co-ordinate system* shall represent the co-ordinate system (planar or conical) of the angle data transmitted by the approach azimuth antenna.

e) *Approach elevation antenna offset* shall represent the minimum distance between the elevation antenna phase centre and a vertical plane containing the runway centre line.

f) *MLS datum point to threshold distance* shall represent the distance measured along the runway centre line from the MLS datum point to the runway threshold.

g) *Approach elevation antenna height* shall represent the height of the elevation antenna phase centre relative to the height of the MLS datum point.

h) *DME offset* shall represent the minimum distance between the DME antenna phase centre and a vertical plane containing the runway centre line.

i) *DME to MLS datum point distance* shall represent the minimum distance between the DME antenna phase centre and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

j) *Back azimuth antenna offset* shall represent the minimum distance between the back azimuth antenna phase centre and a vertical plane containing the runway centre line.

k) *Back azimuth to MLS datum point distance* shall represent the minimum distance between the back azimuth antenna and the vertical plane perpendicular to the runway centre line which contains the MLS datum point.

l) *Back azimuth alignment with runway centre line* shall represent the minimum angle between the zero-degree back azimuth guidance radial and the runway centre line.

Note.— The remaining auxiliary data A contents are to be defined.

3.11.4.9 *System accuracy.* The accuracy standards specified herein shall be met on a 95 per cent probability basis unless otherwise stated.

Note 1.— The over-all error limits include errors from all causes such as those from airborne equipment, ground equipment, and propagation effects.

Note 2.— It is intended that the error limits are to be applied over a flight path interval that includes the approach reference datum or back azimuth reference datum. Information on the interpretation of MLS errors and the measurement of these errors over an interval appropriate for flight inspection is provided in Attachment G to Part I, 2.5.2.

Note 3.— To determine the allowable errors for degradation allowances at points other than the appropriate reference datum, the accuracy specified at the reference datum should first be converted from its linear value into its equivalent angular value with an origin at the antenna.

3.11.4.9.1 *MLS approach reference datum.* The height of the MLS approach reference datum shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) shall be permitted.

Note 1.— The operational objective of defining the height of the MLS approach reference datum is to ensure safe guidance over obstructions and also safe and efficient use of the runway served. The heights noted in 3.11.4.9.1 assume Code 3 or Code 4 runways as defined by Annex 14.

Note 2.— At the same time, the reference datum is to provide a convenient point at which the accuracy and other parameters of the function may be specified.

3.11.4.9.2 *MLS back azimuth reference datum.* The height of the MLS back azimuth reference datum shall be 15 m (50 ft). A tolerance of plus 3 m (10 ft) shall be permitted.

Note.— The objective of defining the MLS back azimuth reference datum is to provide a convenient point at which the accuracy and other parameters of the function may be specified.

3.11.4.9.3 The PFE shall be comprised of those frequency components of the guidance signal error at the output of the airborne receiver which lie below 0.5 rad/s for azimuth guidance information or below 1.5 rad/s for elevation guidance information. The control motion noise shall be comprised of those frequency components of the guidance signal error at the output of the airborne receiver which lie above 0.3 rad/s for azimuth guidance or above 0.5 rad/s for elevation guidance information. The output filter corner frequency of the receiver used for this measurement is 10 rad/s.

3.11.4.9.4 *Approach azimuth guidance functions.* At the approach reference datum, the approach azimuth function shall provide performance as follows:

a) the PFE shall not be greater than plus or minus 6 m (20 ft);

b) the PFN shall not be greater than plus or minus 3.5 m (11.5 ft);

c) the CMN shall not be greater than plus or minus 3.2 m (10.5 ft) or 0.1 degree, whichever is less.

3.11.4.9.4.1 **Recommendation.—** *At the approach reference datum, the PFE should not be greater than plus or minus 4 m (13.5 ft).*

3.11.4.9.4.2 The linear accuracy specified at the reference datum shall be maintained throughout the runway coverage region specified in 3.11.5.2.2.1.2 below except where degradation is allowed as specified in 3.11.4.9.4.3 below.

3.11.4.9.4.3 *Degradation allowance.* The approach azimuth angular PFE, PFN and CMN shall be allowed to degrade linearly to the limits of coverage as follows:

a) *With distance.* The PFE limit and PFN limit, expressed in angular terms at 37 km (20 NM) from the runway threshold along the extended runway centre line, are 2 times the value specified at the approach reference datum. The CMN limit, expressed in angular terms at 18.5 km (10 NM) from the reference datum along the extended runway centre line is 1.3 times the value specified at the approach reference datum.

b) *With azimuth angle.* The PFE limit and PFN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle, are 1.5 times the value on the extended runway centre line at the same distance from the approach reference datum. The CMN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle is 1.3 times the value on the extended runway centre line at the same distance from the approach reference datum.

c) *With elevation angle.* The PFE limit and PFN limit shall not degrade up to an elevation angle of 9 degrees. The PFE limit and PFN limit, expressed in angular terms at an elevation angle of 15 degrees from the approach azimuth antenna phase centre, are 2 times the value permitted below 9 degrees at the same distance from the approach reference datum and the same azimuth angle. The CMN limit shall not degrade with elevation angle.

3.11.4.9.5 *Back azimuth guidance function.* At the back azimuth reference datum, the back azimuth function shall provide performance as follows:

a) the PFE shall not be greater than plus or minus 6 m (20 ft);

b) the PFN component shall not be greater than plus or minus 3.5 m (11.5 ft);

c) the CMN shall not be greater than plus or minus 3.2 m (10.5 ft) or 0.1 degree, whichever is less.

3.11.4.9.5.1 *Degradation allowance.* The back azimuth angular PFE, PFN and CMN shall be allowed to degrade linearly to the limits of coverage as follows:

a) *With distance.* The PFE limit and PFN limit, expressed in angular terms at the limit of coverage along the extended runway centre line, are 2 times the value specified at the back azimuth reference datum. The CMN limit, expressed in angular terms at 9.27 km (5 NM) from the runway stop end along the extended runway centre line is 1.3 times the value specified at the back azimuth reference datum.

b) *With azimuth angle.* The PFE limit and PFN limit, expressed in angular terms at plus or minus 20 degrees azimuth angle, are 1.5 times the value on the extended runway centre line at the same distance from the back azimuth reference datum. The CMN limit, expressed in angular terms at plus or minus 20 degrees azimuth angle is 1.3 times the value on the extended runway centre line at the same distance from the back azimuth reference datum.

c) *With elevation angle.* The PFE limit and PFN limit shall not degrade up to an elevation angle of 9 degrees. The PFE limit and PFN limit, expressed in angular terms at an elevation angle of 15 degrees from the back azimuth antenna phase centre, are 2 times the value permitted below 9 degrees at the same distance from the back azimuth reference datum and the same azimuth angle. The CMN limit shall not degrade with elevation angle.

3.11.4.9.6 *Elevation guidance function.* For equipment sited to provide a minimum glide path of nominally 3 degrees or lower, the approach elevation function shall provide performance at the approach reference datum as follows:

a) the PFE shall not be greater than plus or minus 0.6 m (2 ft);

b) the PFN shall not be greater than plus or minus 0.4 m (1.3 ft);

c) the CMN shall not be greater than plus or minus 0.3 m (1 ft).

3.11.4.9.6.1 *Degradation allowance.* The approach elevation angular PFE, PFN and CMN shall be allowed to degrade linearly to the limits of coverage as follows:

a) *With distance.* The PFE limit and PFN limit, expressed in angular terms at 37 km (20 NM) from the runway threshold on the minimum glide path, are 0.2 degree. The CMN limit, expressed in angular terms at 18.5 km (10 NM) from the reference datum on the minimum glide path is 1.3 times the value specified at the approach reference datum.

b) *With azimuth angle.* The PFE limit and PFN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle, are 1.3 times the value on the extended runway centre line at the same distance from the approach reference datum. The CMN limit, expressed in angular terms at plus or minus 40 degrees azimuth angle is 1.3 times the value on the extended runway centre line at the same distance from the approach reference datum.

c) *With elevation angle.* For elevation angles above the minimum glide path or 3 degrees, whichever is less and up to the maximum of the proportional guidance coverage and at the locus of points directly above the approach reference datum the PFE limit, PFN limit and the CMN limit expressed in angular terms shall be allowed to degrade linearly such that at an elevation angle of 15 degrees the limits are 2 times the value specified at the reference datum. In no case shall the CMN directly above the reference datum exceed plus or minus 0.07 degree. For other regions of coverage within the angular sector from an elevation angle equivalent to the minimum glide path up to the maximum angle of proportional coverage the degradations with distance and azimuth angle specified in a) and b) shall apply.

d) For elevation angles below 60 per cent of the minimum glide path and down to the limit of coverage specified in 3.11.5.3.2.1 c) 2) below, and at the locus of points directly below the approach reference datum the PFE limit, the PFN limit and the CMN limit expressed in angular terms, shall be allowed to increase linearly to 6 times the value at the approach reference datum. For other regions of coverage within the angular sector from an elevation angle equivalent to 60 per cent of the minimum glide path angle value, and down to the limit of coverage the degradation with distance and azimuth angle specified in a) and b) shall apply. In no case shall the PFE be allowed to exceed 0.8 degree, or the CMN be allowed to exceed 0.4 degree.

3.11.4.9.6.2 **Recommendation.**— *The limit expressed in angular terms on the linear degradation of the PFE limit, the PFN limit and the CMN limit at angles below 60 per cent of the minimum glide path and down to the limit of coverage should be 3 times the value permitted at the approach reference datum. For other regions of coverage within the angular sector from an elevation angle equivalent to the minimum glide path and down to the limit of coverage, the degradation with distance and azimuth angle specified in 3.11.4.9.6.1 a) and b) above shall apply. The PFE should not exceed 0.35 degree, and the CMN should not exceed 0.2 degree.*

3.11.4.9.6.3 Approach elevation equipment sited to provide a minimum glide path higher than 3 degrees shall provide angular accuracies not less than those specified for equipment sited for a 3-degree minimum glide path within the coverage volume.

3.11.4.9.7 *Flare elevation guidance function.* At the approach reference datum the flare elevation function shall provide performance as follows:

a) the PFE shall not be greater than plus or minus 0.6 m (2 ft);

b) the PFN shall not be greater than plus or minus 0.4 m (1.3 ft);

c) the CMN shall not be greater than plus or minus 0.3 m (1 ft). In no case shall the CMN exceed plus or minus 0.07 degree.

Note.— Degradation allowances for flare elevation have not yet been defined.

3.11.4.10 *Power density*

3.11.4.10.1 The power density for DPSK, clearance and angle guidance signals shall be at least the values shown in the following table under all operational weather conditions at any point within coverage except as specified in 3.11.4.10.2 below.

Function	DPSK signals (dBW/m^2)	Angle signals (dBW/m^2) 1°	2°	3° (antenna beamwidth)	Clearance signals (dBW/m^2)
Approach azimuth guidance	− 89.5	− 88.0	− 85.5	− 82.0	− 88.0
High rate approach azimuth guidance	− 89.5	− 88.0	− 88.0	− 86.8	− 88.0
Back azimuth guidance	− 81.0	− 79.5	− 77.0	− 73.5	− 79.5
Approach elevation guidance	− 89.5	− 88.0	− 88.0	N/A	N/A

N/A = not applicable

Note 1.— Information relating to interpolation of power density requirements for other antenna beamwidths is provided in Attachment G to Part I, 2.6.2.5.

Note 2.— The table above specifies the minimum power densities for clearance signals and scanning beam signals. The relative values of the two signals are specified in 3.11.4.6.2.5.2. above.

3.11.4.10.2 The power density of the approach azimuth angle guidance signals shall be greater than that specified in 3.11.4.10.1 above by at least:

a) 15 dB at the approach reference datum;

b) 5 dB for one degree or 9 dB for 2 degree or larger beamwidth antennas at 2.5 m (8 ft) above the runway surface, at the MLS datum point, or at the farthest point of the runway centre line which is in line of sight of the azimuth antenna.

Note 1.— Near the runway surface the approach azimuth equipment will normally provide power densities higher than those specified for angle signals in 3.11.4.10.1 above to support auto-land operations. Attachment G to Part I provides guidance as regards antenna beamwidth and power budget considerations.

Note 2.— The specifications for coverage in 3.11.5.2.2 and 3.11.5.3.2 below make provision for difficult ground equipment siting conditions in which it may not be feasible to provide the power density specified in 3.11.4.10.2 above.

3.11.5 Ground equipment characteristics

3.11.5.1 *Synchronization and monitoring.* The synchronization of the time-division-multiplexed angle guidance and data transmissions which are listed in 3.11.4.3.3 above shall be monitored.

Note.— Specific monitoring requirements for various MLS functions are specified in 3.11.5.2.3 and 3.11.5.3.3 below.

3.11.5.1.1 *Residual radiation of MLS functions.* The residual radiation of an MLS function at times when another function is radiating shall be at least 70 dB below the level provided when transmitting.

Note.— The acceptable level of residual radiation for a particular function is that level which has no adverse effect on the reception of any other function and is dependent upon equipment siting and aircraft position.

3.11.5.2 *Azimuth guidance equipment*

3.11.5.2.1 *Scanning beam characteristics.* Azimuth ground equipment antennas shall produce a fan-shaped beam which is narrow in the horizontal plane, broad in the vertical plane and which is scanned horizontally between the limits of the proportional guidance sector.

3.11.5.2.1.1 *Co-ordinate system.* Azimuth guidance information shall be radiated in either conical or planar co-ordinates.

3.11.5.2.1.2 *Antenna beamwidth.* The antenna beamwidth shall not exceed 4 degrees.

Note.— It is intended that the detected scanning beam envelope, throughout the coverage should not exceed 250 microseconds (equivalent to a beamwidth of 5 degrees) in order to ensure proper angle decoding by the airborne equipment.

3.11.5.2.1.3 *Scanning beam shape.* The minus 10-dB points on the beam envelope shall be displaced from the beam centre by at least 0.7 beamwidth, but not more than 0.9 beamwidth.

Note.— The beam shape described applies on boresight in a multipath free environment using a suitable filter. Information on beam shape and side-lobes is provided in Attachment G to Part I, 3.1 and 3.2.

3.11.5.2.2 *Coverage*

Note.— Diagrams illustrating the coverage requirements specified herein are contained in Attachment G to Part I, Figures G-5 and G-6.

3.11.5.2.2.1 *Approach azimuth.* The approach azimuth ground equipment shall provide guidance information in at least the following volumes of space:

3.11.5.2.2.1.1 *Approach region.*

a) Horizontally within a sector plus or minus 40 degrees about the runway centre line originating at the MLS datum point and extending in the direction of the approach to 37 km (20 NM) from the runway threshold.

b) Vertically between:

1) a conical surface originating 2.5 m (8 ft) above the runway centre line at threshold inclined at 0.9 degree above the horizontal; and

2) a conical surface originating at the azimuth ground equipment antenna inclined at 15 degrees above the horizontal to a height of 6 000 m (20 000 ft).

Note 1.— Where intervening obstacles penetrate the 0.9 degree surface, it is intended that guidance need not be provided at less than line-of-sight heights.

Note 2.— Where it is determined that misleading guidance information exists outside the promulgated coverage sector and appropriate operational procedures cannot provide an acceptable solution, techniques to minimize the effects are available. These techniques include adjustment of the proportional coverage or use of out-of-coverage indication signals. Guidance material on the use of these techniques is contained in Attachment G to Part I, 8.

3.11.5.2.2.1.2 *Runway region.*

a) Horizontally within a sector 45 m (150 ft) each side of the runway centre line beginning at the stop end and extending parallel with the runway centre line in the direction of the approach to join the approach region.

b) Vertically between:

1) a horizontal surface which is 2.5 m (8 ft) above the farthest point of the runway centre line which is in line of sight of the azimuth antenna; and

2) a conical surface originating at the azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height of 600 m (2 000 ft).

Note 1.— Information on the determination of the point referred to in b) 1) above is given in Attachment G to Part I, 2.3.6.

Note 2.— When physical characteristics of the runway prevent the achievement of the Standard above, it is intended that guidance need not be provided at less than line-of-sight heights.

3.11.5.2.2.1.3 **Recommendation.—** *The lower level of the coverage in the runway region should be 2.5 m (8 ft) above the runway centre line.*

3.11.5.2.2.1.4 Where required to support automatic landing, roll-out or take-off, the lower level of coverage in the runway region shall not exceed 2.5 m (8 ft) above the runway centre line.

3.11.5.2.2.1.5 **Recommendation.—** *The approach azimuth ground equipment should provide guidance vertically to 30 degrees above the horizontal.*

3.11.5.2.2.1.6 The minimum proportional guidance sector shall be plus or minus 10 degrees about the runway centre line. Where the proportional guidance sector provided is less than the minimum lateral coverage specified in 3.11.5.2.2.1.1 a) above, clearance guidance shall be provided to maintain the over-all coverage sector specified in 3.11.5.2.2.1.1 above.

3.11.5.2.2.2 *Back azimuth.* The back azimuth ground equipment shall provide information in at least the following volume of space:

a) horizontally within a sector plus or minus 20 degrees about the runway centre line originating at the back azimuth ground equipment antenna and extending in the direction of the missed approach at least 9.3 km (5 NM) from the runway stop end;

b) vertically in the runway region between:

1) a horizontal surface 2.5 m (8 ft) above the farthest point of runway centre line which is in line of sight of the back azimuth antenna; and

2) a conical surface originating at the back azimuth ground equipment antenna inclined at 20 degrees above the horizontal up to a height of 600 m (2 000 ft);

c) vertically in the back azimuth region between:

1) a conical surface originating 2.5 m (8 ft) above the runway stop end, inclined at 0.9 degree above the horizontal; and

2) a conical surface originating at the back azimuth ground equipment antenna, inclined at 15 degrees above the horizontal up to a height of 1 500 m (5 000 ft).

Note 1.— Information on the determination of the point referred to in b) 1) above is given in Attachment G to Part I, 2.3.6.

Note 2.— When physical characteristics of the runway or obstacles prevent the achievement of the Standard in b) and c) above, it is intended that guidance need not be provided at less than line-of-sight heights.

3.11.5.2.2.3 **Recommendation.—** *The back azimuth facility should provide guidance information to 30 degrees above the horizontal.*

3.11.5.2.2.4 The minimum proportional guidance sector shall be plus or minus 10 degrees about the runway centre line. Where the proportional guidance sector provided is less than the lateral coverage specified in 3.11.5.2.2.2 a) above, clearance guidance shall be provided to maintain the over-all coverage sectors specified in 3.11.5.2.2.2 above.

Note.— Application information is provided in Attachment G to Part I, 2.3.4.

3.11.5.2.3 *Monitor and control*

3.11.5.2.3.1 The approach azimuth and back azimuth monitor systems shall cause the radiation of their respective functions to cease and a warning shall be provided at the designated control points if any of the following conditions persist for longer than the periods specified:

a) there is a change in the ground equipment contribution to the mean course error such that the PFE at the approach reference datum or in the direction of any azimuth radial, exceeds the limits specified in 3.11.4.9.4 and 3.11.4.9.5 above for a period of more than one second;

b) there is a reduction in the radiated power to less than that necessary to satisfy the requirements specified in 3.11.4.10.1 and 3.11.4.6.2.5.2 above for a period of more than one second;

c) there is an error in the preamble DPSK transmissions which occurs more than once in any one-second period;

d) there is an error in the TDM synchronization of a particular azimuth function such that the requirement specified in 3.11.4.3.2 above is not satisfied, and this condition persists for more than one second.

Note.— Guidance material is provided in Attachment G to Part I, paragraph 6.

3.11.5.2.3.2 Design and operation of the monitor system shall cause radiation to cease and a warning shall be provided at the designated control points in the event of failure of the monitor system itself.

3.11.5.2.3.3 The period during which erroneous guidance information is radiated, including period(s) of zero radiation, shall not exceed the periods specified in 3.11.5.2.3.1 above. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment shall be completed within this time. If the fault is not cleared within the time allowed, the radiation shall cease. After shutdown, no attempt shall be made to restore service until a period of 20 seconds has elapsed.

3.11.5.2.4 *Ground equipment accuracy.* The ground equipment contribution to the mean course error shall not exceed an error equivalent to plus or minus 3 m (10 ft) at the MLS approach reference datum.

3.11.5.2.5 **Recommendation.—** *The ground equipment contribution to the CMN at the reference datum should not exceed 1 m (3.3 ft) or 0.03 degree, whichever is less, on a 95 per cent probability basis.*

Note 1.— This is the equipment error, and does not include any propagation effects.

Note 2.— Guidance on the measurement of this parameter can be found in Attachment G to Part I, 2.5.2.

3.11.5.2.6 *Siting*

Note 1.— It is not intended to restrict the installation of MLS when it is not possible to site the azimuth ground equipment on the extension of the runway centre line.

Note 2.— Guidance material on critical and sensitive areas for azimuth antennas is provided in Attachment G to Part I, 4.2.

3.11.5.2.6.1 Normally, the approach azimuth ground equipment antenna shall be located on the extension of the runway centre line beyond the stop end and shall be adjusted so that the vertical plane containing the zero degree course line will contain the MLS approach reference datum. Siting of the antenna shall be consistent with safe obstacle clearance Standards and Recommended Practices in Annex 14.

3.11.5.2.6.2 The back azimuth ground equipment antenna shall normally be located on the extension of the runway centre line at the threshold end, and the antenna shall be adjusted so that the vertical plane containing the zero degree course line will contain the back azimuth reference datum.

3.11.5.3 *Elevation guidance equipment*

3.11.5.3.1 *Scanning beam characteristics.* Elevation ground equipment antennas shall produce a fan-shaped beam which is narrow in the vertical plane, broad in the horizontal plane and which is scanned vertically between the limits of the proportional guidance sector.

3.11.5.3.1.1 *Co-ordinate system.* Approach elevation and flare guidance information shall be radiated in conical co-ordinates.

3.11.5.3.1.2 *Antenna beamwidth.* The antenna beamwidth shall not exceed 2.5 degrees.

3.11.5.3.1.3 *Scanning beam shape.* The minus 10-dB points on the beam envelope shall be displayed from the centre line by at least 0.7 beamwidth but not more than 0.9 beamwidth.

Note.— The beam shape described applies on bòresight in a multipath free environment using a suitable filter. Information on beam shape and side-lobes is provided in Attachment G to Part I, 3.1 and 3.2.

3.11.5.3.2 *Coverage*

Note.— Diagrams illustrating the coverage requirements specified herein are contained in Attachment G to Part I, Figures G-8 and G-9.

3.11.5.3.2.1 *Approach elevation.* The approach elevation ground equipment shall provide proportional guidance information in at least the following volume of space:

a) laterally within a sector originating at the MLS datum point which is at least equal to the proportional guidance sector provided by the approach azimuth ground equipment;

b) longitudinally from 75 m (250 ft) from the MLS datum point in the direction of the approach to 37 km (20 NM) from threshold;

c) vertically within the sector bounded by:

   1) a surface which is the locus of points 2.5 m (8 ft) above the runway;

   2) a conical surface originating at the MLS datum point and inclined 0.9 degree above the horizontal; and

   3) a conical surface originating at the MLS datum point and inclined 7.5 degrees above the horizontal up to a height of 6 000 m (20 000 ft).

Note.— When the physical characteristics of the approach region prevent the achievement of the Standards under a), b) and c) 2) above, it is intended that guidance need not be provided below a conical surface originating at the elevation antenna and inclined 0.9 degree above the line of sight.

3.11.5.3.2.2 **Recommendation.—** *The approach elevation ground equipment should provide proportional guidance to angles greater than 7.5 degrees above the horizontal when necessary to meet operating requirements.*

3.11.5.3.2.3 *Flare elevation.* The flare elevation ground equipment shall provide proportional guidance information in at least the following volume of space:

a) horizontally over the runway surface and within a sector of plus or minus 10 degrees about the runway centre line originating at a point on the runway 760 m (2 500 ft) from threshold and extending to 9.3 km (5 NM) from threshold in the direction of the approach;

b) vertically within the sector bounded by:

1) surfaces which are the locus of points 2.5 m (8 ft) and 45 m (150 ft) above the runway;

2) a conical surface originating 2.5 m (8 ft) above the runway centre line at the threshold inclined 0.9 degree above the horizontal; and

3) a conical surface originating 760 m (2 500 ft) from threshold in the direction of the stop end and inclined 7.5 degrees above the horizontal up to 1 300 m (4 300 ft).

Note.— Information related to the horizontal radiation pattern of the approach elevation and flare antennas is provided in Attachment G to Part I, 3.3.

3.11.5.3.3 *Monitor and control*

3.11.5.3.3.1 The approach elevation and flare elevation monitor systems shall cause the radiation of their respective functions to cease and a warning shall be provided at the designated control point if any of the following conditions persist for longer than the periods specified:

a) there is a change in the ground equipment contribution to the mean glide path error component such that the PFE at the approach reference datum or on any glide path consistent with published approach procedures exceeds the limits specified in 3.11.4.9.6 and 3.11.4.9.7 above for a period of more than one second;

b) there is a reduction in the radiated power to less than that necessary to satisfy the requirements specified in 3.11.4.10.1 above for a period of more than one second;

c) there is an error in the preamble DPSK transmissions which occurs more than once in any one-second period;

d) there is an error in the TDM synchronization of a particular elevation function such that the requirement specified in 3.11.4.3.2 above is not satisfied and this condition persists for more than one second.

Note.— Guidance material is contained in Attachment G to Part I, 6.

3.11.5.3.3.2 Design and operation of the monitor system shall cause radiation to cease and a warning shall be provided at the designated control points in the event of failure of the monitor system itself.

3.11.5.3.3.3 The period during which erroneous guidance information is radiated, including period(s) of zero radiation, shall not exceed the periods specified in 3.11.5.3.3.1 above. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment shall be completed within this time. If the fault is not cleared within the time allowed, radiation shall cease. After shutdown, no attempt shall be made to restore service until a period of 20 seconds has elapsed.

3.11.5.3.4 *Ground equipment accuracy.* The ground equipment contribution to the mean glide path error component of the PFE shall not exceed an error equivalent to plus or minus 0.3 m (1 ft) at the approach reference datum.

3.11.5.3.4.1 **Recommendation.—** *The ground equipment contribution to the CMN at the reference datum should not exceed 0.15 m (0.5 ft) on a 95 per cent probability basis.*

Note 1.— This is the equipment error, and does not include any propagation effects.

Note 2.— Guidance on the measurement of this parameter can be found in Attachment G to Part I, 2.5.2.

3.11.5.3.5 *Siting*

Note.— Guidance material on critical areas for elevation antennas is provided in Attachment G to Part I, 4.2.

3.11.5.3.5.1 The approach elevation and flare ground equipment antennas shall be located beside the runway. Siting of the antennas shall be consistent with obstacle clearance Standards and Recommended Practices in Annex 14.

3.11.5.3.5.2 The approach elevation ground equipment antenna shall be sited so that the asymptote of the minimum glide path crosses the threshold at the MLS approach reference datum.

3.11.5.3.5.2.1 **Recommendation.—** *The minimum glide path angle is normally 3 degrees and should not exceed 3 degrees except where alternative means of satisfying obstacle clearance requirements are impractical.*

Note.— It is intended that the choice of a minimum glide path angle higher than 3 degrees be determined by operational rather than technical factors.

3.11.5.3.5.3 **Recommendation.—** *When ILS and MLS simultaneously serve the same runway, the ILS reference datum and the MLS approach reference datum should coincide within a tolerance of 1 m (3 ft).*

Note 1.— It is intended that this recommendation would apply only if the ILS reference datum satisfies the height specifications in 3.1.5.1.4 and 3.1.5.1.5 above.

Note 2.— Information related to collocated MLS/ILS siting is provided in Attachment G to Part I, 4.1.

3.11.5.3.5.4 **Recommendation.—** *The flare ground equipment antenna should be located about 1 000 m (3 300 ft) from threshold in the direction of the stop end of the runway.*

3.11.5.4 *Data*

Note.— Guidance material relating to data applications is provided in Attachment G to Part I, 2.7.

3.11.5.4.1 *Basic data.* The basic data words 1, 2, 3, 4 and 6 shall be transmitted throughout the approach azimuth coverage sector.

Note.— The composition of the basic data words is given in Appendix A to Part I, Table A-7.

3.11.5.4.1.1 Where the back azimuth function is provided, basic data words 4, 5 and 6 shall be transmitted throughout the approach azimuth and back azimuth coverage sectors.

3.11.5.4.2 *Auxiliary data.* Auxiliary data words A1, A2 and A3 shall be transmitted throughout the approach azimuth coverage sector.

3.11.5.4.2.1 Where the back azimuth function is provided, auxiliary data words A3 and A4 shall be transmitted throughout the approach azimuth and back azimuth coverage sectors.

Note.— The composition of the auxiliary data words is given in Appendix A to Part I, Table A-10.

3.11.5.4.3 *Monitor and control.* The monitor system shall provide a warning to the designated control point if the radiated power is less than that necessary to satisfy the DPSK requirement specified in 3.11.4.10.1 above. If a detected error in a data word persists, radiation of that word shall cease.

3.11.5.5 *Distance measuring equipment*

3.11.5.5.1 DME information shall be provided at least throughout the coverage volume in which approach and back azimuth guidance is available.

Note.— Siting of DME ground equipment is dependent on runway length, runway profile and local terrain. Guidance on siting of DME ground equipment is given in Attachment G to Part I, 5.

3.11.6 Airborne equipment characteristics

3.11.6.1 *Angle and data functions*

3.11.6.1.1 *Accuracy*

3.11.6.1.1.1 Where the DPSK and scanning beam signal power densities are the minimum specified in 3.11.4.10.1 above, the airborne equipment shall be able to acquire the signal and any decoded angle signal shall have a CMN not exceeding 0.2 degree.

Note 1.— It is intended that basic and auxiliary data words which contain information essential for the desired operation be decoded within a time period and with an integrity which is suitable for the intended application.

Note 2.— Information related to the acquisition and validation of angle guidance and data functions is given in Attachment G to Part I, 7.3.

3.11.6.1.1.2 Where the radiated signal power density is high enough to cause the airborne receiver noise contribution to be insignificant, the airborne equipment shall not degrade the accuracy of any decoded angle guidance signal by greater than plus or minus 0.017 degree (PFE), and plus or minus 0.015 degree (azimuth), and plus or minus 0.01 degree (elevation) CMN.

3.11.6.1.1.3 In order to obtain accurate guidance to 2.5 m (8 ft) above the runway surface, the airborne equipment shall produce less than 0.04 degree CMN with the power densities indicated in 3.11.4.10.2 b) above.

3.11.6.1.2 *Dynamic range*

3.11.6.1.2.1 The airborne equipment shall be able to acquire the signal and the performance in 3.11.6.1.1.2 above shall be met where the power density of any of the radiated signals has any value between the minimum specified in 3.11.4.10.1 above up to a maximum of minus 14.5 dBW/m².

3.11.6.1.2.2 The receiver performance shall not degrade beyond the specified limits when the maximum differential levels permitted in 3.11.6.1.2.1 above exist between signal power densities of individual functions.

3.11.6.1.3 *Receiver angle data output filter characteristics*

3.11.6.1.3.1 For sinusoidal input frequencies, receiver output filters shall not induce amplitude variations or phase lags in the angle data which exceed those obtained with a single pole low-pass filter with a corner frequency of 10 rad/s by more than 20 per cent.

Note.— Receiver outputs intended only to operate visual displays may benefit from appropriate additional filtering. Additional information on output data filtering is given in Attachment G to Part I, 7.4.2.

3.11.6.1.4 *Adjacent channel spurious response.* The receiver performance specified in 3.11.6 above shall be met when a desired signal is being tracked in the presence of an adjacent channel signal that is 25 dB stronger.

3.11.6.2 *Distance measuring function*

Note.— Text for this section is under study.

Table A. DME/MLS angle, DME/VOR and DME/ILS/MLS channelling and pairing

Channel-pairing				DME parameters					
				Interrogation				Reply	
					Pulse codes				
						DME/P mode			
DME no.	VHF frequency MHz	MLS angle frequency MHz	MLS channel no.	Frequency MHz	DME/N µs	Initial approach µs	Final approach µs	Frequency MHz	Pulse codes µs
* 1X	-	-	-	1 025	12	-	-	962	12
** 1Y	-	-	-	1 025	36	-	-	1 088	30
* 2X	-	-	-	1 026	12	-	-	963	12
** 2Y	-	-	-	1 026	36	-	-	1 089	30
* 3X	-	-	-	1 027	12	-	-	964	12
** 3Y	-	-	-	1 027	36	-	-	1 090	30
* 4X	-	-	-	1 028	12	-	-	965	12
** 4Y	-	-	-	1 028	36	-	-	1 091	30
* 5X	-	-	-	1 029	12	-	-	966	12
** 5Y	-	-	-	1 029	36	-	-	1 092	30
* 6X	-	-	-	1 030	12	-	-	967	12
** 6Y	-	-	-	1 030	36	-	-	1 093	30
* 7X	-	-	-	1 031	12	-	-	968	12
** 7Y	-	-	-	1 031	36	-	-	1 094	30
* 8X	-	-	-	1 032	12	-	-	969	12
** 8Y	-	-	-	1 032	36	-	-	1 095	30
* 9X	-	-	-	1 033	12	-	-	970	12
** 9Y	-	-	-	1 033	36	-	-	1 096	30
* 10X	-	-	-	1 034	12	-	-	971	12
** 10Y	-	-	-	1 034	36	-	-	1 097	30
* 11X	-	-	-	1 035	12	-	-	972	12
** 11Y	-	-	-	1 035	36	-	-	1 098	30
* 12X	-	-	-	1 036	12	-	-	973	12
** 12Y	-	-	-	1 036	36	-	-	1 099	30
* 13X	-	-	-	1 037	12	-	-	974	12
** 13Y	-	-	-	1 037	36	-	-	1 100	30
* 14X	-	-	-	1 038	12	-	-	975	12
** 14Y	-	-	-	1 038	36	-	-	1 101	30
* 15X	-	-	-	1 039	12	-	-	976	12
** 15Y	-	-	-	1 039	36	-	-	1 102	30
* 16X	-	-	-	1 040	12	-	-	977	12
** 16Y	-	-	-	1 040	36	-	-	1 103	30
∇ 17X	108.00	-	-	1 041	12	-	-	978	12
17Y	108.05	5 043.0	540	1 041	36	36	42	1 104	30
17Z	-	5 043.3	541	1 041	-	21	27	1 104	15
18X	108.10	5 031.0	500	1 042	12	12	18	979	12
18W	-	5 031.3	501	1 042	-	24	30	979	24
18Y	108.15	5 043.6	542	1 042	36	36	42	1 105	30
18Z	-	5 043.9	543	1 042	-	21	27	1 105	15

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Channel pairing				DME parameters						
				Interrogation					Reply	
					Pulse codes					
						DME/P mode				
DME no.	VHF frequency MHz	MLS angle frequency MHz	MLS channel no.	Frequency MHz	DME/N µs	Initial approach µs	Final approach µs		Frequency MHz	Pulse codes µs
19X	108.20	-	-	1 043	12	-	-		980	12
19Y	108.25	5 044.2	544	1 043	36	36	42		1 106	30
19Z	-	5 044.5	545	1 043	-	21	27		1 106	15
20X	108.30	5 031.6	502	1 044	12	12	18		981	12
20W	-	5 031.9	503	1 044	-	24	30		981	24
20Y	108.35	5 044.8	546	1 044	36	36	42		1 107	30
20Z	-	5 045.1	547	1 044	-	21	27		1 107	15
21X	108.40	-	-	1 045	12	-	-		982	12
21Y	108.45	5 045.4	548	1 045	36	36	42		1 108	30
21Z	-	5 045.7	549	1 045	-	21	27		1 108	15
22X	108.50	5 032.2	504	1 046	12	12	18		983	12
22W	-	5 032.5	505	1 046	-	24	30		983	24
22Y	108.55	5 046.0	550	1 046	36	36	42		1 109	30
22Z	-	5 046.3	551	1 046	-	21	27		1 109	15
23X	108.60	-	-	1 047	12	-	-		984	12
23Y	108.65	5 046.6	552	1 047	36	36	42		1 110	30
23Z	-	5 046.9	553	1 047	-	21	27		1 110	15
24X	108.70	5 032.8	506	1 048	12	12	18		985	12
24W	-	5 033.1	507	1 048	-	24	30		985	24
24Y	108.75	5 047.2	554	1 048	36	36	42		1 111	30
24Z	-	5 047.5	555	1 048	-	21	27		1 111	15
25X	108.80	-	-	1 049	12	-	-		986	12
25Y	108.85	5 047.8	556	1 049	36	36	42		1 112	30
25Z	-	5 048.1	557	1 049	-	21	27		1 112	15
26X	108.90	5 033.4	508	1 050	12	12	18		987	12
26W	-	5 033.7	509	1 050	-	24	30		987	24
26Y	108.95	5 048.4	558	1 050	36	36	42		1 113	30
26Z	-	5 048.7	559	1 050	-	21	27		1 113	15
27X	109.00	-	-	1 051	12	-	-		988	12
27Y	109.05	5 049.0	560	1 051	36	36	42		1 114	30
27Z	-	5 049.3	561	1 051	-	21	27		1 114	15
28X	109.10	5 034.0	510	1 052	12	12	18		989	12
28W	-	5 034.3	511	1 052	-	24	30		989	24
28Y	109.15	5 049.6	562	1 052	36	36	42		1 115	30
28Z	-	5 049.9	563	1 052	-	21	27		1 115	15
29X	109.20	-	-	1 053	12	-	-		990	12
29Y	109.25	5 050.2	564	1 053	36	36	42		1 116	30
29Z	-	5 050.5	565	1 053	-	21	27		1 116	15
30X	109.30	5 034.6	512	1 054	12	12	18		991	12
30W	-	5 034.9	513	1 054	-	24	30		991	24
30Y	109.35	5 050.8	566	1 054	36	36	42		1 117	30
30Z	-	5 051.1	567	1 054	-	21	27		1 117	15
31X	109.40	-	-	1 055	12	-	-		992	12
31Y	109.45	5 051.4	568	1 055	36	36	42		1 118	30
31Z	-	5 051.7	569	1 055	-	21	27		1 118	15
32X	109.50	5 035.2	514	1 056	12	12	18		993	12
32W	-	5 035.5	515	1 056	-	24	30		993	24

Channel pairing				DME parameters					
				Interrogation				Reply	
					Pulse codes				
						DME/P mode			
DME no.	VHF frequency MHz	MLS angle frequency MHz	MLS channel no.	Frequency MHz	DME/N µs	Initial approach µs	Final approach µs	Frequency MHz	Pulse codes µs
32Y	109.55	5 052.0	570	1 056	36	36	42	1 119	30
32Z	-	5 052.3	571	1 056	-	21	27	1 119	15
33X	109.60	-	-	1 057	12	-	-	994	12
33Y	109.65	5 052.6	572	1 057	36	36	42	1 120	30
33Z	-	5 052.9	573	1 057	-	21	27	1 120	15
34X	109.70	5 035.8	516	1 058	12	12	18	995	12
34W	-	5 036.1	517	1 058	-	24	30	995	24
34Y	109.75	5 053.2	574	1 058	36	36	42	1 121	30
34Z	-	5 053.5	575	1 058	-	21	27	1 121	15
35X	109.80	-	-	1 059	12	-	-	996	12
35Y	109.85	5 053.8	576	1 059	36	36	42	1 122	30
35Z	-	5 054.1	577	1 059	-	21	27	1 122	15
36X	109.90	5 036.4	518	1 060	12	12	18	997	12
36W	-	5 036.7	519	1 060	-	24	30	997	24
36Y	109.95	5 054.4	578	1 060	36	36	42	1 123	30
36Z	-	5 054.7	579	1 060	-	21	27	1 123	15
37X	110.00	-	-	1 061	12	-	-	998	12
37Y	110.05	5 055.0	580	1 061	36	36	42	1 124	30
37Z	-	5 055.3	581	1 061	-	21	27	1 124	15
38X	110.10	5 037.0	520	1 062	12	12	18	999	12
38W	-	5 037.3	521	1 062	-	24	30	999	24
38Y	110.15	5 055.6	582	1 062	36	36	42	1 125	30
38Z	-	5 055.9	583	1 062	-	21	27	1 125	15
39X	110.20	-	-	1 063	12	-	-	1 000	12
39Y	110.25	5 056.2	584	1 063	36	36	42	1 126	30
39Z	-	5 056.5	585	1 063	-	21	27	1 126	15
40X	110.30	5 037.6	522	1 064	12	12	18	1 001	12
40W	-	5 037.9	523	1 064	-	24	30	1 001	24
40Y	110.35	5 056.8	586	1 064	36	36	42	1 127	30
40Z	-	5 057.1	587	1 064	-	21	27	1 127	15
41X	110.40	-	-	1 065	12	-	-	1 002	12
41Y	110.45	5 057.4	588	1 065	36	36	42	1 128	30
41Z	-	5 057.7	589	1 065	-	21	27	1 128	15
42X	110.50	5 038.2	524	1 066	12	12	18	1 003	12
42W	-	5 038.5	525	1 066	-	24	30	1 003	24
42Y	110.55	5 058.0	590	1 066	36	36	42	1 129	30
42Z	-	5 058.3	591	1 066	-	21	27	1 129	15
43X	110.60	-	-	1 067	12	-	-	1 004	12
43Y	110.65	5 058.6	592	1 067	36	36	42	1 130	30
43Z	-	5 058.9	593	1 067	-	21	27	1 130	15
44X	110.70	5 038.8	526	1 068	12	12	18	1 005	12
44W	-	5 039.1	527	1 068	-	24	30	1 005	24
44Y	110.75	5 059.2	594	1 068	36	36	42	1 131	30
44Z	-	5 059.5	595	1 068	-	21	27	1 131	15
45X	110.80	-	-	1 069	12	-	-	1 006	12
45Y	110.85	5 059.8	596	1 069	36	36	42	1 132	30
45Z	-	5 060.1	597	1 069	-	21	27	1 132	15

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Channel pairing				DME parameters					
				Interrogation				Reply	
					Pulse codes				
						DME/P mode			
DME no.	VHF frequency MHz	MLS angle frequency MHz	MLS channel no.	Frequency MHz	DME/N µs	Initial approach µs	Final approach µs	Frequency MHz	Pulse codes µs
46X	110.90	5 039.4	528	1 070	12	12	18	1 007	12
46W	–	5 039.7	529	1 070	–	24	30	1 007	24
46Y	110.95	5 060.4	598	1 070	36	36	42	1 133	30
46Z	–	5 060.7	599	1 070	–	21	27	1 133	15
47X	111.00	–	–	1 071	12	–	–	1 008	12
47Y	111.05	5 061.0	600	1 071	36	36	42	1 134	30
47Z	–	5 061.3	601	1 071	–	21	27	1 134	15
48X	111.10	5 040.0	530	1 072	12	12	18	1 009	12
48W	–	5 040.3	531	1 072	–	24	30	1 009	24
48Y	111.15	5 061.6	602	1 072	36	36	42	1 135	30
48Z	–	5 061.9	603	1 072	–	21	27	1 135	15
49X	111.20	–	–	1 073	12	–	–	1 010	12
49Y	111.25	5 062.2	604	1 073	36	36	42	1 136	30
49Z	–	5 062.5	605	1 073	–	21	27	1 136	15
50X	111.30	5 040.6	532	1 074	12	12	18	1 011	12
50W	–	5 040.9	533	1 074	–	24	30	1 011	24
50Y	111.35	5 062.8	606	1 074	36	36	42	1 137	30
50Z	–	5 063.1	607	1 074	–	21	27	1 137	15
51X	111.40	–	–	1 075	12	–	–	1 012	12
51Y	111.45	5 063.4	608	1 075	36	36	42	1 138	30
51Z	–	5 063.7	609	1 075	–	21	27	1 138	15
52X	111.50	5 041.2	534	1 076	12	12	18	1 013	12
52W	–	5 041.5	535	1 076	–	24	30	1 013	24
52Y	111.55	5 064.0	610	1 076	36	36	42	1 139	30
52Z	–	5 064.3	611	1 076	–	21	27	1 139	15
53X	111.60	–	–	1 077	12	–	–	1 014	12
53Y	111.65	5 064.6	612	1 077	36	36	42	1 140	30
53Z	–	5 064.9	613	1 077	–	21	27	1 140	15
54X	111.70	5 041.8	536	1 078	12	12	18	1 015	12
54W	–	5 042.1	537	1 078	–	24	30	1 015	24
54Y	111.75	5 065.2	614	1 078	36	36	42	1 141	30
54Z	–	5 065.5	615	1 078	–	21	27	1 141	15
55X	111.80	–	–	1 079	12	–	–	1 016	12
55Y	111.85	5 065.8	616	1 079	36	36	42	1 142	30
55Z	–	5 066.1	617	1 079	–	21	27	1 142	15
56X	111.90	5 042.4	538	1 080	12	12	18	1 017	12
56W	–	5 042.7	539	1 080	–	24	30	1 017	24
56Y	111.95	5 066.4	618	1 080	36	36	42	1 143	30
56Z	–	5 066.7	619	1 080	–	21	27	1 143	15
57X	112.00	–	–	1 081	12	–	–	1 018	12
57Y	112.05	–	–	1 081	36	–	–	1 144	30
58X	112.10	–	–	1 082	12	–	–	1 019	12
58Y	112.15	–	–	1 082	36	–	–	1 145	30
59X	112.20	–	–	1 083	12	–	–	1 020	12
59Y	112.25	–	–	1 083	36	–	–	1 146	30
** 60X	–	–	–	1 084	12	–	–	1 021	12
** 60Y	–	–	–	1 084	36	–	–	1 147	30

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Channel pairing				*DME parameters*					
				Interrogation				*Reply*	
					Pulse codes				
						DME/P mode			
DME no.	*VHF frequency MHz*	*MLS angle frequency MHz*	*MLS channel no.*	*Frequency MHz*	*DME/N μs*	*Initial approach μs*	*Final approach μs*	*Frequency MHz*	*Pulse codes μs*
** 61X	-	-	-	1 085	12	-	-	1 022	12
** 61Y	-	-	-	1 085	36	-	-	1 148	30
** 62X	-	-	-	1 086	12	-	-	1 023	12
** 62Y	-	-	-	1 086	36	-	-	1 149	30
** 63X	-	-	-	1 087	12	-	-	1 024	12
** 63Y	-	-	-	1 087	36	-	-	1 150	30
** 64X	-	-	-	1 088	12	-	-	1 151	12
** 64Y	-	-	-	1 088	36	-	-	1 025	30
** 65X	-	-	-	1 089	12	-	-	1 152	12
** 65Y	-	-	-	1 089	36	-	-	1 026	30
** 66X	-	-	-	1 090	12	-	-	1 153	12
** 66Y	-	-	-	1 090	36	-	-	1 027	30
** 67X	-	-	-	1 091	12	-	-	1 154	12
** 67Y	-	-	-	1 091	36	-	-	1 028	30
** 68X	-	-	-	1 092	12	-	-	1 155	12
** 68Y	-	-	-	1 092	36	-	-	1 029	30
** 69X	-	-	-	1 093	12	-	-	1 156	12
** 69Y	-	-	-	1 093	36	-	-	1 030	30
70X	112.30	-	-	1 094	12	-	-	1 157	12
** 70Y	112.35	-	-	1 094	36	-	-	1 031	30
71X	112.40	-	-	1 095	12	-	-	1 158	12
** 71Y	112.45	-	-	1 095	36	-	-	1 032	30
72X	112.50	-	-	1 096	12	-	-	1 159	12
** 72Y	112.55	-	-	1 096	36	-	-	1 033	30
73X	112.60	-	-	1 097	12	-	-	1 160	12
** 73Y	112.65	-	-	1 097	36	-	-	1 034	30
74X	112.70	-	-	1 098	12	-	-	1 161	12
** 74Y	112.75	-	-	1 098	36	-	-	1 035	30
75X	112.80	-	-	1 099	12	-	-	1 162	12
** 75Y	112.85	-	-	1 099	36	-	-	1 036	30
76X	112.90	-	-	1 100	12	-	-	1 163	12
** 76Y	112.95	-	-	1 100	36	-	-	1 037	30
77X	113.00	-	-	1 101	12	-	-	1 164	12
** 77Y	113.05	-	-	1 101	36	-	-	1 038	30
78X	113.10	-	-	1 102	12	-	-	1 165	12
** 78Y	113.15	-	-	1 102	36	-	-	1 039	30
79X	113.20	-	-	1 103	12	-	-	1 166	12
** 79Y	113.25	-	-	1 103	36	-	-	1 040	30
80X	113.30	-	-	1 104	12	-	-	1 167	12
80Y	113.35	5 067.0	620	1 104	36	36	42	1 041	30
80Z	-	5 067.3	621	1 104	-	21	27	1 041	15
81X	113.40	-	-	1 105	12	-	-	1 168	12
81Y	113.45	5 067.6	622	1 105	36	36	42	1 042	30
81Z	-	5 067.9	623	1 105	-	21	27	1 042	15

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Channel pairing				DME parameters					
				Interrogation				Reply	
					Pulse codes				
						DME/P mode			
DME no.	VHF frequency MHz	MLS angle frequency MHz	MLS channel no.	Frequency MHz	DME/N µs	Initial approach µs	Final approach µs	Frequency MHz	Pulse codes µs
82X	113.50	-	-	1 106	12	-	-	1 169	12
82Y	113.55	5 068.2	624	1 106	36	36	42	1 043	30
82Z	-	5 068.5	625	1 106	-	21	27	1 043	15
83X	113.60	-	-	1 107	12	-	-	1 170	12
83Y	113.65	5 068.8	626	1 107	36	36	42	1 044	30
83Z	-	5 069.1	627	1 107	-	21	27	1 044	15
84X	113.70	-	-	1 108	12	-	-	1 171	12
84Y	113.75	5 069.4	628	1 108	36	36	42	1 045	30
84Z	-	5 069.7	629	1 108	-	21	27	1 045	15
85X	113.80	-	-	1 109	12	-	-	1 172	12
85Y	113.85	5 070.0	630	1 109	36	36	42	1 046	30
85Z	-	5 070.3	631	1 109	-	21	27	1 046	15
86X	113.90	-	-	1 110	12	-	-	1 173	12
86Y	113.95	5 070.6	632	1 110	36	36	42	1 047	30
86Z	-	5 070.9	633	1 110	-	21	27	1 047	15
87X	114.00	-	-	1 111	12	-	-	1 174	12
87Y	114.05	5 071.2	634	1 111	36	36	42	1 048	30
87Z	-	5 071.5	635	1 111	-	21	27	1 048	15
88X	114.10	-	-	1 112	12	-	-	1 175	12
88Y	114.15	5 071.8	636	1 112	36	36	42	1 049	30
88Z	-	5 072.1	637	1 112	-	21	27	1 049	15
89X	114.20	-	-	1 113	12	-	-	1 176	12
89Y	114.25	5 072.4	638	1 113	36	36	42	1 050	30
89Z	-	5 072.7	639	1 113	-	21	27	1 050	15
90X	114.30	-	-	1 114	12	-	-	1 177	12
90Y	114.35	5 073.0	640	1 114	36	36	42	1 051	30
90Z	-	5 073.3	641	1 114	-	21	27	1 051	15
91X	114.40	-	-	1 115	12	-	-	1 178	12
91Y	114.45	5 073.6	642	1 115	36	36	42	1 052	30
91Z	-	5 073.9	643	1 115	-	21	27	1 052	15
92X	114.50	-	-	1 116	12	-	-	1 179	12
92Y	114.55	5 074.2	644	1 116	36	36	42	1 053	30
92Z	-	5 074.5	645	1 116	-	21	27	1 053	15
93X	114.60	-	-	1 117	12	-	-	1 180	12
93Y	114.65	5 074.8	646	1 117	36	36	42	1 054	30
93Z	-	5 075.1	647	1 117	-	21	27	1 054	15
94X	114.70	-	-	1 118	12	-	-	1 181	12
94Y	114.75	5 075.4	648	1 118	36	36	42	1 055	30
94Z	-	5 075.7	649	1 118	-	21	27	1 055	15
95X	114.80	-	-	1 119	12	-	-	1 182	12
95Y	114.85	5 076.0	650	1 119	36	36	42	1 056	30
95Z	-	5 076.3	651	1 119	-	21	27	1 056	15
96X	114.90	-	-	1 120	12	-	-	1 183	12
96Y	114.95	5 076.6	652	1 120	36	36	42	1 057	30
96Z	-	5 076.9	653	1 120	-	21	27	1 057	15

Channel pairing				DME parameters					
				Interrogation				Reply	
					Pulse codes				
						DME/P mode			
DME no.	VHF frequency MHz	MLS angle frequency MHz	MLS channel no.	Frequency MHz	DME/N µs	Initial approach µs	Final approach µs	Frequency MHz	Pulse codes µs
97X	115.00	-	-	1 121	12	-	-	1 184	12
97Y	115.05	5 077.2	654	1 121	36	36	42	1 058	30
97Z	-	5 077.5	655	1 121	-	21	27	1 058	15
98X	115.10	-	-	1 122	12	-	-	1 185	12
98Y	115.15	5 077.8	656	1 122	36	36	42	1 059	30
98Z	-	5 078.1	657	1 122	-	21	27	1 059	15
99X	115.20	-	-	1 123	12	-	-	1 186	12
99Y	115.25	5 078.4	658	1 123	36	36	42	1 060	30
99Z	-	5 078.7	659	1 123	-	21	27	1 060	15
100X	115.30	-	-	1 124	12	-	-	1 187	12
100Y	115.35	5 079.0	660	1 124	36	36	42	1 061	30
100Z	-	5 079.3	661	1 124	-	21	27	1 061	15
101X	115.40	-	-	1 125	12	-	-	1 188	12
101Y	115.45	5 079.6	662	1 125	36	36	42	1 062	30
101Z	-	5 079.9	663	1 125	-	21	27	1 062	15
102X	115.50	-	-	1 126	12	-	-	1 189	12
102Y	115.55	5 080.2	664	1 126	36	36	42	1 063	30
102Z	-	5 080.5	665	1 126	-	21	27	1 063	15
103X	115.60	-	-	1 127	12	-	-	1 190	12
103Y	115.65	5 080.8	666	1 127	36	36	42	1 064	30
103Z	-	5 081.1	667	1 127	-	21	27	1 064	15
104X	115.70	-	-	1 128	12	-	-	1 191	12
104Y	115.75	5 081.4	668	1 128	36	36	42	1 065	30
104Z	-	5 081.7	669	1 128	-	21	27	1 065	15
105X	115.80	-	-	1 129	12	-	-	1 192	12
105Y	115.85	5 082.0	670	1 129	36	36	42	1 066	30
105Z	-	5 082.3	671	1 129	-	21	27	1 066	15
106X	115.90	-	-	1 130	12	-	-	1 193	12
106Y	115.95	5 082.6	672	1 130	36	36	42	1 067	30
106Z	-	5 082.9	673	1 130	-	21	27	1 067	15
107X	116.00	-	-	1 131	12	-	-	1 194	12
107Y	116.05	5 083.2	674	1 131	36	36	42	1 068	30
107Z	-	5 083.5	675	1 131	-	21	27	1 068	15
108X	116.10	-	-	1 132	12	-	-	1 195	12
108Y	116.15	5 083.8	676	1 132	36	36	42	1 069	30
108Z	-	5 084.1	677	1 132	-	21	27	1 069	15
109X	116.20	-	-	1 133	12	-	-	1 196	12
109Y	116.25	5 084.4	678	1 133	36	36	42	1 070	30
109Z	-	5 084.7	679	1 133	-	21	27	1 070	15
110X	116.30	-	-	1 134	12	-	-	1 197	12
110Y	116.35	5 085.0	680	1 134	36	36	42	1 071	30
110Z	-	5 085.3	681	1 134	-	21	27	1 071	15
111X	116.40	-	-	1 135	12	-	-	1 198	12
111Y	116.45	5 085.6	682	1 135	36	36	42	1 072	30
111Z	-	5 085.9	683	1 135	-	21	27	1 072	15

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Channel pairing				DME parameters					
				Interrogation				Reply	
					Pulse codes				
						DME/P mode			
DME no.	VHF frequency MHz	MLS angle frequency MHz	MLS channel no.	Frequency MHz	DME/N μs	Initial approach μs	Final approach μs	Frequency MHz	Pulse codes μs
112X	116.50	-	-	1 136	12	-	-	1 199	12
112Y	116.55	5 086.2	684	1 136	36	36	42	1 073	30
112Z	-	5 086.5	685	1 136	-	21	27	1 073	15
113X	116.60	-	-	1 137	12	-	-	1 200	12
113Y	116.65	5 086.8	686	1 137	36	36	42	1 074	30
113Z	-	5 087.1	687	1 137	-	21	27	1 074	15
114X	116.70	-	-	1 138	12	-	-	1 201	12
114Y	116.75	5 087.4	688	1 138	36	36	42	1 075	30
114Z	-	5 087.7	689	1 138	-	21	27	1 075	15
115X	116.80	-	-	1 139	12	-	-	1 202	12
115Y	116.85	5 088.0	690	1 139	36	36	42	1 076	30
115Z	-	5 088.3	691	1 139	-	21	27	1 076	15
116X	116.90	-	-	1 140	12	-	-	1 203	12
116Y	116.95	5 088.6	692	1 140	36	36	42	1 077	30
116Z	-	5 088.9	693	1 140	-	21	27	1 077	15
117X	117.00	-	-	1 141	12	-	-	1 204	12
117Y	117.05	5 089.2	694	1 141	36	36	42	1 078	30
117Z	-	5 089.5	695	1 141	-	21	27	1 078	15
118X	117.10	-	-	1 142	12	-	-	1 205	12
118Y	117.15	5 089.8	696	1 142	36	36	42	1 079	30
118Z	-	5 090.1	697	1 142	-	21	27	1 079	15
119X	117.20	-	-	1 143	12	-	-	1 206	12
119Y	117.25	5 090.4	698	1 143	36	36	42	1 080	30
119Z	-	5 090.7	699	1 143	-	21	27	1 080	15
120X	117.30	-	-	1 144	12	-	-	1 207	12
120Y	117.35	-	-	1 144	36	-	-	1 081	30
121X	117.40	-	-	1 145	12	-	-	1 208	12
121Y	117.45	-	-	1 145	36	-	-	1 082	30
122X	117.50	-	-	1 146	12	-	-	1 209	12
122Y	117.55	-	-	1 146	36	-	-	1 083	30
123X	117.60	-	-	1 147	12	-	-	1 210	12
123Y	117.65	-	-	1 147	36	-	-	1 084	30
124X	117.70	-	-	1 148	12	-	-	1 211	12
** 124Y	117.75	-	-	1 148	36	-	-	1 085	30
125X	117.80	-	-	1 149	12	-	-	1 212	12
** 125Y	117.85	-	-	1 149	36	-	-	1 086	30
126X	117.90	-	-	1 150	12	-	-	1 213	12
** 126Y	117.95	-	-	1 150	36	-	-	1 087	30

* These channels are reserved exclusively for national allotments.

** These channels may be used for national allotment on a secondary basis.
The primary reason for reserving these channels is to provide protection for the secondary surveillance radar (SSR) system.

∇ 108.0 MHz is not scheduled for assignment to ILS service. The associated DME operating channel No. 17X may be assigned for emergency use.

Table B. SSR automatic pressure altitude transmission code (pulse position assignment)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
-1 000	to	-950	0	0	0	0	0	0	0	0	0	1	0
-950	to	-850	0	0	0	0	0	0	0	0	1	1	0
-850	to	-750	0	0	0	0	0	0	0	0	1	0	0
-750	to	-650	0	0	0	0	0	0	0	1	1	0	0
-650	to	-550	0	0	0	0	0	0	0	1	1	1	0
-550	to	-450	0	0	0	0	0	0	0	1	0	1	0
-450	to	-350	0	0	0	0	0	0	0	1	0	1	1
-350	to	-250	0	0	0	0	0	0	0	1	0	0	1
-250	to	-150	0	0	0	0	0	0	1	1	0	0	1
-150	to	-50	0	0	0	0	0	0	1	1	0	1	1
-50	to	50	0	0	0	0	0	0	1	1	0	1	0
50	to	150	0	0	0	0	0	0	1	1	1	1	0
150	to	250	0	0	0	0	0	0	1	1	1	0	0
250	to	350	0	0	0	0	0	0	1	0	1	0	0
350	to	450	0	0	0	0	0	0	1	0	1	1	0
450	to	550	0	0	0	0	0	0	1	0	0	1	0
550	to	650	0	0	0	0	0	0	1	0	0	1	1
650	to	750	0	0	0	0	0	0	1	0	0	0	1
750	to	850	0	0	0	0	0	1	1	0	0	0	1
850	to	950	0	0	0	0	0	1	1	0	0	1	1
950	to	1 050	0	0	0	0	0	1	1	0	0	1	0
1 050	to	1 150	0	0	0	0	0	1	1	0	1	1	0
1 150	to	1 250	0	0	0	0	0	1	1	0	1	0	0
1 250	to	1 350	0	0	0	0	0	1	1	1	1	0	0
1 350	to	1 450	0	0	0	0	0	1	1	1	1	1	0
1 450	to	1 550	0	0	0	0	0	1	1	1	0	1	0
1 550	to	1 650	0	0	0	0	0	1	1	1	0	1	1
1 650	to	1 750	0	0	0	0	0	1	1	1	0	0	1
1 750	to	1 850	0	0	0	0	0	1	0	1	0	0	1
1 850	to	1 950	0	0	0	0	0	1	0	1	0	1	1
1 950	to	2 050	0	0	0	0	0	1	0	1	0	1	0
2 050	to	2 150	0	0	0	0	0	1	0	1	1	1	0
2 150	to	2 250	0	0	0	0	0	1	0	1	1	0	0
2 250	to	2 350	0	0	0	0	0	1	0	0	1	0	0
2 350	to	2 450	0	0	0	0	0	1	0	0	1	1	0
2 450	to	2 550	0	0	0	0	0	1	0	0	0	1	0
2 550	to	2 650	0	0	0	0	0	1	0	0	0	1	1
2 650	to	2 750	0	0	0	0	0	1	0	0	0	0	1
2 750	to	2 850	0	0	0	0	1	1	0	0	0	0	1
2 850	to	2 950	0	0	0	0	1	1	0	0	0	1	1
2 950	to	3 050	0	0	0	0	1	1	0	0	0	1	0
3 050	to	3 150	0	0	0	0	1	1	0	0	1	1	0
3 150	to	3 250	0	0	0	0	1	1	0	0	1	0	0
3 250	to	3 350	0	0	0	0	1	1	0	1	1	0	0
3 350	to	3 450	0	0	0	0	1	1	0	1	1	1	0
3 450	to	3 550	0	0	0	0	1	1	0	1	0	1	0
3 550	to	3 650	0	0	0	0	1	1	0	1	0	1	1
3 650	to	3 750	0	0	0	0	1	1	0	1	0	0	1
3 750	to	3 850	0	0	0	0	1	1	1	1	0	0	1
3 850	to	3 950	0	0	0	0	1	1	1	1	0	1	1
3 950	to	4 050	0	0	0	0	1	1	1	1	0	1	0
4 050	to	4 150	0	0	0	0	1	1	1	1	1	1	0
4 150	to	4 250	0	0	0	0	1	1	1	1	1	0	0
4 250	to	4 350	0	0	0	0	1	1	1	0	1	0	0
4 350	to	4 450	0	0	0	0	1	1	1	0	1	1	0
4 450	to	4 550	0	0	0	0	1	1	1	0	0	1	0
4 550	to	4 650	0	0	0	0	1	1	1	0	0	1	1
4 650	to	4 750	0	0	0	0	1	1	1	0	0	0	1

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Table B (cont.)

RANGE Increments (Feet)			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
4 750	to	4 850	0	0	0	0	1	0	1	0	0	0	1
4 850	to	4 950	0	0	0	0	1	0	1	0	0	1	1
4 950	to	5 050	0	0	0	0	1	0	1	0	0	1	0
5 050	to	5 150	0	0	0	0	1	0	1	0	1	1	0
5 150	to	5 250	0	0	0	0	1	0	1	0	1	0	0
5 250	to	5 350	0	0	0	0	1	0	1	1	1	0	0
5 350	to	5 450	0	0	0	0	1	0	1	1	1	1	0
5 450	to	5 550	0	0	0	0	1	0	1	1	0	1	0
5 550	to	5 650	0	0	0	0	1	0	1	1	0	1	1
5 650	to	5 750	0	0	0	0	1	0	1	1	0	0	1
5 750	to	5 850	0	0	0	0	1	0	0	1	0	0	1
5 850	to	5 950	0	0	0	0	1	0	0	1	0	1	1
5 950	to	6 050	0	0	0	0	1	0	0	1	0	1	0
6 050	to	6 150	0	0	0	0	1	0	0	1	1	1	0
6 150	to	6 250	0	0	0	0	1	0	0	1	1	0	0
6 250	to	6 350	0	0	0	0	1	0	0	0	1	0	0
6 350	to	6 450	0	0	0	0	1	0	0	0	1	1	0
6 450	to	6 550	0	0	0	0	1	0	0	0	0	1	0
6 550	to	6 650	0	0	0	0	1	0	0	0	0	1	1
6 650	to	6 750	0	0	0	0	1	0	0	0	0	0	1
6 750	to	6 850	0	0	0	1	1	0	0	0	0	0	1
6 850	to	6 950	0	0	0	1	1	0	0	0	0	1	1
6 950	to	7 050	0	0	0	1	1	0	0	0	0	1	0
7 050	to	7 150	0	0	0	1	1	0	0	0	1	1	0
7 150	to	7 250	0	0	0	1	1	0	0	0	1	0	0
7 250	to	7 350	0	0	0	1	1	0	0	1	1	0	0
7 350	to	7 450	0	0	0	1	1	0	0	1	1	1	0
7 450	to	7 550	0	0	0	1	1	0	0	1	0	1	0
7 550	to	7 650	0	0	0	1	1	0	0	1	0	1	1
7 650	to	7 750	0	0	0	1	1	0	0	1	0	0	1
7 750	to	7 850	0	0	0	1	1	0	1	1	0	0	1
7 850	to	7 950	0	0	0	1	1	0	1	1	0	1	1
7 950	to	8 050	0	0	0	1	1	0	1	1	0	1	0
8 050	to	8 150	0	0	0	1	1	0	1	1	1	1	0
8 150	to	8 250	0	0	0	1	1	0	1	1	1	0	0
8 250	to	8 350	0	0	0	1	1	0	1	0	1	0	0
8 350	to	8 450	0	0	0	1	1	0	1	0	1	1	0
8 450	to	8 550	0	0	0	1	1	0	1	0	0	1	0
8 550	to	8 650	0	0	0	1	1	0	1	0	0	1	1
8 650	to	8 750	0	0	0	1	1	0	1	0	0	0	1
8 750	to	8 850	0	0	0	1	1	1	1	0	0	0	1
8 850	to	8 950	0	0	0	1	1	1	1	0	0	1	1
8 950	to	9 050	0	0	0	1	1	1	1	0	0	1	0
9 050	to	9 150	0	0	0	1	1	1	1	0	1	1	0
9 150	to	9 250	0	0	0	1	1	1	1	0	1	0	0
9 250	to	9 350	0	0	0	1	1	1	1	1	1	0	0
9 350	to	9 450	0	0	0	1	1	1	1	1	1	1	0
9 450	to	9 550	0	0	0	1	1	1	1	1	0	1	0
9 550	to	9 650	0	0	0	1	1	1	1	1	0	1	1
9 650	to	9 750	0	0	0	1	1	1	1	1	0	0	1
9 750	to	9 850	0	0	0	1	1	1	0	1	0	0	1
9 850	to	9 950	0	0	0	1	1	1	0	1	0	1	1
9 950	to	10 050	0	0	0	1	1	1	0	1	0	1	0
10 050	to	10 150	0	0	0	1	1	1	0	1	1	1	0
10 150	to	10 250	0	0	0	1	1	1	0	1	1	0	0
10 250	to	10 350	0	0	0	1	1	1	0	0	1	0	0
10 350	to	10 450	0	0	0	1	1	1	0	0	1	1	0
10 450	to	10 550	0	0	0	1	1	1	0	0	0	1	0
10 550	to	10 650	0	0	0	1	1	1	0	0	0	1	1
10 650	to	10 750	0	0	0	1	1	1	0	0	0	0	1
10 750	to	10 850	0	0	0	1	0	1	0	0	0	0	1
10 850	to	10 950	0	0	0	1	0	1	0	0	0	1	1
10 950	to	11 050	0	0	0	1	0	1	0	0	0	1	0
11 050	to	11 150	0	0	0	1	0	1	0	0	1	1	0
11 150	to	11 250	0	0	0	1	0	1	0	0	1	0	0

Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
11 250	to	11 350	0	0	0	1	0	1	0	1	1	0	0
11 350	to	11 450	0	0	0	1	0	1	0	1	1	1	0
11 450	to	11 550	0	0	0	1	0	1	0	1	0	1	0
11 550	to	11 650	0	0	0	1	0	1	0	1	0	1	1
11 650	to	11 750	0	0	0	1	0	1	0	1	0	0	1
11 750	to	11 850	0	0	0	1	0	1	1	1	0	0	1
11 850	to	11 950	0	0	0	1	0	1	1	1	0	1	1
11 950	to	12 050	0	0	0	1	0	1	1	1	0	1	0
12 050	to	12 150	0	0	0	1	0	1	1	1	1	1	0
12 150	to	12 250	0	0	0	1	0	1	1	1	1	0	0
12 250	to	12 350	0	0	0	1	0	1	1	0	1	0	0
12 350	to	12 450	0	0	0	1	0	1	1	0	1	1	0
12 450	to	12 550	0	0	0	1	0	1	1	0	0	1	0
12 550	to	12 650	0	0	0	1	0	1	1	0	0	1	1
12 650	to	12 750	0	0	0	1	0	1	1	0	0	0	1
12 750	to	12 850	0	0	0	1	0	0	1	0	0	0	1
12 850	to	12 950	0	0	0	1	0	0	1	0	0	1	1
12 950	to	13 050	0	0	0	1	0	0	1	0	0	1	0
13 050	to	13 150	0	0	0	1	0	0	1	0	1	1	0
13 150	to	13 250	0	0	0	1	0	0	1	0	1	0	0
13 250	to	13 350	0	0	0	1	0	0	1	1	1	0	0
13 350	to	13 450	0	0	0	1	0	0	1	1	1	1	0
13 450	to	13 550	0	0	0	1	0	0	1	1	0	1	0
13 550	to	13 650	0	0	0	1	0	0	1	1	0	1	1
13 650	to	13 750	0	0	0	1	0	0	1	1	0	0	1
13 750	to	13 850	0	0	0	1	0	0	0	1	0	0	1
13 850	to	13 950	0	0	0	1	0	0	0	1	0	1	1
13 950	to	14 050	0	0	0	1	0	0	0	1	0	1	0
14 050	to	14 150	0	0	0	1	0	0	0	1	1	1	0
14 150	to	14 250	0	0	0	1	0	0	0	1	1	0	0
14 250	to	14 350	0	0	0	1	0	0	0	0	1	0	0
14 350	to	14 450	0	0	0	1	0	0	0	0	1	1	0
14 450	to	14 550	0	0	0	1	0	0	0	0	0	1	0
14 550	to	14 650	0	0	0	1	0	0	0	0	0	1	1
14 650	to	14 750	0	0	0	1	0	0	0	0	0	0	1
14 750	to	14 850	0	0	1	1	0	0	0	0	0	0	1
14 850	to	14 950	0	0	1	1	0	0	0	0	0	1	1
14 950	to	15 050	0	0	1	1	0	0	0	0	0	1	0
15 050	to	15 150	0	0	1	1	0	0	0	0	1	1	0
15 150	to	15 250	0	0	1	1	0	0	0	0	1	0	0
15 250	to	15 350	0	0	1	1	0	0	0	1	1	0	0
15 350	to	15 450	0	0	1	1	0	0	0	1	1	1	0
15 450	to	15 550	0	0	1	1	0	0	0	1	0	1	0
15 550	to	15 650	0	0	1	1	0	0	0	1	0	1	1
15 650	to	15 750	0	0	1	1	0	0	0	1	0	0	1
15 750	to	15 850	0	0	1	1	0	0	1	1	0	0	1
15 850	to	15 950	0	0	1	1	0	0	1	1	0	1	1
15 950	to	16 050	0	0	1	1	0	0	1	1	0	1	0
16 050	to	16 150	0	0	1	1	0	0	1	1	1	1	0
16 150	to	16 250	0	0	1	1	0	0	1	1	1	0	0
16 250	to	16 350	0	0	1	1	0	0	1	0	1	0	0
16 350	to	16 450	0	0	1	1	0	0	1	0	1	1	0
16 450	to	16 550	0	0	1	1	0	0	1	0	0	1	0
16 550	to	16 650	0	0	1	1	0	0	1	0	0	1	1
16 650	to	16 750	0	0	1	1	0	0	1	0	0	0	1
16 750	to	16 850	0	0	1	1	0	1	1	0	0	0	1
16 850	to	16 950	0	0	1	1	0	1	1	0	0	1	1
16 950	to	17 050	0	0	1	1	0	1	1	0	0	1	0
17 050	to	17 150	0	0	1	1	0	1	1	0	1	1	0
17 150	to	17 250	0	0	1	1	0	1	1	0	1	0	0
17 250	to	17 350	0	0	1	1	0	1	1	1	1	0	0
17 350	to	17 450	0	0	1	1	0	1	1	1	1	1	0
17 450	to	17 550	0	0	1	1	0	1	1	1	0	1	0
17 550	to	17 650	0	0	1	1	0	1	1	1	0	1	1
17 650	to	17 750	0	0	1	1	0	1	1	1	0	0	1

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
17 750	to	17 850	0	0	1	1	0	1	0	1	0	0	1
17 850	to	17 950	0	0	1	1	0	1	0	1	0	1	1
17 950	to	18 050	0	0	1	1	0	1	0	1	0	1	0
18 050	to	18 150	0	0	1	1	0	1	0	1	1	1	0
18 150	to	18 250	0	0	1	1	0	1	0	1	1	0	0
18 250	to	18 350	0	0	1	1	0	1	0	0	1	0	0
18 350	to	18 450	0	0	1	1	0	1	0	0	1	1	0
18 450	to	18 550	0	0	1	1	0	1	0	0	0	1	0
18 550	to	18 650	0	0	1	1	0	1	0	0	0	1	1
18 650	to	18 750	0	0	1	1	0	1	0	0	0	0	1
18 750	to	18 850	0	0	1	1	1	1	0	0	0	0	1
18 850	to	18 950	0	0	1	1	1	1	0	0	0	1	1
18 950	to	19 050	0	0	1	1	1	1	0	0	0	1	0
19 050	to	19 150	0	0	1	1	1	1	0	0	1	1	0
19 150	to	19 250	0	0	1	1	1	1	0	0	1	0	0
19 250	to	19 350	0	0	1	1	1	1	0	1	1	0	0
19 350	to	19 450	0	0	1	1	1	1	0	1	1	1	0
19 450	to	19 550	0	0	1	1	1	1	0	1	0	1	0
19 550	to	19 650	0	0	1	1	1	1	0	1	0	1	1
19 650	to	19 750	0	0	1	1	1	1	0	1	0	0	1
19 750	to	19 850	0	0	1	1	1	1	1	1	0	0	1
19 850	to	19 950	0	0	1	1	1	1	1	1	0	1	1
19 950	to	20 050	0	0	1	1	1	1	1	1	0	1	0
20 050	to	20 150	0	0	1	1	1	1	1	1	1	1	0
20 150	to	20 250	0	0	1	1	1	1	1	1	1	0	0
20 250	to	20 350	0	0	1	1	1	1	1	0	1	0	0
20 350	to	20 450	0	0	1	1	1	1	1	0	1	1	0
20 450	to	20 550	0	0	1	1	1	1	1	0	0	1	0
20 550	to	20 650	0	0	1	1	1	1	1	0	0	1	1
20 650	to	20 750	0	0	1	1	1	1	1	0	0	0	1
20 750	to	20 850	0	0	1	1	1	0	1	0	0	0	1
20 850	to	20 950	0	0	1	1	1	0	1	0	0	1	1
20 950	to	21 050	0	0	1	1	1	0	1	0	0	1	0
21 050	to	21 150	0	0	1	1	1	0	1	0	1	1	0
21 150	to	21 250	0	0	1	1	1	0	1	0	1	0	0
21 250	to	21 350	0	0	1	1	1	0	1	1	1	0	0
21 350	to	21 450	0	0	1	1	1	0	1	1	1	1	0
21 450	to	21 550	0	0	1	1	1	0	1	1	0	1	0
21 550	to	21 650	0	0	1	1	1	0	1	1	0	1	1
21 650	to	21 750	0	0	1	1	1	0	1	1	0	0	1
21 750	to	21 850	0	0	1	1	1	0	0	1	0	0	1
21 850	to	21 950	0	0	1	1	1	0	0	1	0	1	1
21 950	to	22 050	0	0	1	1	1	0	0	1	0	1	0
22 050	to	22 150	0	0	1	1	1	0	0	1	1	1	0
22 150	to	22 250	0	0	1	1	1	0	0	1	1	0	0
22 250	to	22 350	0	0	1	1	1	0	0	0	1	0	0
22 350	to	22 450	0	0	1	1	1	0	0	0	1	1	0
22 450	to	22 550	0	0	1	1	1	0	0	0	0	1	0
22 550	to	22 650	0	0	1	1	1	0	0	0	0	1	1
22 650	to	22 750	0	0	1	1	1	0	0	0	0	0	1
22 750	to	22 850	0	0	1	0	1	0	0	0	0	0	1
22 850	to	22 950	0	0	1	0	1	0	0	0	0	1	1
22 950	to	23 050	0	0	1	0	1	0	0	0	0	1	0
23 050	to	23 150	0	0	1	0	1	0	0	0	1	1	0
23 150	to	23 250	0	0	1	0	1	0	0	0	1	0	0
23 250	to	23 350	0	0	1	0	1	0	0	1	1	0	0
23 350	to	23 450	0	0	1	0	1	0	0	1	1	1	0
23 450	to	23 550	0	0	1	0	1	0	0	1	0	1	0
23 550	to	23 650	0	0	1	0	1	0	0	1	0	1	1
23 650	to	23 750	0	0	1	0	1	0	0	1	0	0	1
23 750	to	23 850	0	0	1	0	1	0	1	1	0	0	1
23 850	to	23 950	0	0	1	0	1	0	1	1	0	1	1
23 950	to	24 050	0	0	1	0	1	0	1	1	0	1	0
24 050	to	24 150	0	0	1	0	1	0	1	1	1	1	0
24 150	to	24 250	0	0	1	0	1	0	1	1	1	0	0

Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
24 250	to	24 350	0	0	1	0	1	0	1	0	1	0	0
24 350	to	24 450	0	0	1	0	1	0	1	0	1	1	0
24 450	to	24 550	0	0	1	0	1	0	1	0	0	1	0
24 550	to	24 650	0	0	1	0	1	0	1	0	0	1	1
24 650	to	24 750	0	0	1	0	1	0	1	0	0	0	1
24 750	to	24 850	0	0	1	0	1	1	1	0	0	0	1
24 850	to	24 950	0	0	1	0	1	1	1	0	0	1	1
24 950	to	25 050	0	0	1	0	1	1	1	0	0	1	0
25 050	to	25 150	0	0	1	0	1	1	1	0	1	1	0
25 150	to	25 250	0	0	1	0	1	1	1	0	1	0	0
25 250	to	25 350	0	0	1	0	1	1	1	1	1	0	0
25 350	to	25 450	0	0	1	0	1	1	1	1	1	1	0
25 450	to	25 550	0	0	1	0	1	1	1	1	0	1	0
25 550	to	25 650	0	0	1	0	1	1	1	1	0	1	1
25 650	to	25 750	0	0	1	0	1	1	1	1	0	0	1
25 750	to	25 850	0	0	1	0	1	1	0	1	0	0	1
25 850	to	25 950	0	0	1	0	1	1	0	1	0	1	1
25 950	to	26 050	0	0	1	0	1	1	0	1	0	1	0
26 050	to	26 150	0	0	1	0	1	1	0	1	1	1	0
26 150	to	26 250	0	0	1	0	1	1	0	1	1	0	0
26 250	to	26 350	0	0	1	0	1	1	0	0	1	0	0
26 350	to	26 450	0	0	1	0	1	1	0	0	1	1	0
26 450	to	26 550	0	0	1	0	1	1	0	0	0	1	0
26 550	to	26 650	0	0	1	0	1	1	0	0	0	1	1
26 650	to	26 750	0	0	1	0	1	1	0	0	0	0	1
26 750	to	26 850	0	0	1	0	0	1	0	0	0	0	1
26 850	to	26 950	0	0	1	0	0	1	0	0	0	1	1
26 950	to	27 050	0	0	1	0	0	1	0	0	0	1	0
27 050	to	27 150	0	0	1	0	0	1	0	0	1	1	0
27 150	to	27 250	0	0	1	0	0	1	0	0	1	0	0
27 250	to	27 350	0	0	1	0	0	1	0	1	1	0	0
27 350	to	27 450	0	0	1	0	0	1	0	1	1	1	0
27 450	to	27 550	0	0	1	0	0	1	0	1	0	1	0
27 550	to	27 650	0	0	1	0	0	1	0	1	0	1	1
27 650	to	27 750	0	0	1	0	0	1	0	1	0	0	1
27 750	to	27 850	0	0	1	0	0	1	1	1	0	0	1
27 850	to	27 950	0	0	1	0	0	1	1	1	0	1	1
27 950	to	28 050	0	0	1	0	0	1	1	1	0	1	0
28 050	to	28 150	0	0	1	0	0	1	1	1	1	1	0
28 150	to	28 250	0	0	1	0	0	1	1	1	1	0	0
28 250	to	28 350	0	0	1	0	0	1	1	0	1	0	0
28 350	to	28 450	0	0	1	0	0	1	1	0	1	1	0
28 450	to	28 550	0	0	1	0	0	1	1	0	0	1	0
28 550	to	28 650	0	0	1	0	0	1	1	0	0	1	1
28 650	to	28 750	0	0	1	0	0	1	1	0	0	0	1
28 750	to	28 850	0	0	1	0	0	0	1	0	0	0	1
28 850	to	28 950	0	0	1	0	0	0	1	0	0	1	1
28 950	to	29 050	0	0	1	0	0	0	1	0	0	1	0
29 050	to	29 150	0	0	1	0	0	0	1	0	1	1	0
29 150	to	29 250	0	0	1	0	0	0	1	0	1	0	0
29 250	to	29 350	0	0	1	0	0	0	1	1	1	0	0
29 350	to	29 450	0	0	1	0	0	0	1	1	1	1	0
29 450	to	29 550	0	0	1	0	0	0	1	1	0	1	0
29 550	to	29 650	0	0	1	0	0	0	1	1	0	1	1
29 650	to	29 750	0	0	1	0	0	0	1	1	0	0	1
29 750	to	29 850	0	0	1	0	0	0	0	1	0	0	1
29 850	to	29 950	0	0	1	0	0	0	0	1	0	1	1
29 950	to	30 050	0	0	1	0	0	0	0	1	0	1	0
30 050	to	30 150	0	0	1	0	0	0	0	1	1	1	0
30 150	to	30 250	0	0	1	0	0	0	0	1	1	0	0
30 250	to	30 350	0	0	1	0	0	0	0	0	1	0	0
30 350	to	30 450	0	0	1	0	0	0	0	0	1	1	0
30 450	to	30 550	0	0	1	0	0	0	0	0	0	1	0
30 550	to	30 650	0	0	1	0	0	0	0	0	0	1	1
30 650	to	30 750	0	0	1	0	0	0	0	0	0	0	1

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Table B (cont.)

RANGE INCREMENTS (*Feet*)	PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
	D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
30 750 to 30 850	0	1	1	0	0	0	0	0	0	0	1
30 850 to 30 950	0	1	1	0	0	0	0	0	0	1	1
30 950 to 31 050	0	1	1	0	0	0	0	0	0	1	0
31 050 to 31 150	0	1	1	0	0	0	0	0	1	1	0
31 150 to 31 250	0	1	1	0	0	0	0	0	1	0	0
31 250 to 31 350	0	1	1	0	0	0	0	1	1	0	0
31 350 to 31 450	0	1	1	0	0	0	0	1	1	1	0
31 450 to 31 550	0	1	1	0	0	0	0	1	0	1	0
31 550 to 31 650	0	1	1	0	0	0	0	1	0	1	1
31 650 to 31 750	0	1	1	0	0	0	0	1	0	0	1
31 750 to 31 850	0	1	1	0	0	0	1	1	0	0	1
31 850 to 31 950	0	1	1	0	0	0	1	1	0	1	1
31 950 to 32 050	0	1	1	0	0	0	1	1	0	1	0
32 050 to 32 150	0	1	1	0	0	0	1	1	1	1	0
32 150 to 32 250	0	1	1	0	0	0	1	1	1	0	0
32 250 to 32 350	0	1	1	0	0	0	1	0	1	0	0
32 350 to 32 450	0	1	1	0	0	0	1	0	1	1	0
32 450 to 32 550	0	1	1	0	0	0	1	0	0	1	0
32 550 to 32 650	0	1	1	0	0	0	1	0	0	1	1
32 650 to 32 750	0	1	1	0	0	0	1	0	0	0	1
32 750 to 32 850	0	1	1	0	0	1	1	0	0	0	1
32 850 to 32 950	0	1	1	0	0	1	1	0	0	1	1
32 950 to 33 050	0	1	1	0	0	1	1	0	0	1	0
33 050 to 33 150	0	1	1	0	0	1	1	0	1	1	0
33 150 to 33 250	0	1	1	0	0	1	1	0	1	0	0
33 250 to 33 350	0	1	1	0	0	1	1	1	1	0	0
33 350 to 33 450	0	1	1	0	0	1	1	1	1	1	0
33 450 to 33 550	0	1	1	0	0	1	1	1	0	1	0
33 550 to 33 650	0	1	1	0	0	1	1	1	0	1	1
33 650 to 33 750	0	1	1	0	0	1	1	1	0	0	1
33 750 to 33 850	0	1	1	0	0	1	0	1	0	0	1
33 850 to 33 950	0	1	1	0	0	1	0	1	0	1	1
33 950 to 34 050	0	1	1	0	0	1	0	1	0	1	0
34 050 to 34 150	0	1	1	0	0	1	0	1	1	1	0
34 150 to 34 250	0	1	1	0	0	1	0	1	1	0	0
34 250 to 34 350	0	1	1	0	0	1	0	0	1	0	0
34 350 to 34 450	0	1	1	0	0	1	0	0	1	1	0
34 450 to 34 550	0	1	1	0	0	1	0	0	0	1	0
34 550 to 34 650	0	1	1	0	0	1	0	0	0	1	1
34 650 to 34 750	0	1	1	0	0	1	0	0	0	0	1
34 750 to 34 850	0	1	1	0	1	1	0	0	0	0	1
34 850 to 34 950	0	1	1	0	1	1	0	0	0	1	1
34 950 to 35 050	0	1	1	0	1	1	0	0	0	1	0
35 050 to 35 150	0	1	1	0	1	1	0	0	1	1	0
35 150 to 35 250	0	1	1	0	1	1	0	0	1	0	0
35 250 to 35 350	0	1	1	0	1	1	0	1	1	0	0
35 350 to 35 450	0	1	1	0	1	1	0	1	1	1	0
35 450 to 35 550	0	1	1	0	1	1	0	1	0	1	0
35 550 to 35 650	0	1	1	0	1	1	0	1	0	1	1
35 650 to 35 750	0	1	1	0	1	1	0	1	0	0	1
35 750 to 35 850	0	1	1	0	1	1	1	1	0	0	1
35 850 to 35 950	0	1	1	0	1	1	1	1	0	1	1
35 950 to 36 050	0	1	1	0	1	1	1	1	0	1	0
36 050 to 36 150	0	1	1	0	1	1	1	1	1	1	0
36 150 to 36 250	0	1	1	0	1	1	1	1	1	0	0
36 250 to 36 350	0	1	1	0	1	1	1	0	1	0	0
36 350 to 36 450	0	1	1	0	1	1	1	0	1	1	0
36 450 to 36 550	0	1	1	0	1	1	1	0	0	1	0
36 550 to 36 650	0	1	1	0	1	1	1	0	0	1	1
36 650 to 36 750	0	1	1	0	1	1	1	0	0	0	1
36 750 to 36 850	0	1	1	0	1	0	1	0	0	0	1
36 850 to 36 950	0	1	1	0	1	0	1	0	0	1	1
36 950 to 37 050	0	1	1	0	1	0	1	0	0	1	0
37 050 to 37 150	0	1	1	0	1	0	1	0	1	1	0
37 150 to 37 250	0	1	1	0	1	0	1	0	1	0	0

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Table B (cont.)

RANGE			PULSE POSITIONS (0 or 1 in a pulse position denotes absence or presence of a pulse, respectively)										
INCREMENTS (Feet)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
37 250	to	37 350	0	1	1	0	1	0	1	1	1	0	0
37 350	to	37 450	0	1	1	0	1	0	1	1	1	1	0
37 450	to	37 550	0	1	1	0	1	0	1	1	0	1	0
37 550	to	37 650	0	1	1	0	1	0	1	1	0	1	1
37 650	to	37 750	0	1	1	0	1	0	1	1	0	0	1
37 750	to	37 850	0	1	1	0	1	0	0	1	0	0	1
37 850	to	37 950	0	1	1	0	1	0	0	1	0	1	1
37 950	to	38 050	0	1	1	0	1	0	0	1	0	1	0
38 050	to	38 150	0	1	1	0	1	0	0	1	1	1	0
38 150	to	38 250	0	1	1	0	1	0	0	1	1	0	0
38 250	to	38 350	0	1	1	0	1	0	0	0	1	0	0
38 350	to	38 450	0	1	1	0	1	0	0	0	1	1	0
38 450	to	38 550	0	1	1	0	1	0	0	0	0	1	0
38 550	to	38 650	0	1	1	0	1	0	0	0	0	1	1
38 650	to	38 750	0	1	1	0	1	0	0	0	0	0	1
38 750	to	38 850	0	1	1	1	1	0	0	0	0	0	1
38 850	to	38 950	0	1	1	1	1	0	0	0	0	1	1
38 950	to	39 050	0	1	1	1	1	0	0	0	0	1	0
39 050	to	39 150	0	1	1	1	1	0	0	0	1	1	0
39 150	to	39 250	0	1	1	1	1	0	0	0	1	0	0
39 250	to	39 350	0	1	1	1	1	0	0	1	1	0	0
39 350	to	39 450	0	1	1	1	1	0	0	1	1	1	0
39 450	to	39 550	0	1	1	1	1	0	0	1	0	1	0
39 550	to	39 650	0	1	1	1	1	0	0	1	0	1	1
39 650	to	39 750	0	1	1	1	1	0	0	1	0	0	1
39 750	to	39 850	0	1	1	1	1	0	1	1	0	0	1
39 850	to	39 950	0	1	1	1	1	0	1	1	0	1	1
39 950	to	40 050	0	1	1	1	1	0	1	1	0	1	0
40 050	to	40 150	0	1	1	1	1	0	1	1	1	1	0
40 150	to	40 250	0	1	1	1	1	0	1	1	1	0	0
40 250	to	40 350	0	1	1	1	1	0	1	0	1	0	0
40 350	to	40 450	0	1	1	1	1	0	1	0	1	1	0
40 450	to	40 550	0	1	1	1	1	0	1	0	0	1	0
40 550	to	40 650	0	1	1	1	1	0	1	0	0	1	1
40 650	to	40 750	0	1	1	1	1	0	1	0	0	0	1
40 750	to	40 850	0	1	1	1	1	1	1	0	0	0	1
40 850	to	40 950	0	1	1	1	1	1	1	0	0	1	1
40 950	to	41 050	0	1	1	1	1	1	1	0	0	1	0
41 050	to	41 150	0	1	1	1	1	1	1	0	1	1	0
41 150	to	41 250	0	1	1	1	1	1	1	0	1	0	0
41 250	to	41 350	0	1	1	1	1	1	1	1	1	0	0
41 350	to	41 450	0	1	1	1	1	1	1	1	1	1	0
41 450	to	41 550	0	1	1	1	1	1	1	1	0	1	0
41 550	to	41 650	0	1	1	1	1	1	1	1	0	1	1
41 650	to	41 750	0	1	1	1	1	1	1	1	0	0	1
41 750	to	41 850	0	1	1	1	1	1	0	1	0	0	1
41 850	to	41 950	0	1	1	1	1	1	0	1	0	1	1
41 950	to	42 050	0	1	1	1	1	1	0	1	0	1	0
42 050	to	42 150	0	1	1	1	1	1	0	1	1	1	0
42 150	to	42 250	0	1	1	1	1	1	0	1	1	0	0
42 250	to	42 350	0	1	1	1	1	1	0	0	1	0	0
42 350	to	42 450	0	1	1	1	1	1	0	0	1	1	0
42 450	to	42 550	0	1	1	1	1	1	0	0	0	1	0
42 550	to	42 650	0	1	1	1	1	1	0	0	0	1	1
42 650	to	42 750	0	1	1	1	1	1	0	0	0	0	1
42 750	to	42 850	0	1	1	1	0	1	0	0	0	0	1
42 850	to	42 950	0	1	1	1	0	1	0	0	0	1	1
42 950	to	43 050	0	1	1	1	0	1	0	0	0	1	0
43 050	to	43 150	0	1	1	1	0	1	0	0	1	1	0
43 150	to	43 250	0	1	1	1	0	1	0	0	1	0	0
43 250	to	43 350	0	1	1	1	0	1	0	1	1	0	0
43 350	to	43 450	0	1	1	1	0	1	0	1	1	1	0
43 450	to	43 550	0	1	1	1	0	1	0	1	0	1	0
43 550	to	43 650	0	1	1	1	0	1	0	1	0	1	1
43 650	to	43 750	0	1	1	1	0	1	0	1	0	0	1

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
43 750	to	43 850	0	1	1	1	0	1	1	1	0	0	1
43 850	to	43 950	0	1	1	1	0	1	1	1	0	1	1
43 950	to	44 050	0	1	1	1	0	1	1	1	0	1	0
44 050	to	44 150	0	1	1	1	0	1	1	1	1	1	0
44 150	to	44 250	0	1	1	1	0	1	1	1	1	0	0
44 250	to	44 350	0	1	1	1	0	1	1	0	1	0	0
44 350	to	44 450	0	1	1	1	0	1	1	0	1	1	0
44 450	to	44 550	0	1	1	1	0	1	1	0	0	1	0
44 550	to	44 650	0	1	1	1	0	1	1	0	0	1	1
44 650	to	44 750	0	1	1	1	0	1	1	0	0	0	1
44 750	to	44 850	0	1	1	1	0	0	1	0	0	0	1
44 850	to	44 950	0	1	1	1	0	0	1	0	0	1	1
44 950	to	45 050	0	1	1	1	0	0	1	0	0	1	0
45 050	to	45 150	0	1	1	1	0	0	1	0	1	1	0
45 150	to	45 250	0	1	1	1	0	0	1	0	1	0	0
45 250	to	45 350	0	1	1	1	0	0	1	1	1	0	0
45 350	to	45 450	0	1	1	1	0	0	1	1	1	1	0
45 450	to	45 550	0	1	1	1	0	0	1	1	0	1	0
45 550	to	45 650	0	1	1	1	0	0	1	1	0	1	1
45 650	to	45 750	0	1	1	1	0	0	1	1	0	0	1
45 750	to	45 850	0	1	1	1	0	0	0	1	0	0	1
45 850	to	45 950	0	1	1	1	0	0	0	1	0	1	1
45 950	to	46 050	0	1	1	1	0	0	0	1	0	1	0
46 050	to	46 150	0	1	1	1	0	0	0	1	1	1	0
46 150	to	46 250	0	1	1	1	0	0	0	1	1	0	0
46 250	to	46 350	0	1	1	1	0	0	0	0	1	0	0
46 350	to	46 450	0	1	1	1	0	0	0	0	1	1	0
46 450	to	46 550	0	1	1	1	0	0	0	0	0	1	0
46 550	to	46 650	0	1	1	1	0	0	0	0	0	1	1
46 650	to	46 750	0	1	1	1	0	0	0	0	0	0	1
46 750	to	46 850	0	1	0	1	0	0	0	0	0	0	1
46 850	to	46 950	0	1	0	1	0	0	0	0	0	1	1
46 950	to	47 050	0	1	0	1	0	0	0	0	0	1	0
47 050	to	47 150	0	1	0	1	0	0	0	0	1	1	0
47 150	to	47 250	0	1	0	1	0	0	0	0	1	0	0
47 250	to	47 350	0	1	0	1	0	0	0	1	1	0	0
47 350	to	47 450	0	1	0	1	0	0	0	1	1	1	0
47 450	to	47 550	0	1	0	1	0	0	0	1	0	1	0
47 550	to	47 650	0	1	0	1	0	0	0	1	0	1	1
47 650	to	47 750	0	1	0	1	0	0	0	1	0	0	1
47 750	to	47 850	0	1	0	1	0	0	1	1	0	0	1
47 850	to	47 950	0	1	0	1	0	0	1	1	0	1	1
47 950	to	48 050	0	1	0	1	0	0	1	1	0	1	0
48 050	to	48 150	0	1	0	1	0	0	1	1	1	1	0
48 150	to	48 250	0	1	0	1	0	0	1	1	1	0	0
48 250	to	48 350	0	1	0	1	0	0	1	0	1	0	0
48 350	to	48 450	0	1	0	1	0	0	1	0	1	1	0
48 450	to	48 550	0	1	0	1	0	0	1	0	0	1	0
48 550	to	48 650	0	1	0	1	0	0	1	0	0	1	1
48 650	to	48 750	0	1	0	1	0	0	1	0	0	0	1
48 750	to	48 850	0	1	0	1	0	1	1	0	0	0	1
48 850	to	48 950	0	1	0	1	0	1	1	0	0	1	1
48 950	to	49 050	0	1	0	1	0	1	1	0	0	1	0
49 050	to	49 150	0	1	0	1	0	1	1	0	1	1	0
49 150	to	49 250	0	1	0	1	0	1	1	0	1	0	0
49 250	to	49 350	0	1	0	1	0	1	1	1	1	0	0
49 350	to	49 450	0	1	0	1	0	1	1	1	1	1	0
49 450	to	49 550	0	1	0	1	0	1	1	1	0	1	0
49 550	to	49 650	0	1	0	1	0	1	1	1	0	1	1
49 650	to	49 750	0	1	0	1	0	1	1	1	0	0	1
49 750	to	49 850	0	1	0	1	0	1	0	1	0	0	1
49 850	to	49 950	0	1	0	1	0	1	0	1	0	1	1
49 950	to	50 050	0	1	0	1	0	1	0	1	0	1	0
50 050	to	50 150	0	1	0	1	0	1	0	1	1	1	0
50 150	to	50 250	0	1	0	1	0	1	0	1	1	0	0

Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
50 250	to	50 350	0	1	0	1	0	1	0	0	1	0	0
50 350	to	50 450	0	1	0	1	0	1	0	0	1	1	0
50 450	to	50 550	0	1	0	1	0	1	0	0	0	1	0
50 550	to	50 650	0	1	0	1	0	1	0	0	0	1	1
50 650	to	50 750	0	1	0	1	0	1	0	0	0	0	1
50 750	to	50 850	0	1	0	1	1	1	0	0	0	0	1
50 850	to	50 950	0	1	0	1	1	1	0	0	0	1	1
50 950	to	51 050	0	1	0	1	1	1	0	0	0	1	0
51 050	to	51 150	0	1	0	1	1	1	0	0	1	1	0
51 150	to	51 250	0	1	0	1	1	1	0	0	1	0	0
51 250	to	51 350	0	1	0	1	1	1	0	1	1	0	0
51 350	to	51 450	0	1	0	1	1	1	0	1	1	1	0
51 450	to	51 550	0	1	0	1	1	1	0	1	0	1	0
51 550	to	51 650	0	1	0	1	1	1	0	1	0	1	1
51 650	to	51 750	0	1	0	1	1	1	0	1	0	0	1
51 750	to	51 850	0	1	0	1	1	1	1	1	0	0	1
51 850	to	51 950	0	1	0	1	1	1	1	1	0	1	1
51 950	to	52 050	0	1	0	1	1	1	1	1	0	1	0
52 050	to	52 150	0	1	0	1	1	1	1	1	1	1	0
52 150	to	52 250	0	1	0	1	1	1	1	1	1	0	0
52 250	to	52 350	0	1	0	1	1	1	1	0	1	0	0
52 350	to	52 450	0	1	0	1	1	1	1	0	1	1	0
52 450	to	52 550	0	1	0	1	1	1	1	0	0	1	0
52 550	to	52 650	0	1	0	1	1	1	1	0	0	1	1
52 650	to	52 750	0	1	0	1	1	1	1	0	0	0	1
52 750	to	52 850	0	1	0	1	1	0	1	0	0	0	1
52 850	to	52 950	0	1	0	1	1	0	1	0	0	1	1
52 950	to	53 050	0	1	0	1	1	0	1	0	0	1	0
53 050	to	53 150	0	1	0	1	1	0	1	0	1	1	0
53 150	to	53 250	0	1	0	1	1	0	1	0	1	0	0
53 250	to	53 350	0	1	0	1	1	0	1	1	1	0	0
53 350	to	53 450	0	1	0	1	1	0	1	1	1	1	0
53 450	to	53 550	0	1	0	1	1	0	1	1	0	1	0
53 550	to	53 650	0	1	0	1	1	0	1	1	0	1	1
53 650	to	53 750	0	1	0	1	1	0	1	1	0	0	1
53 750	to	53 850	0	1	0	1	1	0	0	1	0	0	1
53 850	to	53 950	0	1	0	1	1	0	0	1	0	1	1
53 950	to	54 050	0	1	0	1	1	0	0	1	0	1	0
54 050	to	54 150	0	1	0	1	1	0	0	1	1	1	0
54 150	to	54 250	0	1	0	1	1	0	0	1	1	0	0
54 250	to	54 350	0	1	0	1	1	0	0	0	1	0	0
54 350	to	54 450	0	1	0	1	1	0	0	0	1	1	0
54 450	to	54 550	0	1	0	1	1	0	0	0	0	1	0
54 550	to	54 650	0	1	0	1	1	0	0	0	0	1	1
54 650	to	54 750	0	1	0	1	1	0	0	0	0	0	1
54 750	to	54 850	0	1	0	0	1	0	0	0	0	0	1
54 850	to	54 950	0	1	0	0	1	0	0	0	0	1	1
54 950	to	55 050	0	1	0	0	1	0	0	0	0	1	0
55 050	to	55 150	0	1	0	0	1	0	0	0	1	1	0
55 150	to	55 250	0	1	0	0	1	0	0	0	1	0	0
55 250	to	55 350	0	1	0	0	1	0	0	1	1	0	0
55 350	to	55 450	0	1	0	0	1	0	0	1	1	1	0
55 450	to	55 550	0	1	0	0	1	0	0	1	0	1	0
55 550	to	55 650	0	1	0	0	1	0	0	1	0	1	1
55 650	to	55 750	0	1	0	0	1	0	0	1	0	0	1
55 750	to	55 850	0	1	0	0	1	0	1	1	0	0	1
55 850	to	55 950	0	1	0	0	1	0	1	1	0	1	1
55 950	to	56 050	0	1	0	0	1	0	1	1	0	1	0
56 050	to	56 150	0	1	0	0	1	0	1	1	1	1	0
56 150	to	56 250	0	1	0	0	1	0	1	1	1	0	0
56 250	to	56 350	0	1	0	0	1	0	1	0	1	0	0
56 350	to	56 450	0	1	0	0	1	0	1	0	1	1	0
56 450	to	56 550	0	1	0	0	1	0	1	0	0	1	0
56 550	to	56 650	0	1	0	0	1	0	1	0	0	1	1
56 650	to	56 750	0	1	0	0	1	0	1	0	0	0	1

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Table B (cont.)

RANGE Increments (*Feet*)			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
56 750	to	56 850	0	1	0	0	1	1	1	0	0	0	1
56 850	to	56 950	0	1	0	0	1	1	1	0	0	1	1
56 950	to	57 050	0	1	0	0	1	1	1	0	0	1	0
57 050	to	57 150	0	1	0	0	1	1	1	0	1	1	0
57 150	to	57 250	0	1	0	0	1	1	1	0	1	0	0
57 250	to	57 350	0	1	0	0	1	1	1	1	1	0	0
57 350	to	57 450	0	1	0	0	1	1	1	1	1	1	0
57 450	to	57 550	0	1	0	0	1	1	1	1	0	1	0
57 550	to	57 650	0	1	0	0	1	1	1	1	0	1	1
57 650	to	57 750	0	1	0	0	1	1	1	1	0	0	1
57 750	to	57 850	0	1	0	0	1	1	0	1	0	0	1
57 850	to	57 950	0	1	0	0	1	1	0	1	0	1	1
57 950	to	58 050	0	1	0	0	1	1	0	1	0	1	0
58 050	to	58 150	0	1	0	0	1	1	0	1	1	1	0
58 150	to	58 250	0	1	0	0	1	1	0	1	1	0	0
58 250	to	58 350	0	1	0	0	1	1	0	0	1	0	0
58 350	to	58 450	0	1	0	0	1	1	0	0	1	1	0
58 450	to	58 550	0	1	0	0	1	1	0	0	0	1	0
58 550	to	58 650	0	1	0	0	1	1	0	0	0	1	1
58 650	to	58 750	0	1	0	0	1	1	0	0	0	0	1
58 750	to	58 850	0	1	0	0	0	1	0	0	0	0	1
58 850	to	58 950	0	1	0	0	0	1	0	0	0	1	1
58 950	to	59 050	0	1	0	0	0	1	0	0	0	1	0
59 050	to	59 150	0	1	0	0	0	1	0	0	1	1	0
59 150	to	59 250	0	1	0	0	0	1	0	0	1	0	0
59 250	to	59 350	0	1	0	0	0	1	0	1	1	0	0
59 350	to	59 450	0	1	0	0	0	1	0	1	1	1	0
59 450	to	59 550	0	1	0	0	0	1	0	1	0	1	0
59 550	to	59 650	0	1	0	0	0	1	0	1	0	1	1
59 650	to	59 750	0	1	0	0	0	1	0	1	0	0	1
59 750	to	59 850	0	1	0	0	0	1	1	1	0	0	1
59 850	to	59 950	0	1	0	0	0	1	1	1	0	1	1
59 950	to	60 050	0	1	0	0	0	1	1	1	0	1	0
60 050	to	60 150	0	1	0	0	0	1	1	1	1	1	0
60 150	to	60 250	0	1	0	0	0	1	1	1	1	0	0
60 250	to	60 350	0	1	0	0	0	1	1	0	1	0	0
60 350	to	60 450	0	1	0	0	0	1	1	0	1	1	0
60 450	to	60 550	0	1	0	0	0	1	1	0	0	1	0
60 550	to	60 650	0	1	0	0	0	1	1	0	0	1	1
60 650	to	60 750	0	1	0	0	0	1	1	0	0	0	1
60 750	to	60 850	0	1	0	0	0	0	1	0	0	0	1
60 850	to	60 950	0	1	0	0	0	0	1	0	0	1	1
60 950	to	61 050	0	1	0	0	0	0	1	0	0	1	0
61 050	to	61 150	0	1	0	0	0	0	1	0	1	1	0
61 150	to	61 250	0	1	0	0	0	0	1	0	1	0	0
61 250	to	61 350	0	1	0	0	0	0	1	1	1	0	0
61 350	to	61 450	0	1	0	0	0	0	1	1	1	1	0
61 450	to	61 550	0	1	0	0	0	0	1	1	0	1	0
61 550	to	61 650	0	1	0	0	0	0	1	1	0	1	1
61 650	to	61 750	0	1	0	0	0	0	1	1	0	0	1
61 750	to	61 850	0	1	0	0	0	0	0	1	0	0	1
61 850	to	61 950	0	1	0	0	0	0	0	1	0	1	1
61 950	to	62 050	0	1	0	0	0	0	0	1	0	1	0
62 050	to	62 150	0	1	0	0	0	0	0	1	1	1	0
62 150	to	62 250	0	1	0	0	0	0	0	1	1	0	0
62 250	to	62 350	0	1	0	0	0	0	0	0	1	0	0
62 350	to	62 450	0	1	0	0	0	0	0	0	1	1	0
62 450	to	62 550	0	1	0	0	0	0	0	0	0	1	0
62 550	to	62 650	0	1	0	0	0	0	0	0	0	1	1
62 650	to	62 750	0	1	0	0	0	0	0	0	0	0	1
62 750	to	62 850	1	1	0	0	0	0	0	0	0	0	1
62 850	to	62 950	1	1	0	0	0	0	0	0	0	1	1
62 950	to	63 050	1	1	0	0	0	0	0	0	0	1	0
63 050	to	63 150	1	1	0	0	0	0	0	0	1	1	0
63 150	to	63 250	1	1	0	0	0	0	0	0	1	0	0

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
63 250	to	63 350	1	1	0	0	0	0	0	1	1	0	0
63 350	to	63 450	1	1	0	0	0	0	0	1	1	1	0
63 450	to	63 550	1	1	0	0	0	0	0	1	0	1	0
63 550	to	63 650	1	1	0	0	0	0	0	1	0	1	1
63 650	to	63 750	1	1	0	0	0	0	0	1	0	0	1
63 750	to	63 850	1	1	0	0	0	0	1	1	0	0	1
63 850	to	63 950	1	1	0	0	0	0	1	1	0	1	1
63 950	to	64 050	1	1	0	0	0	0	1	1	0	1	0
64 050	to	64 150	1	1	0	0	0	0	1	1	1	1	0
64 150	to	64 250	1	1	0	0	0	0	1	1	1	0	0
64 250	to	64 350	1	1	0	0	0	0	1	0	1	0	0
64 350	to	64 450	1	1	0	0	0	0	1	0	1	1	0
64 450	to	64 550	1	1	0	0	0	0	1	0	0	1	0
64 550	to	64 650	1	1	0	0	0	0	1	0	0	1	1
64 650	to	64 750	1	1	0	0	0	0	1	0	0	0	1
64 750	to	64 850	1	1	0	0	0	1	1	0	0	0	1
64 850	to	64 950	1	1	0	0	0	1	1	0	0	1	1
64 950	to	65 050	1	1	0	0	0	1	1	0	0	1	0
65 050	to	65 150	1	1	0	0	0	1	1	0	1	1	0
65 150	to	65 250	1	1	0	0	0	1	1	0	1	0	0
65 250	to	65 350	1	1	0	0	0	1	1	1	1	0	0
65 350	to	65 450	1	1	0	0	0	1	1	1	1	1	0
65 450	to	65 550	1	1	0	0	0	1	1	1	0	1	0
65 550	to	65 650	1	1	0	0	0	1	1	1	0	1	1
65 650	to	65 750	1	1	0	0	0	1	1	1	0	0	1
65 750	to	65 850	1	1	0	0	0	1	0	1	0	0	1
65 850	to	65 950	1	1	0	0	0	1	0	1	0	1	1
65 950	to	66 050	1	1	0	0	0	1	0	1	0	1	0
66 050	to	66 150	1	1	0	0	0	1	0	1	1	1	0
66 150	to	66 250	1	1	0	0	0	1	0	1	1	0	0
66 250	to	66 350	1	1	0	0	0	1	0	0	1	0	0
66 350	to	66 450	1	1	0	0	0	1	0	0	1	1	0
66 450	to	66 550	1	1	0	0	0	1	0	0	0	1	0
66 550	to	66 650	1	1	0	0	0	1	0	0	0	1	1
66 650	to	66 750	1	1	0	0	0	1	0	0	0	0	1
66 750	to	66 850	1	1	0	0	1	1	0	0	0	0	1
66 850	to	66 950	1	1	0	0	1	1	0	0	0	1	1
66 950	to	67 050	1	1	0	0	1	1	0	0	0	1	0
67 050	to	67 150	1	1	0	0	1	1	0	0	1	1	0
67 150	to	67 250	1	1	0	0	1	1	0	0	1	0	0
67 250	to	67 350	1	1	0	0	1	1	0	1	1	0	0
67 350	to	67 450	1	1	0	0	1	1	0	1	1	1	0
67 450	to	67 550	1	1	0	0	1	1	0	1	0	1	0
67 550	to	67 650	1	1	0	0	1	1	0	1	0	1	1
67 650	to	67 750	1	1	0	0	1	1	0	1	0	0	1
67 750	to	67 850	1	1	0	0	1	1	1	1	0	0	1
67 850	to	67 950	1	1	0	0	1	1	1	1	0	1	1
67 950	to	68 050	1	1	0	0	1	1	1	1	0	1	0
68 050	to	68 150	1	1	0	0	1	1	1	1	1	1	0
68 150	to	68 250	1	1	0	0	1	1	1	1	1	0	0
68 250	to	68 350	1	1	0	0	1	1	1	0	1	0	0
68 350	to	68 450	1	1	0	0	1	1	1	0	1	1	0
68 450	to	68 550	1	1	0	0	1	1	1	0	0	1	0
68 550	to	68 650	1	1	0	0	1	1	1	0	0	1	1
68 650	to	68 750	1	1	0	0	1	1	1	0	0	0	1
68 750	to	68 850	1	1	0	0	1	0	1	0	0	0	1
68 850	to	68 950	1	1	0	0	1	0	1	0	0	1	1
68 950	to	69 050	1	1	0	0	1	0	1	0	0	1	0
69 050	to	69 150	1	1	0	0	1	0	1	0	1	1	0
69 150	to	69 250	1	1	0	0	1	0	1	0	1	0	0
69 250	to	69 350	1	1	0	0	1	0	1	1	1	0	0
69 350	to	69 450	1	1	0	0	1	0	1	1	1	1	0
69 450	to	69 550	1	1	0	0	1	0	1	1	0	1	0
69 550	to	69 650	1	1	0	0	1	0	1	1	0	1	1
69 650	to	69 750	1	1	0	0	1	0	1	1	0	0	1

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Table B (cont.)

RANGE Increments (*Feet*)			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
69 750	to	69 850	1	1	0	0	1	0	0	1	0	0	1
69 850	to	69 950	1	1	0	0	1	0	0	1	0	1	1
69 950	to	70 050	1	1	0	0	1	0	0	1	0	1	0
70 050	to	70 150	1	1	0	0	1	0	0	1	1	1	0
70 150	to	70 250	1	1	0	0	1	0	0	1	1	0	0
70 250	to	70 350	1	1	0	0	1	0	0	0	1	0	0
70 350	to	70 450	1	1	0	0	1	0	0	0	1	1	0
70 450	to	70 550	1	1	0	0	1	0	0	0	0	1	0
70 550	to	70 650	1	1	0	0	1	0	0	0	0	1	1
70 650	to	70 750	1	1	0	0	1	0	0	0	0	0	1
70 750	to	70 850	1	1	0	1	1	0	0	0	0	0	1
70 850	to	70 950	1	1	0	1	1	0	0	0	0	1	1
70 950	to	71 050	1	1	0	1	1	0	0	0	0	1	0
71 050	to	71 150	1	1	0	1	1	0	0	0	1	1	0
71 150	to	71 250	1	1	0	1	1	0	0	0	1	0	0
71 250	to	71 350	1	1	0	1	1	0	0	1	1	0	0
71 350	to	71 450	1	1	0	1	1	0	0	1	1	1	0
71 450	to	71 550	1	1	0	1	1	0	0	1	0	1	0
71 550	to	71 650	1	1	0	1	1	0	0	1	0	1	1
71 650	to	71 750	1	1	0	1	1	0	0	1	0	0	1
71 750	to	71 850	1	1	0	1	1	0	1	1	0	0	1
71 850	to	71 950	1	1	0	1	1	0	1	1	0	1	1
71 950	to	72 050	1	1	0	1	1	0	1	1	0	1	0
72 050	to	72 150	1	1	0	1	1	0	1	1	1	1	0
72 150	to	72 250	1	1	0	1	1	0	1	1	1	0	0
72 250	to	72 350	1	1	0	1	1	0	1	0	1	0	0
72 350	to	72 450	1	1	0	1	1	0	1	0	1	1	0
72 450	to	72 550	1	1	0	1	1	0	1	0	0	1	0
72 550	to	72 650	1	1	0	1	1	0	1	0	0	1	1
72 650	to	72 750	1	1	0	1	1	0	1	0	0	0	1
72 750	to	72 850	1	1	0	1	1	1	1	0	0	0	1
72 850	to	72 950	1	1	0	1	1	1	1	0	0	1	1
72 950	to	73 050	1	1	0	1	1	1	1	0	0	1	0
73 050	to	73 150	1	1	0	1	1	1	1	0	1	1	0
73 150	to	73 250	1	1	0	1	1	1	1	0	1	0	0
73 250	to	73 350	1	1	0	1	1	1	1	1	1	0	0
73 350	to	73 450	1	1	0	1	1	1	1	1	1	1	0
73 450	to	73 550	1	1	0	1	1	1	1	1	0	1	0
73 550	to	73 650	1	1	0	1	1	1	1	1	0	1	1
73 650	to	73 750	1	1	0	1	1	1	1	1	0	0	1
73 750	to	73 850	1	1	0	1	1	1	0	1	0	0	1
73 850	to	73 950	1	1	0	1	1	1	0	1	0	1	1
73 950	to	74 050	1	1	0	1	1	1	0	1	0	1	0
74 050	to	74 150	1	1	0	1	1	1	0	1	1	1	0
74 150	to	74 250	1	1	0	1	1	1	0	1	1	0	0
74 250	to	74 350	1	1	0	1	1	1	0	0	1	0	0
74 350	to	74 450	1	1	0	1	1	1	0	0	1	1	0
74 450	to	74 550	1	1	0	1	1	1	0	0	0	1	0
74 550	to	74 650	1	1	0	1	1	1	0	0	0	1	1
74 650	to	74 750	1	1	0	1	1	1	0	0	0	0	1
74 750	to	74 850	1	1	0	1	0	1	0	0	0	0	1
74 850	to	74 950	1	1	0	1	0	1	0	0	0	1	1
74 950	to	75 050	1	1	0	1	0	1	0	0	0	1	0
75 050	to	75 150	1	1	0	1	0	1	0	0	1	1	0
75 150	to	75 250	1	1	0	1	0	1	0	0	1	0	0
75 250	to	75 350	1	1	0	1	0	1	0	1	1	0	0
75 350	to	75 450	1	1	0	1	0	1	0	1	1	1	0
75 450	to	75 550	1	1	0	1	0	1	0	1	0	1	0
75 550	to	75 650	1	1	0	1	0	1	0	1	0	1	1
75 650	to	75 750	1	1	0	1	0	1	0	1	0	0	1
75 750	to	75 850	1	1	0	1	0	1	1	1	0	0	1
75 850	to	75 950	1	1	0	1	0	1	1	1	0	1	1
75 950	to	76 050	1	1	0	1	0	1	1	1	0	1	0
76 050	to	76 150	1	1	0	1	0	1	1	1	1	1	0
76 150	to	76 250	1	1	0	1	0	1	1	1	1	0	0

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
76 250	to	76 350	1	1	0	1	0	1	1	0	1	0	0
76 350	to	76 450	1	1	0	1	0	1	1	0	1	1	0
76 450	to	76 550	1	1	0	1	0	1	1	0	0	1	0
76 550	to	76 650	1	1	0	1	0	1	1	0	0	1	1
76 650	to	76 750	1	1	0	1	0	1	1	0	0	0	1
76 750	to	76 850	1	1	0	1	0	0	1	0	0	0	1
76 850	to	76 950	1	1	0	1	0	0	1	0	0	1	1
76 950	to	77 050	1	1	0	1	0	0	1	0	0	1	0
77 050	to	77 150	1	1	0	1	0	0	1	0	1	1	0
77 150	to	77 250	1	1	0	1	0	0	1	0	1	0	0
77 250	to	77 350	1	1	0	1	0	0	1	1	1	0	0
77 350	to	77 450	1	1	0	1	0	0	1	1	1	1	0
77 450	to	77 550	1	1	0	1	0	0	1	1	0	1	0
77 550	to	77 650	1	1	0	1	0	0	1	1	0	1	1
77 650	to	77 750	1	1	0	1	0	0	1	1	0	0	1
77 750	to	77 850	1	1	0	1	0	0	0	1	0	0	1
77 850	to	77 950	1	1	0	1	0	0	0	1	0	1	1
77 950	to	78 050	1	1	0	1	0	0	0	1	0	1	0
78 050	to	78 150	1	1	0	1	0	0	0	1	1	1	0
78 150	to	78 250	1	1	0	1	0	0	0	1	1	0	0
78 250	to	78 350	1	1	0	1	0	0	0	0	1	0	0
78 350	to	78 450	1	1	0	1	0	0	0	0	1	1	0
78 450	to	78 550	1	1	0	1	0	0	0	0	0	1	0
78 550	to	78 650	1	1	0	1	0	0	0	0	0	1	1
78 650	to	78 750	1	1	0	1	0	0	0	0	0	0	1
78 750	to	78 850	1	1	1	1	0	0	0	0	0	0	1
78 850	to	78 950	1	1	1	1	0	0	0	0	0	1	1
78 950	to	79 050	1	1	1	1	0	0	0	0	0	1	0
79 050	to	79 150	1	1	1	1	0	0	0	0	1	1	0
79 150	to	79 250	1	1	1	1	0	0	0	0	1	0	0
79 250	to	79 350	1	1	1	1	0	0	0	1	1	0	0
79 350	to	79 450	1	1	1	1	0	0	0	1	1	1	0
79 450	to	79 550	1	1	1	1	0	0	0	1	0	1	0
79 550	to	79 650	1	1	1	1	0	0	0	1	0	1	1
79 650	to	79 750	1	1	1	1	0	0	0	1	0	0	1
79 750	to	79 850	1	1	1	1	0	0	1	1	0	0	1
79 850	to	79 950	1	1	1	1	0	0	1	1	0	1	1
79 950	to	80 050	1	1	1	1	0	0	1	1	0	1	0
80 050	to	80 150	1	1	1	1	0	0	1	1	1	1	0
80 150	to	80 250	1	1	1	1	0	0	1	1	1	0	0
80 250	to	80 350	1	1	1	1	0	0	1	0	1	0	0
80 350	to	80 450	1	1	1	1	0	0	1	0	1	1	0
80 450	to	80 550	1	1	1	1	0	0	1	0	0	1	0
80 550	to	80 650	1	1	1	1	0	0	1	0	0	1	1
80 650	to	80 750	1	1	1	1	0	0	1	0	0	0	1
80 750	to	80 850	1	1	1	1	0	1	1	0	0	0	1
80 850	to	80 950	1	1	1	1	0	1	1	0	0	1	1
80 950	to	81 050	1	1	1	1	0	1	1	0	0	1	0
81 050	to	81 150	1	1	1	1	0	1	1	0	1	1	0
81 150	to	81 250	1	1	1	1	0	1	1	0	1	0	0
81 250	to	81 350	1	1	1	1	0	1	1	1	1	0	0
81 350	to	81 450	1	1	1	1	0	1	1	1	1	1	0
81 450	to	81 550	1	1	1	1	0	1	1	1	0	1	0
81 550	to	81 650	1	1	1	1	0	1	1	1	0	1	1
81 650	to	81 750	1	1	1	1	0	1	1	1	0	0	1
81 750	to	81 850	1	1	1	1	0	1	0	1	0	0	1
81 850	to	81 950	1	1	1	1	0	1	0	1	0	1	1
81 950	to	82 050	1	1	1	1	0	1	0	1	0	1	0
82 050	to	82 150	1	1	1	1	0	1	0	1	1	1	0
82 150	to	82 250	1	1	1	1	0	1	0	1	1	0	0
82 250	to	82 350	1	1	1	1	0	1	0	0	1	0	0
82 350	to	82 450	1	1	1	1	0	1	0	0	1	1	0
82 450	to	82 550	1	1	1	1	0	1	0	0	0	1	0
82 550	to	82 650	1	1	1	1	0	1	0	0	0	1	1
82 650	to	82 750	1	1	1	1	0	1	0	0	0	0	1

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
82 750	to	82 850	1	1	1	1	1	1	0	0	0	0	1
82 850	to	82 950	1	1	1	1	1	1	0	0	0	1	1
82 950	to	83 050	1	1	1	1	1	1	0	0	0	1	0
83 050	to	83 150	1	1	1	1	1	1	0	0	1	1	0
83 150	to	83 250	1	1	1	1	1	1	0	0	1	0	0
83 250	to	83 350	1	1	1	1	1	1	0	1	1	0	0
83 350	to	83 450	1	1	1	1	1	1	0	1	1	1	0
83 450	to	83 550	1	1	1	1	1	1	0	1	0	1	0
83 550	to	83 650	1	1	1	1	1	1	0	1	0	1	1
83 650	to	83 750	1	1	1	1	1	1	0	1	0	0	1
83 750	to	83 850	1	1	1	1	1	1	1	1	0	0	1
83 850	to	83 950	1	1	1	1	1	1	1	1	0	1	1
83 950	to	84 050	1	1	1	1	1	1	1	1	0	1	0
84 050	to	84 150	1	1	1	1	1	1	1	1	1	1	0
84 150	to	84 250	1	1	1	1	1	1	1	1	1	0	0
84 250	to	84 350	1	1	1	1	1	1	1	0	1	0	0
84 350	to	84 450	1	1	1	1	1	1	1	0	1	1	0
84 450	to	84 550	1	1	1	1	1	1	1	0	0	1	0
84 550	to	84 650	1	1	1	1	1	1	1	0	0	1	1
84 650	to	84 750	1	1	1	1	1	1	1	0	0	0	1
84 750	to	84 850	1	1	1	1	1	0	1	0	0	0	1
84 850	to	84 950	1	1	1	1	1	0	1	0	0	1	1
84 950	to	85 050	1	1	1	1	1	0	1	0	0	1	0
85 050	to	85 150	1	1	1	1	1	0	1	0	1	1	0
85 150	to	85 250	1	1	1	1	1	0	1	0	1	0	0
85 250	to	85 350	1	1	1	1	1	0	1	1	1	0	0
85 350	to	85 450	1	1	1	1	1	0	1	1	1	1	0
85 450	to	85 550	1	1	1	1	1	0	1	1	0	1	0
85 550	to	85 650	1	1	1	1	1	0	1	1	0	1	1
85 650	to	85 750	1	1	1	1	1	0	1	1	0	0	1
85 750	to	85 850	1	1	1	1	1	0	0	1	0	0	1
85 850	to	85 950	1	1	1	1	1	0	0	1	0	1	1
85 950	to	86 050	1	1	1	1	1	0	0	1	0	1	0
86 050	to	86 150	1	1	1	1	1	0	0	1	1	1	0
86 150	to	86 250	1	1	1	1	1	0	0	1	1	0	0
86 250	to	86 350	1	1	1	1	1	0	0	0	1	0	0
86 350	to	86 450	1	1	1	1	1	0	0	0	1	1	0
86 450	to	86 550	1	1	1	1	1	0	0	0	0	1	0
86 550	to	86 650	1	1	1	1	1	0	0	0	0	1	1
86 650	to	86 750	1	1	1	1	1	0	0	0	0	0	1
86 750	to	86 850	1	1	1	0	1	0	0	0	0	0	1
86 850	to	86 950	1	1	1	0	1	0	0	0	0	1	1
86 950	to	87 050	1	1	1	0	1	0	0	0	0	1	0
87 050	to	87 150	1	1	1	0	1	0	0	0	1	1	0
87 150	to	87 250	1	1	1	0	1	0	0	0	1	0	0
87 250	to	87 350	1	1	1	0	1	0	0	1	1	0	0
87 350	to	87 450	1	1	1	0	1	0	0	1	1	1	0
87 450	to	87 550	1	1	1	0	1	0	0	1	0	1	0
87 550	to	87 650	1	1	1	0	1	0	0	1	0	1	1
87 650	to	87 750	1	1	1	0	1	0	0	1	0	0	1
87 750	to	87 850	1	1	1	0	1	0	1	1	0	0	1
87 850	to	87 950	1	1	1	0	1	0	1	1	0	1	1
87 950	to	88 050	1	1	1	0	1	0	1	1	0	1	0
88 050	to	88 150	1	1	1	0	1	0	1	1	1	1	0
88 150	to	88 250	1	1	1	0	1	0	1	1	1	0	0
88 250	to	88 350	1	1	1	0	1	0	1	0	1	0	0
88 350	to	88 450	1	1	1	0	1	0	1	0	1	1	0
88 450	to	88 550	1	1	1	0	1	0	1	0	0	1	0
88 550	to	88 650	1	1	1	0	1	0	1	0	0	1	1
88 650	to	88 750	1	1	1	0	1	0	1	0	0	0	1
88 750	to	88 850	1	1	1	0	1	1	1	0	0	0	1
88 850	to	88 950	1	1	1	0	1	1	1	0	0	1	1
88 950	to	89 050	1	1	1	0	1	1	1	0	0	1	0
89 050	to	89 150	1	1	1	0	1	1	1	0	1	1	0
89 150	to	89 250	1	1	1	0	1	1	1	0	1	0	0

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
89 250	to	89 350	1	1	1	0	1	1	1	1	1	0	0
89 350	to	89 450	1	1	1	0	1	1	1	1	1	1	0
89 450	to	89 550	1	1	1	0	1	1	1	1	0	1	0
89 550	to	89 650	1	1	1	0	1	1	1	1	0	1	1
89 650	to	89 750	1	1	1	0	1	1	1	1	0	0	1
89 750	to	89 850	1	1	1	0	1	1	0	1	0	0	1
89 850	to	89 950	1	1	1	0	1	1	0	1	0	1	1
89 950	to	90 050	1	1	1	0	1	1	0	1	0	1	0
90 050	to	90 150	1	1	1	0	1	1	0	1	1	1	0
90 150	to	90 250	1	1	1	0	1	1	0	1	1	0	0
90 250	to	90 350	1	1	1	0	1	1	0	0	1	0	0
90 350	to	90 450	1	1	1	0	1	1	0	0	1	1	0
90 450	to	90 550	1	1	1	0	1	1	0	0	0	1	0
90 550	to	90 650	1	1	1	0	1	1	0	0	0	1	1
90 650	to	90 750	1	1	1	0	1	1	0	0	0	0	1
90 750	to	90 850	1	1	1	0	0	1	0	0	0	0	1
90 850	to	90 950	1	1	1	0	0	1	0	0	0	1	1
90 950	to	91 050	1	1	1	0	0	1	0	0	0	1	0
91 050	to	91 150	1	1	1	0	0	1	0	0	1	1	0
91 150	to	91 250	1	1	1	0	0	1	0	0	1	0	0
91 250	to	91 350	1	1	1	0	0	1	0	1	1	0	0
91 350	to	91 450	1	1	1	0	0	1	0	1	1	1	0
91 450	to	91 550	1	1	1	0	0	1	0	1	0	1	0
91 550	to	91 650	1	1	1	0	0	1	0	1	0	1	1
91 650	to	91 750	1	1	1	0	0	1	0	1	0	0	1
91 750	to	91 850	1	1	1	0	0	1	1	1	0	0	1
91 850	to	91 950	1	1	1	0	0	1	1	1	0	1	1
91 950	to	92 050	1	1	1	0	0	1	1	1	0	1	0
92 050	to	92 150	1	1	1	0	0	1	1	1	1	1	0
92 150	to	92 250	1	1	1	0	0	1	1	1	1	0	0
92 250	to	92 350	1	1	1	0	0	1	1	0	1	0	0
92 350	to	92 450	1	1	1	0	0	1	1	0	1	1	0
92 450	to	92 550	1	1	1	0	0	1	1	0	0	1	0
92 550	to	92 650	1	1	1	0	0	1	1	0	0	1	1
92 650	to	92 750	1	1	1	0	0	1	1	0	0	0	1
92 750	to	92 850	1	1	1	0	0	0	1	0	0	0	1
92 850	to	92 950	1	1	1	0	0	0	1	0	0	1	1
92 950	to	93 050	1	1	1	0	0	0	1	0	0	1	0
93 050	to	93 150	1	1	1	0	0	0	1	0	1	1	0
93 150	to	93 250	1	1	1	0	0	0	1	0	1	0	0
93 250	to	93 350	1	1	1	0	0	0	1	1	1	0	0
93 350	to	93 450	1	1	1	0	0	0	1	1	1	1	0
93 450	to	93 550	1	1	1	0	0	0	1	1	0	1	0
93 550	to	93 650	1	1	1	0	0	0	1	1	0	1	1
93 650	to	93 750	1	1	1	0	0	0	1	1	0	0	1
93 750	to	93 850	1	1	1	0	0	0	0	1	0	0	1
93 850	to	93 950	1	1	1	0	0	0	0	1	0	1	1
93 950	to	94 050	1	1	1	0	0	0	0	1	0	1	0
94 050	to	94 150	1	1	1	0	0	0	0	1	1	1	0
94 150	to	94 250	1	1	1	0	0	0	0	1	1	0	0
94 250	to	94 350	1	1	1	0	0	0	0	0	1	0	0
94 350	to	94 450	1	1	1	0	0	0	0	0	1	1	0
94 450	to	94 550	1	1	1	0	0	0	0	0	0	1	0
94 550	to	94 650	1	1	1	0	0	0	0	0	0	1	1
94 650	to	94 750	1	1	1	0	0	0	0	0	0	0	1
94 750	to	94 850	1	0	1	0	0	0	0	0	0	0	1
94 850	to	94 950	1	0	1	0	0	0	0	0	0	1	1
94 950	to	95 050	1	0	1	0	0	0	0	0	0	1	0
95 050	to	95 150	1	0	1	0	0	0	0	0	1	1	0
95 150	to	95 250	1	0	1	0	0	0	0	0	1	0	0
95 250	to	95 350	1	0	1	0	0	0	0	1	1	0	0
95 350	to	95 450	1	0	1	0	0	0	0	1	1	1	0
95 450	to	95 550	1	0	1	0	0	0	0	1	0	1	0
95 550	to	95 650	1	0	1	0	0	0	0	1	0	1	1
95 650	to	95 750	1	0	1	0	0	0	0	1	0	0	1

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
95 750	to	95 850	1	0	1	0	0	0	1	1	0	0	1
95 850	to	95 950	1	0	1	0	0	0	1	1	0	1	1
95 950	to	96 050	1	0	1	0	0	0	1	1	0	1	0
96 050	to	96 150	1	0	1	0	0	0	1	1	1	1	0
96 150	to	96 250	1	0	1	0	0	0	1	1	1	0	0
96 250	to	96 350	1	0	1	0	0	0	1	0	1	0	0
96 350	to	96 450	1	0	1	0	0	0	1	0	1	1	0
96 450	to	96 550	1	0	1	0	0	0	1	0	0	1	0
96 550	to	96 650	1	0	1	0	0	0	1	0	0	1	1
96 650	to	96 750	1	0	1	0	0	0	1	0	0	0	1
96 750	to	96 850	1	0	1	0	0	1	1	0	0	0	1
96 850	to	96 950	1	0	1	0	0	1	1	0	0	1	1
96 950	to	97 050	1	0	1	0	0	1	1	0	0	1	0
97 050	to	97 150	1	0	1	0	0	1	1	0	1	1	0
97 150	to	97 250	1	0	1	0	0	1	1	0	1	0	0
97 250	to	97 350	1	0	1	0	0	1	1	1	1	0	0
97 350	to	97 450	1	0	1	0	0	1	1	1	1	1	0
97 450	to	97 550	1	0	1	0	0	1	1	1	0	1	0
97 550	to	97 650	1	0	1	0	0	1	1	1	0	1	1
97 650	to	97 750	1	0	1	0	0	1	1	1	0	0	1
97 750	to	97 850	1	0	1	0	0	1	0	1	0	0	1
97 850	to	97 950	1	0	1	0	0	1	0	1	0	1	1
97 950	to	98 050	1	0	1	0	0	1	0	1	0	1	0
98 050	to	98 150	1	0	1	0	0	1	0	1	1	1	0
98 150	to	98 250	1	0	1	0	0	1	0	1	1	0	0
98 250	to	98 350	1	0	1	0	0	1	0	0	1	0	0
98 350	to	98 450	1	0	1	0	0	1	0	0	1	1	0
98 450	to	98 550	1	0	1	0	0	1	0	0	0	1	0
98 550	to	98 650	1	0	1	0	0	1	0	0	0	1	1
98 650	to	98 750	1	0	1	0	0	1	0	0	0	0	1
98 750	to	98 850	1	0	1	0	1	1	0	0	0	0	1
98 850	to	98 950	1	0	1	0	1	1	0	0	0	1	1
98 950	to	99 050	1	0	1	0	1	1	0	0	0	1	0
99 050	to	99 150	1	0	1	0	1	1	0	0	1	1	0
99 150	to	99 250	1	0	1	0	1	1	0	0	1	0	0
99 250	to	99 350	1	0	1	0	1	1	0	1	1	0	0
99 350	to	99 450	1	0	1	0	1	1	0	1	1	1	0
99 450	to	99 550	1	0	1	0	1	1	0	1	0	1	0
99 550	to	99 650	1	0	1	0	1	1	0	1	0	1	1
99 650	to	99 750	1	0	1	0	1	1	0	1	0	0	1
99 750	to	99 850	1	0	1	0	1	1	1	1	0	0	1
99 850	to	99 950	1	0	1	0	1	1	1	1	0	1	1
99 950	to	100 050	1	0	1	0	1	1	1	1	0	1	0
100 050	to	100 150	1	0	1	0	1	1	1	1	1	1	0
100 150	to	100 250	1	0	1	0	1	1	1	1	1	0	0
100 250	to	100 350	1	0	1	0	1	1	1	0	1	0	0
100 350	to	100 450	1	0	1	0	1	1	1	0	1	1	0
100 450	to	100 550	1	0	1	0	1	1	1	0	0	1	0
100 550	to	100 650	1	0	1	0	1	1	1	0	0	1	1
100 650	to	100 750	1	0	1	0	1	1	1	0	0	0	1
100 750	to	100 850	1	0	1	0	1	0	1	0	0	0	1
100 850	to	100 950	1	0	1	0	1	0	1	0	0	1	1
100 950	to	101 050	1	0	1	0	1	0	1	0	0	1	0
101 050	to	101 150	1	0	1	0	1	0	1	0	1	1	0
101 150	to	101 250	1	0	1	0	1	0	1	0	1	0	0
101 250	to	101 350	1	0	1	0	1	0	1	1	1	0	0
101 350	to	101 450	1	0	1	0	1	0	1	1	1	1	0
101 450	to	101 550	1	0	1	0	1	0	1	1	0	1	0
101 550	to	101 650	1	0	1	0	1	0	1	1	0	1	1
101 650	to	101 750	1	0	1	0	1	0	1	1	0	0	1
101 750	to	101 850	1	0	1	0	1	0	0	1	0	0	1
101 850	to	101 950	1	0	1	0	1	0	0	1	0	1	1
101 950	to	102 050	1	0	1	0	1	0	0	1	0	1	0
102 050	to	102 150	1	0	1	0	1	0	0	1	1	1	0
102 150	to	102 250	1	0	1	0	1	0	0	1	1	0	0

Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
102 250	to	102 350	1	0	1	0	1	0	0	0	1	0	0
102 350	to	102 450	1	0	1	0	1	0	0	0	1	1	0
102 450	to	102 550	1	0	1	0	1	0	0	0	0	1	0
102 550	to	102 650	1	0	1	0	1	0	0	0	0	1	1
102 650	to	102 750	1	0	1	0	1	0	0	0	0	0	1
102 750	to	102 850	1	0	1	1	1	0	0	0	0	0	1
102 850	to	102 950	1	0	1	1	1	0	0	0	0	1	1
102 950	to	103 050	1	0	1	1	1	0	0	0	0	1	0
103 050	to	103 150	1	0	1	1	1	0	0	0	1	1	0
103 150	to	103 250	1	0	1	1	1	0	0	0	1	0	0
103 250	to	103 350	1	0	1	1	1	0	0	1	1	0	0
103 350	to	103 450	1	0	1	1	1	0	0	1	1	1	0
103 450	to	103 550	1	0	1	1	1	0	0	1	0	1	0
103 550	to	103 650	1	0	1	1	1	0	0	1	0	1	1
103 650	to	103 750	1	0	1	1	1	0	0	1	0	0	1
103 750	to	103 850	1	0	1	1	1	0	1	1	0	0	1
103 850	to	103 950	1	0	1	1	1	0	1	1	0	1	1
103 950	to	104 050	1	0	1	1	1	0	1	1	0	1	0
104 050	to	104 150	1	0	1	1	1	0	1	1	1	1	0
104 150	to	104 250	1	0	1	1	1	0	1	1	1	0	0
104 250	to	104 350	1	0	1	1	1	0	1	0	1	0	0
104 350	to	104 450	1	0	1	1	1	0	1	0	1	1	0
104 450	to	104 550	1	0	1	1	1	0	1	0	0	1	0
104 550	to	104 650	1	0	1	1	1	0	1	0	0	1	1
104 650	to	104 750	1	0	1	1	1	0	1	0	0	0	1
104 750	to	104 850	1	0	1	1	1	1	1	0	0	0	1
104 850	to	104 950	1	0	1	1	1	1	1	0	0	1	1
104 950	to	105 050	1	0	1	1	1	1	1	0	0	1	0
105 050	to	105 150	1	0	1	1	1	1	1	0	1	1	0
105 150	to	105 250	1	0	1	1	1	1	1	0	1	0	0
105 250	to	105 350	1	0	1	1	1	1	1	1	1	0	0
105 350	to	105 450	1	0	1	1	1	1	1	1	1	1	0
105 450	to	105 550	1	0	1	1	1	1	1	1	0	1	0
105 550	to	105 650	1	0	1	1	1	1	1	1	0	1	1
105 650	to	105 750	1	0	1	1	1	1	1	1	0	0	1
105 750	to	105 850	1	0	1	1	1	1	0	1	0	0	1
105 850	to	105 950	1	0	1	1	1	1	0	1	0	1	1
105 950	to	106 050	1	0	1	1	1	1	0	1	0	1	0
106 050	to	106 150	1	0	1	1	1	1	0	1	1	1	0
106 150	to	106 250	1	0	1	1	1	1	0	1	1	0	0
106 250	to	106 350	1	0	1	1	1	1	0	0	1	0	0
106 350	to	106 450	1	0	1	1	1	1	0	0	1	1	0
106 450	to	106 550	1	0	1	1	1	1	0	0	0	1	0
106 550	to	106 650	1	0	1	1	1	1	0	0	0	1	1
106 650	to	106 750	1	0	1	1	1	1	0	0	0	0	1
106 750	to	106 850	1	0	1	1	0	1	0	0	0	0	1
106 850	to	106 950	1	0	1	1	0	1	0	0	0	1	1
106 950	to	107 050	1	0	1	1	0	1	0	0	0	1	0
107 050	to	107 150	1	0	1	1	0	1	0	0	1	1	0
107 150	to	107 250	1	0	1	1	0	1	0	0	1	0	0
107 250	to	107 350	1	0	1	1	0	1	0	1	1	0	0
107 350	to	107 450	1	0	1	1	0	1	0	1	1	1	0
107 450	to	107 550	1	0	1	1	0	1	0	1	0	1	0
107 550	to	107 650	1	0	1	1	0	1	0	1	0	1	1
107 650	to	107 750	1	0	1	1	0	1	0	1	0	0	1
107 750	to	107 850	1	0	1	1	0	1	1	1	0	0	1
107 850	to	107 950	1	0	1	1	0	1	1	1	0	1	1
107 950	to	108 050	1	0	1	1	0	1	1	1	0	1	0
108 050	to	108 150	1	0	1	1	0	1	1	1	1	1	0
108 150	to	108 250	1	0	1	1	0	1	1	1	1	0	0
108 250	to	108 350	1	0	1	1	0	1	1	0	1	0	0
108 350	to	108 450	1	0	1	1	0	1	1	0	1	1	0
108 450	to	108 550	1	0	1	1	0	1	1	0	0	1	0
108 550	to	108 650	1	0	1	1	0	1	1	0	0	1	1
108 650	to	108 750	1	0	1	1	0	1	1	0	0	0	1

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
108 750	to	108 850	1	0	1	1	0	0	1	0	0	0	1
108 850	to	108 950	1	0	1	1	0	0	1	0	0	1	1
108 950	to	109 050	1	0	1	1	0	0	1	0	0	1	0
109 050	to	109 150	1	0	1	1	0	0	1	0	1	1	0
109 150	to	109 250	1	0	1	1	0	0	1	0	1	0	0
109 250	to	109 350	1	0	1	1	0	0	1	1	1	0	0
109 350	to	109 450	1	0	1	1	0	0	1	1	1	1	0
109 450	to	109 550	1	0	1	1	0	0	1	1	0	1	0
109 550	to	109 650	1	0	1	1	0	0	1	1	0	1	1
109 650	to	109 750	1	0	1	1	0	0	1	1	0	0	1
109 750	to	109 850	1	0	1	1	0	0	0	1	0	0	1
109 850	to	109 950	1	0	1	1	0	0	0	1	0	1	1
109 950	to	110 050	1	0	1	1	0	0	0	1	0	1	0
110 050	to	110 150	1	0	1	1	0	0	0	1	1	1	0
110 150	to	110 250	1	0	1	1	0	0	0	1	1	0	0
110 250	to	110 350	1	0	1	1	0	0	0	0	1	0	0
110 350	to	110 450	1	0	1	1	0	0	0	0	1	1	0
110 450	to	110 550	1	0	1	1	0	0	0	0	0	1	0
110 550	to	110 650	1	0	1	1	0	0	0	0	0	1	1
110 650	to	110 750	1	0	1	1	0	0	0	0	0	0	1
110 750	to	110 850	1	0	0	1	0	0	0	0	0	0	1
110 850	to	110 950	1	0	0	1	0	0	0	0	0	1	1
110 950	to	111 050	1	0	0	1	0	0	0	0	0	1	0
111 050	to	111 150	1	0	0	1	0	0	0	0	1	1	0
111 150	to	111 250	1	0	0	1	0	0	0	0	1	0	0
111 250	to	111 350	1	0	0	1	0	0	0	1	1	0	0
111 350	to	111 450	1	0	0	1	0	0	0	1	1	1	0
111 450	to	111 550	1	0	0	1	0	0	0	1	0	1	0
111 550	to	111 650	1	0	0	1	0	0	0	1	0	1	1
111 650	to	111 750	1	0	0	1	0	0	0	1	0	0	1
111 750	to	111 850	1	0	0	1	0	0	1	1	0	0	1
111 850	to	111 950	1	0	0	1	0	0	1	1	0	1	1
111 950	to	112 050	1	0	0	1	0	0	1	1	0	1	0
112 050	to	112 150	1	0	0	1	0	0	1	1	1	1	0
112 150	to	112 250	1	0	0	1	0	0	1	1	1	0	0
112 250	to	112 350	1	0	0	1	0	0	1	0	1	0	0
112 350	to	112 450	1	0	0	1	0	0	1	0	1	1	0
112 450	to	112 550	1	0	0	1	0	0	1	0	0	1	0
112 550	to	112 650	1	0	0	1	0	0	1	0	0	1	1
112 650	to	112 750	1	0	0	1	0	0	1	0	0	0	1
112 750	to	112 850	1	0	0	1	0	1	1	0	0	0	1
112 850	to	112 950	1	0	0	1	0	1	1	0	0	1	1
112 950	to	113 050	1	0	0	1	0	1	1	0	0	1	0
113 050	to	113 150	1	0	0	1	0	1	1	0	1	1	0
113 150	to	113 250	1	0	0	1	0	1	1	0	1	0	0
113 250	to	113 350	1	0	0	1	0	1	1	1	1	0	0
113 350	to	113 450	1	0	0	1	0	1	1	1	1	1	0
113 450	to	113 550	1	0	0	1	0	1	1	1	0	1	0
113 550	to	113 650	1	0	0	1	0	1	1	1	0	1	1
113 650	to	113 750	1	0	0	1	0	1	1	1	0	0	1
113 750	to	113 850	1	0	0	1	0	1	0	1	0	0	1
113 850	to	113 950	1	0	0	1	0	1	0	1	0	1	1
113 950	to	114 050	1	0	0	1	0	1	0	1	0	1	0
114 050	to	114 150	1	0	0	1	0	1	0	1	1	1	0
114 150	to	114 250	1	0	0	1	0	1	0	1	1	0	0
114 250	to	114 350	1	0	0	1	0	1	0	0	1	0	0
114 350	to	114 450	1	0	0	1	0	1	0	0	1	1	0
114 450	to	114 550	1	0	0	1	0	1	0	0	0	1	0
114 550	to	114 650	1	0	0	1	0	1	0	0	0	1	1
114 650	to	114 750	1	0	0	1	0	1	0	0	0	0	1
114 750	to	114 850	1	0	0	1	1	1	0	0	0	0	1
114 850	to	114 950	1	0	0	1	1	1	0	0	0	1	1
114 950	to	115 050	1	0	0	1	1	1	0	0	0	1	0
115 050	to	115 150	1	0	0	1	1	1	0	0	1	1	0
115 150	to	115 250	1	0	0	1	1	1	0	0	1	0	0

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
115 250	to	115 350	1	0	0	1	1	1	0	1	1	0	0
115 350	to	115 450	1	0	0	1	1	1	0	1	1	1	0
115 450	to	115 550	1	0	0	1	1	1	0	1	0	1	0
115 550	to	115 650	1	0	0	1	1	1	0	1	0	1	1
115 650	to	115 750	1	0	0	1	1	1	0	1	0	0	1
115 750	to	115 850	1	0	0	1	1	1	1	1	0	0	1
115 850	to	115 950	1	0	0	1	1	1	1	1	0	1	1
115 950	to	116 050	1	0	0	1	1	1	1	1	0	1	0
116 050	to	116 150	1	0	0	1	1	1	1	1	1	1	0
116 150	to	116 250	1	0	0	1	1	1	1	1	1	0	0
116 250	to	116 350	1	0	0	1	1	1	1	0	1	0	0
116 350	to	116 450	1	0	0	1	1	1	1	0	1	1	0
116 450	to	116 550	1	0	0	1	1	1	1	0	0	1	0
116 550	to	116 650	1	0	0	1	1	1	1	0	0	1	1
116 650	to	116 750	1	0	0	1	1	1	1	0	0	0	1
116 750	to	116 850	1	0	0	1	1	0	1	0	0	0	1
116 850	to	116 950	1	0	0	1	1	0	1	0	0	1	1
116 950	to	117 050	1	0	0	1	1	0	1	0	0	1	0
117 050	to	117 150	1	0	0	1	1	0	1	0	1	1	0
117 150	to	117 250	1	0	0	1	1	0	1	0	1	0	0
117 250	to	117 350	1	0	0	1	1	0	1	1	1	0	0
117 350	to	117 450	1	0	0	1	1	0	1	1	1	1	0
117 450	to	117 550	1	0	0	1	1	0	1	1	0	1	0
117 550	to	117 650	1	0	0	1	1	0	1	1	0	1	1
117 650	to	117 750	1	0	0	1	1	0	1	1	0	0	1
117 750	to	117 850	1	0	0	1	1	0	0	1	0	0	1
117 850	to	117 950	1	0	0	1	1	0	0	1	0	1	1
117 950	to	118 050	1	0	0	1	1	0	0	1	0	1	0
118 050	to	118 150	1	0	0	1	1	0	0	1	1	1	0
118 150	to	118 250	1	0	0	1	1	0	0	1	1	0	0
118 250	to	118 350	1	0	0	1	1	0	0	0	1	0	0
118 350	to	118 450	1	0	0	1	1	0	0	0	1	1	0
118 450	to	118 550	1	0	0	1	1	0	0	0	0	1	0
118 550	to	118 650	1	0	0	1	1	0	0	0	0	1	1
118 650	to	118 750	1	0	0	1	1	0	0	0	0	0	1
118 750	to	118 850	1	0	0	0	1	0	0	0	0	0	1
118 850	to	118 950	1	0	0	0	1	0	0	0	0	1	1
118 950	to	119 050	1	0	0	0	1	0	0	0	0	1	0
119 050	to	119 150	1	0	0	0	1	0	0	0	1	1	0
119 150	to	119 250	1	0	0	0	1	0	0	0	1	0	0
119 250	to	119 350	1	0	0	0	1	0	0	1	1	0	0
119 350	to	119 450	1	0	0	0	1	0	0	1	1	1	0
119 450	to	119 550	1	0	0	0	1	0	0	1	0	1	0
119 550	to	119 650	1	0	0	0	1	0	0	1	0	1	1
119 650	to	119 750	1	0	0	0	1	0	0	1	0	0	1
119 750	to	119 850	1	0	0	0	1	0	1	1	0	0	1
119 850	to	119 950	1	0	0	0	1	0	1	1	0	1	1
119 950	to	120 050	1	0	0	0	1	0	1	1	0	1	0
120 050	to	120 150	1	0	0	0	1	0	1	1	1	1	0
120 150	to	120 250	1	0	0	0	1	0	1	1	1	0	0
120 250	to	120 350	1	0	0	0	1	0	1	0	1	0	0
120 350	to	120 450	1	0	0	0	1	0	1	0	1	1	0
120 450	to	120 550	1	0	0	0	1	0	1	0	0	1	0
120 550	to	120 650	1	0	0	0	1	0	1	0	0	1	1
120 650	to	120 750	1	0	0	0	1	0	1	0	0	0	1
120 750	to	120 850	1	0	0	0	1	1	1	0	0	0	1
120 850	to	120 950	1	0	0	0	1	1	1	0	0	1	1
120 950	to	121 050	1	0	0	0	1	1	1	0	0	1	0
121 050	to	121 150	1	0	0	0	1	1	1	0	1	1	0
121 150	to	121 250	1	0	0	0	1	1	1	0	1	0	0
121 250	to	121 350	1	0	0	0	1	1	1	1	1	0	0
121 350	to	121 450	1	0	0	0	1	1	1	1	1	1	0
121 450	to	121 550	1	0	0	0	1	1	1	1	0	1	0
121 550	to	121 650	1	0	0	0	1	1	1	1	0	1	1
121 650	to	121 750	1	0	0	0	1	1	1	1	0	0	1

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Table B (cont.)

RANGE			PULSE POSITIONS (*0 or 1 in a pulse position denotes absence or presence of a pulse, respectively*)										
INCREMENTS (*Feet*)			D_2	D_4	A_1	A_2	A_4	B_1	B_2	B_4	C_1	C_2	C_4
121 750	to	121 850	1	0	0	0	1	1	0	1	0	0	1
121 850	to	121 950	1	0	0	0	1	1	0	1	0	1	1
121 950	to	122 050	1	0	0	0	1	1	0	1	0	1	0
122 050	to	122 150	1	0	0	0	1	1	0	1	1	1	0
122 150	to	122 250	1	0	0	0	1	1	0	1	1	0	0
122 250	to	122 350	1	0	0	0	1	1	0	0	1	0	0
122 350	to	122 450	1	0	0	0	1	1	0	0	1	1	0
122 450	to	122 550	1	0	0	0	1	1	0	0	0	1	0
122 550	to	122 650	1	0	0	0	1	1	0	0	0	1	1
122 650	to	122 750	1	0	0	0	1	1	0	0	0	0	1
122 750	to	122 850	1	0	0	0	0	1	0	0	0	0	1
122 850	to	122 950	1	0	0	0	0	1	0	0	0	1	1
122 950	to	123 050	1	0	0	0	0	1	0	0	0	1	0
123 050	to	123 150	1	0	0	0	0	1	0	0	1	1	0
123 150	to	123 250	1	0	0	0	0	1	0	0	1	0	0
123 250	to	123 350	1	0	0	0	0	1	0	1	1	0	0
123 350	to	123 450	1	0	0	0	0	1	0	1	1	1	0
123 450	to	123 550	1	0	0	0	0	1	0	1	0	1	0
123 550	to	123 650	1	0	0	0	0	1	0	1	0	1	1
123 650	to	123 750	1	0	0	0	0	1	0	1	0	0	1
123 750	to	123 850	1	0	0	0	0	1	1	1	0	0	1
123 850	to	123 950	1	0	0	0	0	1	1	1	0	1	1
123 950	to	124 050	1	0	0	0	0	1	1	1	0	1	0
124 050	to	124 150	1	0	0	0	0	1	1	1	1	1	0
124 150	to	124 250	1	0	0	0	0	1	1	1	1	0	0
124 250	to	124 350	1	0	0	0	0	1	1	0	1	0	0
124 350	to	124 450	1	0	0	0	0	1	1	0	1	1	0
124 450	to	124 550	1	0	0	0	0	1	1	0	0	1	0
124 550	to	124 650	1	0	0	0	0	1	1	0	0	1	1
124 650	to	124 750	1	0	0	0	0	1	1	0	0	0	1
124 750	to	124 850	1	0	0	0	0	0	1	0	0	0	1
124 850	to	124 950	1	0	0	0	0	0	1	0	0	1	1
124 950	to	125 050	1	0	0	0	0	0	1	0	0	1	0
125 050	to	125 150	1	0	0	0	0	0	1	0	1	1	0
125 150	to	125 250	1	0	0	0	0	0	1	0	1	0	0
125 250	to	125 350	1	0	0	0	0	0	1	1	1	0	0
125 350	to	125 450	1	0	0	0	0	0	1	1	1	1	0
125 450	to	125 550	1	0	0	0	0	0	1	1	0	1	0
125 550	to	125 650	1	0	0	0	0	0	1	1	0	1	1
125 650	to	125 750	1	0	0	0	0	0	1	1	0	0	1
125 750	to	125 850	1	0	0	0	0	0	0	1	0	0	1
125 850	to	125 950	1	0	0	0	0	0	0	1	0	1	1
125 950	to	126 050	1	0	0	0	0	0	0	1	0	1	0
126 050	to	126 150	1	0	0	0	0	0	0	1	1	1	0
126 150	to	126 250	1	0	0	0	0	0	0	1	1	0	0
126 250	to	126 350	1	0	0	0	0	0	0	0	1	0	0
126 350	to	126 450	1	0	0	0	0	0	0	0	1	1	0
126 450	to	126 550	1	0	0	0	0	0	0	0	0	1	0
126 550	to	126 650	1	0	0	0	0	0	0	0	0	1	1
126 650	to	126 750	1	0	0	0	0	0	0	0	0	0	1

Table C. Allowable DME/P errors

Location	*Standard*	*Mode*	*PFE*	*CMN*
37 km (20 NM) to 9.3 km (5 NM) from MLS approach reference datum	1 and 2	IA	±250 m (±820 ft) reducing linearly to ±85 m (±279 ft)	±68 m (±223 ft) reducing linearly to ±34 m (±111 ft)
9.3 km (5 NM) to MLS approach reference datum	1	FA	±85 m (±279 ft) reducing linearly to ±30 m (±100 ft)	±18 m (±60 ft)
	2	FA	±85 m (±279 ft) reducing linearly to ±12 m (±40 ft)	±12 m (±40 ft)
	See Note	IA	±100 m (±328 ft)	±68 m (±223 ft)
At MLS approach reference datum and through runway coverage	1	FA	±30 m (±100 ft)	±18 m (±60 ft)
	2	FA	±12 m (±40 ft)	±12 m (±40 ft)
Throughout back azimuth coverage volume	1 and 2	FA	±100 m (±328 ft)	±68 m (±223 ft)
	See Note	IA	±100 m (±328 ft)	±68 m (±223 ft)

Note.— At distances from 9.3 km (5 NM) to the MLS approach reference datum and throughout the back azimuth coverage the IA mode may be used when the FA mode is not operative.

CHAPTER 4. COMMUNICATION SYSTEMS

4.1 Definitions

Data signalling rate. Data signalling rate refers to the passage of information per unit of time, and is expressed in bits/second. Data signalling rate is given by the formula:

$$\sum_{i=1}^{i=m} \frac{1}{T_i} \log_2 n_i$$

where m is the number of parallel channels, T_i is the minimum interval for the ith channel expressed in seconds, n_i is the number of significant conditions of the modulation in the ith channel.

Note 1.—

a) *For a single channel (serial transmission) it reduces to* $(1/T)\log_2 n$; *with a two-condition modulation* (n = 2), *it is* 1/T.

b) *For a parallel transmission with equal minimum intervals and equal number of significant conditions on each channel, it is* $m(1/T)\log_2 n$ ($m(1/T)$ *in case of a two-condition modulation).*

Note 2.— In the above definition, the term "parallel channels" is interpreted to mean: channels, each of which carries an integral part of an information unit, e.g. the parallel transmission of bits forming a character. In the case of a circuit comprising a number of channels, each of which carries information "independently", with the sole purpose of increasing the traffic handling capacity, these channels are not to be regarded as parallel channels in the context of this definition.

Degree of standardized test distortion. The degree of distortion of the restitution measured during a specific period of time when the modulation is perfect and corresponds to a specific text.

Effective margin. That margin of an individual apparatus which could be measured under actual operating conditions.

Low modulation rates. Modulation rates up to and including 300 bauds.

Margin. The maximum degree of distortion of the circuit at the end of which the apparatus is situated which is compatible with the correct translation of all the signals which it may possibly receive.

Medium modulation rates. Modulation rates above 300 and up to and including 3 000 bauds.

Modulation rate. The reciprocal of the unit interval measured in seconds. This rate is expressed in bauds.

Note.— Telegraph signals are characterized by intervals of time of duration equal to or longer than the shortest or unit interval. The modulation rate (formerly telegraph speed) is therefore expressed as the inverse of the value of this unit interval. If, for example, the unit interval is 20 milliseconds, the modulation rate is 50 bauds.

SELCAL system. A system which permits the selective calling of individual aircraft over radiotelephone channels linking a ground station with the aircraft.

Synchronous operation. Operation in which the time interval between code units is a constant.

4.2 Technical provisions relating to teletypewriter apparatus and circuits used in the AFTN

4.2.1 In international teletypewriter circuits of the AFTN, using a 5-unit code, the International Telegraph Alphabet No. 2 shall be used only to the extent prescribed in 4.1.2 of Volume II.

4.2.2 **Recommendation.—** *The modulation rate should be determined by bilateral or multilateral agreement between administrations concerned, taking into account primarily traffic volume.*

4.2.3 **Recommendation.—** *The nominal duration of the transmitting cycle should be at least 7.4 units (preferably 7.5), the stop element lasting for at least 1.4 units (preferably 1.5).*

4.2.3.1 **Recommendation.—** *The receiver should be able to translate correctly in service the signals coming from a transmitter with a nominal transmitting cycle of 7 units.*

4.2.4 **Recommendation.—** *Apparatus in service should be maintained and adjusted in such a manner that its net effective margin is never less than 35 per cent.*

4.2.5 **Recommendation.—** *The number of characters which the textual line of the page-printing apparatus may contain should be fixed at 69.*

4.2.6 **Recommendation.—** *In start-stop apparatus fitted with automatic time delay switches, the disconnection of the power supply to the motor should not take place before the lapse of at least 45 seconds after the reception of the last signal.*

Table 4-1. International Telegraph Alphabets No. 2 and No. 3

Number of signal	*Letter case*	*Figure case*	*Impulses 5-unit code* Start	12345	Stop
				International Code No. 2	
1	A	—	A	ZZAAA	Z
2	B	?	A	ZAAZZ	Z
3	C	:	A	AZZZA	Z
4	D	Note 1	A	ZAAZA	Z
5	E	3	A	ZAAAA	Z
6	F		A	ZAZZA	Z
7	G		A	AZAZZ	Z
8	H		A	AAZAZ	Z
9	I	8	A	AZZAA	Z
10	J	Attention signal	A	ZZAZA	Z
11	K	(	A	ZZZZA	Z
12	L	)	A	AZAAZ	Z
13	M	.	A	AAZZZ	Z
14	N	,	A	AAZZA	Z
15	O	9	A	AAAZZ	Z
16	P	0	A	AZZAZ	Z
17	Q	1	A	ZZZAZ	Z
18	R	4	A	AZAZA	Z
19	S	'	A	ZAZAA	Z
20	T	5	A	AAAAZ	Z
21	U	7	A	ZZZAA	Z
22	V	=	A	AZZZZ	Z
23	W	2	A	ZZAAZ	Z
24	X	/	A	ZAZZZ	Z
25	Y	6	A	ZAZAZ	Z
26	Z	+	A	ZAAAZ	Z
27	carriage return		A	AAAZA	Z
28	line feed		A	AZAAA	Z
29	letters		A	ZZZZZ	Z
30	figures		A	ZZAZZ	Z
31	space		A	AAZAA	Z
32	unperforated tape		A	AAAAA	Z
33	signal repetition				
34	signal α				
35	signal β				

Sign	*Closed circuit*	*Double current*
A	No current	Negative current
Z	Positive current	Positive current

Note 1. Used for answer-back facility.

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4.2.7 **Recommendation.—** *Arrangements should be made to avoid the mutilation of signals transmitted at the head of a message and received on start-stop reperforating apparatus.*

4.2.7.1 **Recommendation.—** *If the reperforating apparatus is provided with local means for feeding the paper, not more than one mutilated signal should be tolerated.*

4.2.8 **Recommendation.—** *Complete circuits should be so engineered and maintained that their degree of standardized test distortion does not exceed 28 per cent on the standardized text:*

THE QUICK BROWN FOX JUMPS
OVER THE LAZY DOG

or

VOYEZ LE BRICK GEANT QUE
JEXAMINE PRES DU WHARF

4.2.9 **Recommendation.—** *The degree of isochronous distortion on the standardized text of each of the parts of a complete circuit should be as low as possible, and in any case should not exceed 10 per cent.*

4.2.10 **Recommendation.—** *The over-all distortion in transmitting equipment used on teletypewriter channels should not exceed 5 per cent.*

4.2.11 **Recommendation.—** *AFTN circuits should be equipped with a system of continuous check of channel condition. Additionally, controlled circuit protocols should be applied.*

4.3 Terminal equipment associated with aeronautical radioteletypewriter channels operating in the band 2.5 MHz to 30 MHz

4.3.1 Selection of type of modulation and code

4.3.1.1 **Recommendation.—** *Frequency shift modulation (F1B) should be employed in radioteletypewriter systems used in the aeronautical fixed service (AFS), except where the characteristics of the independent sideband (ISB) method of operation are of advantage.*

Note.— F1B type of modulation is accomplished by shifting a radio frequency carrier between two frequencies representing "position A" (start signal polarity) and "position Z" (stop signal polarity) of the start-stop 5-unit telegraphic code.

4.3.2 System characteristics

4.3.2.1 **Recommendation.—** *The characteristics of signals from radioteletypewriter transmitters utilizing F1B modulation should be as follows:*

a) Frequency shift: *the lowest possible value.*

b) Frequency shift tolerance: *within plus or minus 3 per cent of the nominal value of the frequency shift.*

c) Polarity: single channel circuits: *the higher frequency corresponds to "position A" (start signal polarity).*

4.3.2.2 **Recommendation.—** *The variation of the mean between the radio frequencies representing respectively "position A" and "position Z" should not exceed 100 Hz during any two-hour period.*

4.3.2.3 **Recommendation.—** *The over-all distortion of the teletypewriter signal, as monitored at the output of the radio transmitter or in its immediate vicinity, should not exceed 10 per cent.*

Note.— Such distortion means the displacement in time of the transitions between elements from their proper positions, expressed as a percentage of unit element time.

4.3.2.4 **Recommendation.—** *Radioteletypewriter receivers concerned with F1B modulation should be capable of operating satisfactorily on signals having the characteristics set out in 4.3.2.1 and 4.3.2.2 above.*

4.3.2.5 **Recommendation.—** *The characteristics of multichannel transmission of teletypewriter signals over a radio circuit should be established by agreement between the Administrations concerned.*

4.4 Characteristics of interregional AFS circuits

4.4.1 **Recommendation.—** *Interregional AFS circuits being implemented or upgraded should employ high quality telecommunications service. Modulation rate should take into account traffic volumes expected under both normal and alternate route conditions.*

4.5 Air-ground VHF communication system characteristics

4.5.1 The characteristics of the air-ground VHF communication system used in the International Aeronautical Mobile Service shall be in conformity with the following specifications:

4.5.1.1 Radiotelephone emissions shall be A3E as defined in the ITU Radio Regulations.

4.5.1.2 Spurious emissions shall be kept at the lowest value which the state of technique and the nature of the service permit.

Note.— Appendix 8 to the Radio Regulations contains the tolerances for the levels of spurious emissions to which transmitters must conform in accordance with RR 304.

4.5.1.3 The radio frequencies used shall be selected from the radio frequencies in the band 117.975 MHz to 136 MHz and the band 136 MHz to 137 MHz subject to the conditions of Radio Regulation 595. The separation between assignable frequencies (channel spacing) and frequency tolerances applicable to elements of the system shall be as specified in Part II, 4.1.2 and 4.1.6.

Note.— The band 117.975 MHz to 132 MHz was allocated to the Aeronautical Mobile (R) Service in the Radio Regulations (1947). By subsequent revisions of the Regulations at ITU World Administrative Conferences the bands 132 MHz to 136 MHz and 136 MHz to 137 MHz were added to the (R) allocation under conditions which differ for ITU Regions, or for specified countries or combinations of countries.

4.5.1.4 The design polarization of emissions shall be vertical.

4.6 System characteristics of the ground installation

4.6.1 Transmitting function

4.6.1.1 *Frequency stability.* The radio frequency of operation shall not vary more than plus or minus 0.005 per cent from the assigned frequency. Where 25 kHz channel spacing is introduced in accordance with Part II, 4.1.2, the radio frequency of operation shall not vary more than plus or minus 0.002 per cent from the assigned frequency.

Note.— The above tolerances will not be suitable for off-set carrier systems.

4.6.1.1.1 *Off-set carrier systems.* The stability of individual carriers of an off-set carrier system shall be such as to prevent first order heterodyne frequencies of less than 4 kHz and, additionally, the maximum frequency excursion of the outer carrier frequencies from the assigned carrier frequency shall not exceed 8 kHz.

Note.— Examples of the required stability of the individual carriers of off-set carrier systems may be found at Attachment D to Part I, 1.2.

4.6.1.2 *Power*

Recommendation.— *On a high percentage of occasions, the effective radiated power should be such as to provide a field strength of a least 75 microvolts per metre (minus 109 dBW/m^2) within the defined operational coverage of the facility, on the basis of free space propagation.*

4.6.1.3 *Modulation.* A peak modulation factor of at least 0.85 shall be achievable.

4.6.1.4 **Recommendation.—** *Means should be provided to maintain the average modulation factor at the highest practicable value without overmodulation.*

4.6.2 Receiving function

4.6.2.1 *Sensitivity.* After due allowance has been made for feeder loss and antenna polar diagram variation, the sensitivity of the receiving function shall be such as to provide on a high percentage of occasions an audio output signal with a wanted/unwanted ratio of 15 dB, with a 50 per cent amplitude modulated (A3E) radio signal having a field strength of 20 microvolts per metre (minus 120 dBW/m^2) or more.

4.6.2.2 *Effective acceptance bandwidth.* The receiving system shall provide an adequate and intelligible audio output when the signal specified at 4.6.2.1 above has a carrier frequency within plus or minus 0.005 per cent of the assigned frequency.

4.6.2.3 *Adjacent channel rejection.* The receiving system shall ensure an effective rejection of 60 dB or more at the next assignable channel.

Note.— The next assignable frequency will normally be plus or minus 50 kHz. Where this channel spacing will not suffice, the next assignable frequency will be plus or minus 25 kHz implemented in accordance with the provisions of Part II, 4.1.2. It is recognized that in certain areas of the world receivers designed for 50 kHz or 100 kHz channel spacing may continue to be used.

4.7 System characteristics of the airborne installation

4.7.1 Transmitting function

4.7.1.1 *Frequency stability.* The radio frequency of operation shall not vary more than plus or minus 0.005 per cent from the assigned frequency. Where 25 kHz channel spacing is introduced, the radio frequency of operation shall not vary more than plus or minus 0.003 per cent from the assigned frequency.

4.7.1.2 *Power.* On a high percentage of occasions, the effective radiated power shall be such as to provide a field strength of at least 20 microvolts per metre (minus 120 dBW/m^2) on the basis of free space propagation, at ranges and altitudes appropriate to the operational conditions pertaining to the areas over which the aircraft is operated.

4.7.1.3 *Modulation.* A peak modulation factor of at least 0.85 shall be achievable.

4.7.1.4 **Recommendation.—** *Means should be provided to maintain the average modulation factor at the highest practicable value without overmodulation.*

4.7.2 Receiving function

4.7.2.1 *Sensitivity*

Recommendation.— After due allowance has been made for aircraft feeder mismatch, attenuation loss and antenna polar diagram variation, the sensitivity of the receiving function should be such as to provide on a high percentage of occasions an audio output signal with a wanted/unwanted ratio of 15 dB, with a 50 per cent amplitude modulated (A3E) radio signal having a field strength of 75 microvolts per metre (minus 109 dBW/m^2).

Note.— For planning extended range VHF facilities, an airborne receiving function sensitivity of 30 microvolts per metre may be assumed.

4.7.2.2 *Effective acceptance bandwidth for 100 kHz, 50 kHz and 25 kHz channel spacing receiving installations.* The receiving function shall ensure an effective acceptance bandwidth as follows:

a) in areas where off-set carrier systems are employed, the receiving function shall provide an adequate audio output when the signal specified at 4.7.2.1 above has a carrier frequency within 8 kHz of the assigned frequency;

b) in areas where off-set carrier systems are not employed, the receiving function shall provide an adequate audio output when the signal specified at 4.7.2.1 above has a carrier frequency within plus or minus 0.005 per cent of the assigned frequency.

4.7.2.3 *Adjacent channel rejection.* The receiving function shall ensure an effective adjacent channel rejection as follows:

a) *25 kHz channel spacing environment:* 50 dB or more at plus or minus 25 kHz with respect to the assigned frequency and 40 dB or more at plus or minus 17 kHz;

b) *50 kHz channel spacing environment:* 50 dB or more at plus or minus 50 kHz with respect to the assigned frequency and 40 dB or more at plus or minus 35 kHz;

c) *100 kHz channel spacing environment:* 50 dB or more at plus or minus 100 kHz with respect to the assigned frequency.

4.7.2.4 **Recommendation.—** *Whenever practicable, the receiving system should ensure an effective adjacent channel rejection characteristic of 60 dB or more at plus or minus 25 kHz, 50 kHz and 100 kHz from the assigned frequency for receiving systems intended to operate in channel spacing environments of 25 kHz, 50 kHz and 100 kHz respectively.*

Note.— Frequency planning is normally based on an assumption of 60 dB effective adjacent channel rejection at plus or minus 25 kHz, 50 kHz or 100 kHz from the assigned frequency as appropriate to the channel spacing environment.

4.7.2.5 **Recommendation.—** *In the case of receivers complying with 4.7.2.2 above used in areas where off-set carrier systems are in force, the characteristics of the receiver should be such that:*

a) the audio frequency response precludes harmful levels of audio heterodynes resulting from the reception of two or more off-set carrier frequencies;

b) the receiver muting circuits, if provided, operate satisfactorily in the presence of audio heterodynes resulting from the reception of two or more off-set carrier frequencies.

4.7.3 Interference immunity performance

4.7.3.1 After 1 January 1998, the VHF communications receiving system shall provide satisfactory performance in the presence of two signal, third-order intermodulation products caused by VHF FM broadcast signals having levels at the receiver input of minus 5 dBm.

4.7.3.2 After 1 January 1998, the VHF communications receiving system shall not be desensitized in the presence of VHF FM broadcast signals having levels at the receiver input of minus 5 dBm.

Note.— Guidance material on immunity criteria to be used for the performance quoted in 4.7.3.1 and 4.7.3.2 above is contained in Attachment D to Part I, 1.3.

4.7.3.3 After 1 January 1995, all new installations of airborne VHF communications receiving systems shall meet the provisions of 4.7.3.1 and 4.7.3.2 above.

4.7.3.4 **Recommendation.—** *Airborne VHF communications receiving systems meeting the immunity performance Standards of 4.7.3.1 and 4.7.3.2 above should be placed into operation at the earliest possible date.*

4.8 SELCAL system

4.8.1 **Recommendation.—** *Where a SELCAL system is installed, the following system characteristics should be applied:*

a) Transmitted code. *Each transmitted code should be made up of two consecutive tone pulses, with each pulse containing two simultaneously transmitted tones. The pulses should be of 1.0 plus or minus 0.25 seconds duration, separated by an interval of 0.2 plus or minus 0.1 second.*

b) Stability. *The frequency of transmitted tones should be held to plus or minus 0.15 per cent tolerance to ensure proper operation of the airborne decoder.*

c) Distortion. *The over-all audio distortion present on the transmitted RF signal should not exceed 15 per cent.*

d) Per cent modulation. *The RF signal transmitted by the ground radio station should contain, within 3 dB, equal amounts of the two modulating tones. The combination of tones should result in a modulation envelope having a nominal modulation percentage as high as possible and in no case less than 60 per cent.*

e) Transmitted tones. *Tone codes should be made up of various combinations of the tones listed in the following table and designated by colour and letter as indicated:*

Designation	*Frequency (Hz)*
Red A	*312.6*
Red B	*346.7*
Red C	*384.6*
Red D	*426.6*
Red E	*473.2*
Red F	*524.8*
Red G	*582.1*
Red H	*645.7*
Red J	*716.1*
Red K	*794.3*
Red L	*881.0*
Red M	*977.2*
Red P	*1 083.9*
Red Q	*1 202.3*
Red R	*1 333.5*
Red S	*1 479.1*

Note 1.— It should be noted that the tones are spaced by Log^{-1} *0.045 to avoid the possibility of harmonic combinations.*

Note 2.— In accordance with the application principles developed by the Sixth Session of the Communications Division, the only codes at present used internationally are selected from the red group.

Note 3.— Guidance material on the use of SELCAL systems is contained in Attachment D to Part I.

Note 4.— The tones Red P, Red Q, Red R, and Red S are applicable after 1 September 1985, in accordance with 4.8.2 below.

4.8.2 As from 1 September 1985, aeronautical stations which are required to communicate with SELCAL-equipped aircraft shall have SELCAL encoders in accordance with the red group in the table of tone frequencies of 4.8.1 above. After 1 September 1985, SELCAL codes using the tones Red P, Red Q, Red R, and Red S may be assigned.

4.9 Technical provisions relating to ATS message transmission

4.9.1 *Interconnection by direct or omnibus channels — low modulation rates — 5-unit code.*

Note.— See 4.11 below for medium modulation rates.

4.9.1.1 **Recommendation.—** *AFTN techniques (cf. 4.2 above) should be used.*

4.10 Single sideband (SSB) HF communication system characteristics for use in the aeronautical mobile service

4.10.1 The characteristics of the air-ground HF SSB system, where used in the Aeronautical Mobile Service, shall be in conformity with the following specifications.

4.10.1.1 *Frequency range*

4.10.1.1.1 HF SSB installations shall be capable of operation at any SSB carrier (reference) frequency available to the Aeronautical Mobile (R) Service in the band 2.8 MHz to 22 MHz and necessary to meet the approved assignment plan for the region(s) in which the system is intended to operate, and in compliance with the relevant provisions of the Radio Regulations.

Note 1.— See Introduction to Chapter 3, Part II and Figures 4-1 and 4-2.

Note 2.— The Extraordinary Administrative Radio Conference (EARC), Geneva, 1966, established an Allotment Plan (Appendix 27 to the Radio Regulations). The ITU World Administrative Radio Conference, Aeronautical Mobile (R) Service, Geneva, 1978, established a new Allotment Plan (Appendix 27, Aer2 to the Radio Regulations).

4.10.1.1.2 The equipment shall be capable of operating on integral multiples of 1 kHz.

4.10.1.2 *Sideband selection*

4.10.1.2.1 The sideband transmitted shall be that on the higher frequency side of its carrier (reference) frequency.

4.10.1.3 *Carrier (reference) frequency*

4.10.1.3.1 Until 1 February 1983 channel utilization shall be in conformity with the Allotment Plan in either Appendix 27 EARC* or Appendix 27 Aer2** as follows:

a) where Appendix 27 EARC channels are used the carrier (reference) frequency shall in the case of the upper half of the previous DSB channel be the same as the carrier (reference) frequency of that channel;

b) where Appendix 27 EARC channels are used the carrier (reference) frequency shall in the case of the lower half of the previous DSB channel be 3 kHz lower than the carrier (reference) frequency of that channel;

* Appendix 27 EARC means Appendix 27 to the Radio Regulations (1968 Edition).

** Appendix 27 Aer2 means Appendix 27, as amended by the ITU World Administrative Radio Conference (1978).

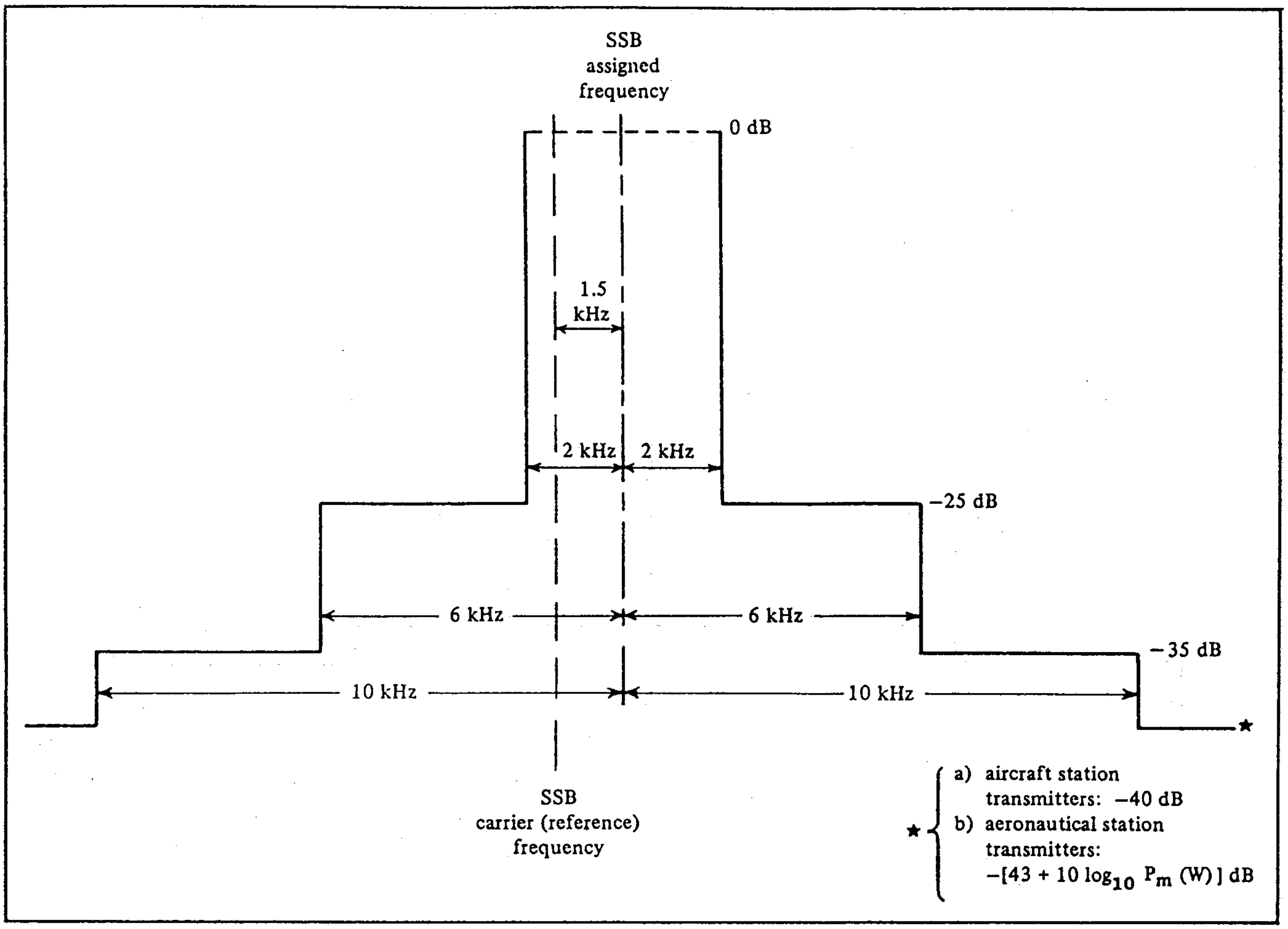

Figure 4-1. Required spectrum limits (in terms of mean power) for aircraft station transmitter types and for aeronautical station transmitters first installed before 1 February 1983

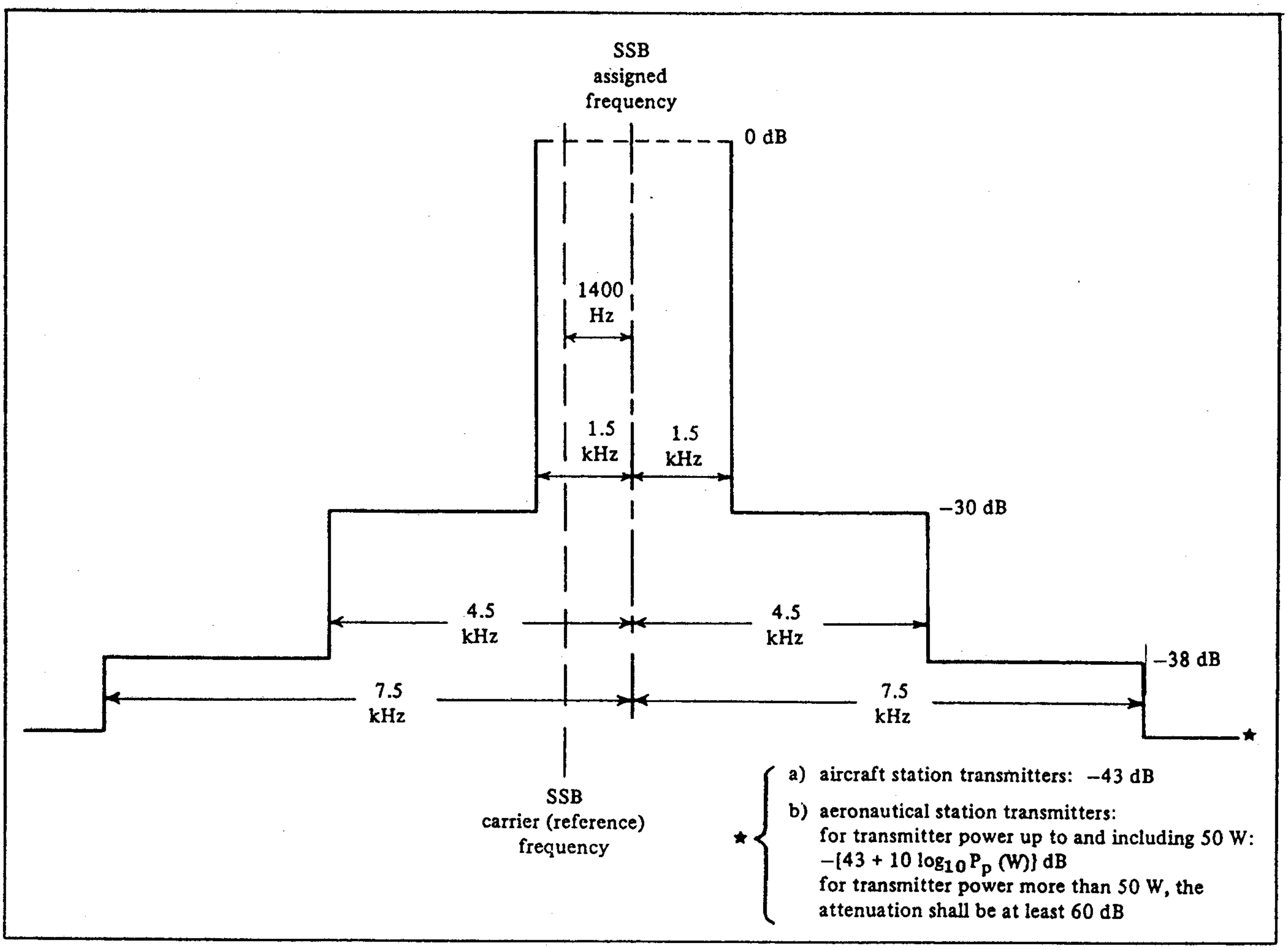

Figure 4-2. Required spectrum limits (in terms of peak power) for aircraft station transmitters first installed after 1 February 1983 and aeronautical station transmitters in use after 1 February 1983

c) where Appendix 27 Aer2 channels are used the carrier (reference) frequency shall be in conformity with the table at 27/16 of Appendix 27 Aer2.

4.10.1.3.2 With effect from 1 February 1983 channel utilization shall be in conformity with the table of carrier (reference) frequencies at 27/16 and the Allotment Plan at 27/186 to 27/207 inclusive (or frequencies established on the basis of 27/21, as may be appropriate) of Appendix 27 Aer2.

Note.— It is intended that only the carrier (reference) frequency be promulgated in Regional Plans and Aeronautical Publications.

4.10.1.4 *Classes of emission and carrier suppression*

4.10.1.4.1 The system shall utilize the suppressed carrier class of emission J3E (also J7B and J9B as applicable). When SELCAL is employed as specified in 4.8 above, the installation shall utilize class H2B emission.

4.10.1.4.2 By 1 February 1982 aeronautical stations and aircraft stations shall have introduced the appropriate class(es) of emission prescribed in 4.10.1.4.1 above. Effective this date the use of class A3E emission shall be discontinued except as provided in 4.10.1.4.4 below.

4.10.1.4.3 Until 1 February 1982 aeronautical stations and aircraft stations equipped for single sideband operations shall also be equipped to transmit class H3E emission where required to be compatible with reception by double sideband equipment. Effective this date the use of class H3E emission shall be discontinued except as provided in 4.10.1.4.4 below.

4.10.1.4.4 **Recommendation.—** *For stations directly involved in co-ordinated search and rescue operations using the frequencies 3 023 kHz and 5 680 kHz, the class of emission J3E should be used; however, since maritime mobile and land mobile services may be involved, A3E and H3E classes of emission may be used.*

4.10.1.4.5 After 1 April 1981 no new DSB equipment shall be installed.

4.10.1.4.6 Aircraft station transmitters shall be capable of at least 26 dB carrier suppression with respect to peak envelope power (P_p) for classes of emission J3E, J7B or J9B.

4.10.1.4.7 Aeronautical station transmitters shall be capable of 40 dB carrier suppression with respect to peak envelope power (P_p) for classes of emission J3E, J7B or J9B.

4.10.1.5 *Audio frequency bandwidth*

4.10.1.5.1 For radiotelephone emissions the audio frequencies shall be limited to between 300 and 2 700 Hz and the occupied bandwidth of other authorized emissions shall not exceed the upper limit of J3E emissions. In specifying these limits, however, no restriction in their extension shall be implied in so far as emissions other than J3E are concerned, provided that the limits of unwanted emissions are met (see 4.10.1.7 below).

Note.— For aircraft and aeronautical station transmitter types first installed before 1 February 1983 the audio frequencies will be limited to 3 000 Hz.

4.10.1.5.2 For other authorized classes of emission the modulation frequencies shall be such that the required spectrum limits of 4.10.1.7 below will be met.

4.10.1.6 *Frequency tolerance*

4.10.1.6.1 The basic frequency stability of the transmitting function for classes of emission J3E, J7B or J9B shall be such that the difference between the actual carrier of the transmission and the carrier (reference) frequency shall not exceed:

— 20 Hz for airborne installations;
— 10 Hz for ground installations.

4.10.1.6.2 The basic frequency stability of the receiving function shall be such that, with the transmitting function stabilities specified in 4.10.1.6.1 above, the over-all frequency difference between ground and airborne functions achieved in service and including Doppler shift, does not exceed 45 Hz. However, a greater frequency difference shall be permitted in the case of supersonic aircraft.

4.10.1.7 *Spectrum limits*

4.10.1.7.1 For aircraft station transmitter types and for aeronautical station transmitters first installed before 1 February 1983 and using single sideband classes of emission H2B, H3E, J3E, J7B or J9B the mean power of any emission on any discrete frequency shall be less than the mean power (P_m) of the transmitter in accordance with the following:

— on any frequency removed by 2 kHz or more up to 6 kHz from the assigned frequency: at least 25 dB;

— on any frequency removed by 6 kHz or more up to 10 kHz from the assigned frequency: at least 35 dB;

— on any frequency removed from the assigned frequency by 10 kHz or more:

a) aircraft station transmitters: 40 dB;

b) aeronautical station transmitters:

$$[43 + 10 \log_{10} P_m \text{ (W)}] \text{ dB}$$

4.10.1.7.2 For aircraft station transmitters first installed after 1 February 1983 and for aeronautical station transmitters in use as of 1 February 1983 and using single sideband classes of emission H2B, H3E, J3E, J7B or J9B, the peak envelope power (P_p) of any emission on any discrete frequency shall be less than the peak envelope power (P_p) of the transmitter in accordance with the following:

— on any frequency removed by 1.5 kHz or more up to 4.5 kHz from the assigned frequency: at least 30 dB;

— on any frequency removed by 4.5 kHz or more up to 7.5 kHz from the assigned frequency: at least 38 dB;

— on any frequency removed from the assigned frequency by 7.5 kHz or more:

a) aircraft station transmitters: 43 dB;

b) aeronautical station transmitters: for transmitter power up to and including 50 W:

$$[43 + 10 \log_{10} P_p \text{ (W)}] \text{ dB}.$$

For transmitter power more than 50 W: 60 dB.

Note.— See Figures 4-1 and 4-2.

4.10.1.8 *Power*

4.10.1.8.1 *Aeronautical station installations.* Except as permitted by the relevant provisions of Appendix 27 Aer2 to the Radio Regulations the peak envelope power (P_p) supplied to the antenna transmission line for H2B, H3E, J3E, J7B or J9B classes of emissions shall not exceed a maximum value of 6 kW.

4.10.1.8.2 *Aircraft station installations.* The peak envelope power supplied to the antenna transmission line for H2B, H3E, J3E, J7B or J9B classes of emission shall not exceed 400 W except as provided for in Appendix 27 Aer2 of the Radio Regulations as follows:

27/62 It is recognized that the power employed by aircraft transmitters may, in practice, exceed the limits specified in No. 27/54. However, the use of such increased power (which normally should not exceed 600 W P_p) shall not cause harmful interference to stations using frequencies in accordance with the technical principles on which the Allotment Plan is based.

27/54 Unless otherwise specified in Part II of this Appendix, the peak envelope powers supplied to the antenna transmission line shall not exceed the maximum values indicated in the table below; the corresponding peak effective radiated powers being assumed to be equal to two-thirds of these values:

Class of emission	*Stations*	*Max. peak envelope power (P_p)*
H2B, J3E, J7B, J9B, A3E*, H3E* (100% modulation)	Aeronautical stations Aircraft stations	6 kW 400 W
Other emission such as A1A, F1B	Aeronautical stations Aircraft stations	1.5 kW 100 W

* A3E and H3E to be used only on 3 023 kHz and 5 680 kHz, as well as in cases covered by Resolution No. 402.

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4.10.1.9 *Method of operation.* Single channel simplex shall be employed.

4.11 Technical provisions relating to international ground-ground data interchange at medium and higher signalling rates

Note.— Throughout this section in the context of coded character sets, the term "unit" means the unit of selective information, and is essentially equivalent to the term "bit".

4.11.1 General

4.11.1.1 **Recommendation.—** *In international data interchange of characters, a 7-unit coded character set providing a repertoire of 128 characters and designated as International Alphabet No. 5 (IA-5) should be used. Compatibility with the 5-unit coded character set of International Telegraph Alphabet No. 2 (ITA-2) should be ensured where applicable.*

4.11.1.2 When the provisions of 4.11.1.1 above are applied, International Alphabet No. 5 (IA-5) contained in Table 4-4 shall be used.

4.11.1.2.1 The serial transmission of units comprising an individual character of IA-5 shall be with the low order unit (b_1) transmitted first.

4.11.1.2.2 **Recommendation.—** *When IA-5 is used, each character should include an additional unit for parity in the eighth level position.*

4.11.1.2.3 When the provisions of 4.11.1.2.2 above are applied, the sense of the character parity bit shall produce even parity in links which operate on the start-stop principle, and odd parity in links using end-to-end synchronous operations.

4.11.1.2.4 Character-for-character conversion shall be as listed in Tables 4-2 and 4-3 for all characters which are authorized in the AFTN format for transmission on the AFS in both IA-5 and ITA-2.

4.11.1.2.5 Characters which appear in only one code set, or which are not authorized for transmission on the AFS shall be as depicted in the code conversion tables.

4.11.2 Data transmission characteristics

4.11.2.1 **Recommendation.—** *The data signalling rate should be chosen from among the following:*

600 bits/s	*4 800 bits/s*
1 200 bits/s	*9 600 bits/s*
2 400 bits/s	

4.11.2.2 **Recommendation.—** *The type of transmission for each data signalling rate should be chosen as follows:*

Data signalling rate	Type of transmission
600 bits/s	*Synchronous or asynchronous serial transmission*
1 200 bits/s	*Synchronous or asynchronous serial transmission*
2 400 bits/s	*Synchronous serial transmission*
4 800 bits/s	*Synchronous serial transmission*
9 600 bits/s	*Synchronous serial transmission*

4.11.2.3 **Recommendation.—** *The type of modulation for each data signalling rate should be chosen as follows:*

Data signalling rate	Type of modulation
600 bits/s	*Frequency*
1 200 bits/s	*Frequency*
2 400 bits/s	*Phase*
4 800 bits/s	*Phase*
9 600 bits/s	*Phase-amplitude*

Note.— This recommendation does not necessarily apply to ground-ground extensions of air-ground links used exclusively for the transfer of air-ground data, inasmuch as such circuits may be considered as part of the air-ground link.

4.11.2.4 *Character structure on data links*

4.11.2.4.1 Character parity shall not be used for error checking on CIDIN links. Parity appended to IA-5 coded characters per 4.11.1.2.2 above, prior to entry to the CIDIN shall be ignored. For messages exiting the CIDIN, parity shall be generated in accordance with 4.11.1.2.3 above.

4.11.2.4.2 Characters of less than eight bits in length shall be padded out to eight bits in length before transmission over any octet based or bit-oriented communications network. The padding bits shall occupy the higher order end of the octet, i.e. bit 8, bit 7 as required, and shall have the binary values 0.

4.11.2.5 When exchanging data over CIDIN links using bit-oriented procedures, the entry centre address, exit centre addresses and destination addresses in the Transport and CIDIN Packet Headers shall be in the IA-5 character set contained in Table 4-4.

4.11.2.6 **Recommendation.—** *When transmitting messages in AFTN format over CIDIN links using bit-oriented procedures, the messages should be in the IA-5 character set contained in Table 4-4.*

4.11.3 Ground-ground character-oriented data link control procedures

Note.— The provisions of this section pertain to ground-ground data interchange applications using IA-5 prescribed by 4.11.1 above and which employ the ten transmission control characters (SOH, STX, ETX, EOT, ENQ, ACK, DLE, NAK, SYN, and ETB) for data link control, over synchronous or asynchronous transmission facilities.

4.11.3.1 *Descriptions.* The following descriptions shall apply to data link applications contained in this section.

a) A master station is that station which has control of the data link at a given instant.

b) A slave station is one that has been selected to receive a transmission from the master station.

c) A control station is the single station on a multipoint link that is permitted to assume master status and deliver messages to one or more individually selected (non-control) tributary stations, or it is permitted to assign temporary master status to any of the other tributary stations.

4.11.3.2 *Message composition*

a) A transmission shall consist of characters from IA-5 transmitted in accordance with 4.11.1.2.2 above and shall be either an information message or a supervisory sequence.

b) An information message used for the exchange of data shall take one of the following forms:

```
1)  S            E  B
    T  ---TEXT---  T  C
    X            X  C

2)  S            E  B
    T  ---TEXT---  T  C
    X            B  C

3)  S               S            E  B
    O  ---HEADING---  T  ---TEXT---  T  C
    H               X            X  C

4)  S               S            E  B
    O  ---HEADING---  T  ---TEXT---  T  C
    H               X            B  C

5)  S               E  B
    O  ---HEADING---  T  C
    H               B  C
```

Note 1.— B C C is a block check character (BCC).

Note 2.— In formats 2), 4), and 5) above which end with ETB, some continuation is required.

c) A supervisory sequence shall be composed of either a single transmission control character (EOT, ENQ, ACK, or NAK) or a single transmission control (ENQ) preceded by a prefix of up to 15 non-control characters, or the character DLE used in conjunction with other graphic and control characters to provide additional communication control functions.

Table 4-2. Conversion from the International Telegraph Alphabet No. 2 (ITA-2) to the International Alphabet No. 5 (IA-5)

ITA-2 letter case of signal No.		*IA-5 column/row*		*ITA-2 figure case of signal No.*		*IA-5 column/row*	
1	A	4/1	A	1	–	2/13	–
2	B	4/2	B	2	?	3/15	?
3	C	4/3	C	3	:	3/10	:
4	D	4/4	D	4		3/15	?
5	E	4/5	E	5	3	3/3	3
6	F	4/6	F	6		3/15	?
7	G	4/7	G	7		3/15	?
8	H	4/8	H	8		3/15	?
9	I	4/9	I	9	8	3/8	8
10	J	4/10	J	10	Attention signal *(Note 3)*	0/7	Bel
11	K	4/11	K	11	(	2/8	(
12	L	4/12	L	12	)	2/9	)
13	M	4/13	M	13	.	2/14	.
14	N	4/14	N	14	,	2/12	,
15	O	4/15	O	15	9	3/9	9
16	P	5/0	P	16	0	3/0	0
17	Q	5/1	Q	17	1	3/1	1
18	R	5/2	R	18	4	3/4	4
19	S	5/3	S	19	'	2/7	'
20	T	5/4	T	20	5	3/5	5
21	U	5/5	U	21	7	3/7	7
22	V	5/6	V	22	=	3/13	=
23	W	5/7	W	23	2	3/2	2
24	X	5/8	X	24	/	2/15	/
25	Y	5/9	Y	25	6	3/6	6
26	Z	5/10	Z	26	+	2/11	+
27	CR	0/13	CR	27	CR	0/13	CR
28	LF	0/10	LF	28	LF	0/10	LF
29	LTRS	*		29	LTRS	*	
30	FIGS	*		30	FIGS	*	
31	SP	2/0	SP	31	SP	2/0	SP
32		*		32		*	

* *No conversion shall be made for these positions and the signal/character shall be removed from the data.*

Note 1.— The end-of-message signal NNNN (in letter and figure case) shall convert to ETX (0/3).
Note 2.— The start-of-message signal ZCZC (in letter and figure case) shall convert to SOH (0/1).
Note 3.— Figures case of Signal No. 10 shall only be converted upon detection of the AFTN priority alarm which shall convert to five occurrences of BEL (0/7).
Note 4.— When converting from ITA-2, a STX (0/2) character shall be inserted once at the beginning of the next line following detection of CR LF or LF CR at the end of the Origin Line.
Note 5.— The sequence of seven signal 28 (LF) shall convert to one VT (0/11) character.

Table 4-3. Conversion from the International Alphabet No. 5 (IA-5) to the International Telegraph Alphabet No. 2 (ITA-2)

Row \ Col.	0	1	2	3	4	5	6	7
0	*	*	31FL	16F	2F	16L	2F	16L
1	Note 5	*	2F	17F	1L	17L	1L	17L
2	*	*	2F	23F	2L	18L	2L	18L
3	Note 1	*	2F	5F	3L	19L	3L	19L
4	*	*	2F	18F	4L	20L	4L	20L
5	*	*	2F	20F	5L	21L	5L	21L
6	*	*	2F	25F	6L	22L	6L	22L
7	Note 2	*	19F	21F	7L	23L	7L	23L
8	*	*	11F	9F	8L	24L	8L	24L
9	*	*	12F	15F	9L	25L	9L	25L
10	28FL	*	2F	3F	10L	26L	10L	26L
11	Note 3	*	26F	2F	11L	2F	11L	2F
12	*	*	14F	2F	12L	2F	12L	2F
13	27FL	*	1F	22F	13L	2F	13L	2F
14	*	*	13F	2F	14L	2F	14L	2F
15	*	*	24F	2F	15L	2F	15L	*

** No conversion shall be made for these positions and the signal/character shall be removed from the data.*

Example: *To find the ITA-2 signal to which the charater 3/6 of IA-5 is to be converted, look at column 3, row 6.*

25F means figure case of signal No. 25

(L = letter case, FL = either case designation).

Note 1.– *The character 0/3 (ETX) shall convert to the ITA-2 sequence signals 14L, 14L, 14L, 14L (NNNN).*

Note 2.– *The signal 0/7 (BEL) shall only be converted when a sequence of 5 occurrences is detected, which shall convert to the ITA-2 sequence signals 30, 10F, 10F, 10F, 10F, 10F, 29.*

Note 3.– *The character sequence CR CR LF VT (0/11) ETX (0/3) shall convert to the ITA-2 sequence signals 29, 27, 27, 28, 28, 28, 28, 28, 28, 28, 28, 14L, 14L, 14L, 14L.*

Note 4.– *To prevent redundant generation of figure and letter characters in ITA-2 when converting from IA-5, no case designation shall be assigned to ITA-2 non-printing functions (signals No. 27, 28, 29, 30, 31).*

Note 5.– *The character 0/1 (SOH) shall convert to the ITA-2 sequence signals 26L, 3L, 26L, 3L (ZCZC).*

Table 4-4. International Alphabet No. 5 (IA-5)
(international reference version)

				b_7	0	0	0	0	1	1	1	1
				b_6	0	0	1	1	0	0	1	1
				b_5	0	1	0	1	0	1	0	1
b_4	b_3	b_2	b_1		0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	TC_7 (DLE)	SP	0	@	P	`	p
0	0	0	1	1	TC_1 (SOH)	DC_1	!	1	A	Q	a	q
0	0	1	0	2	TC_2 (STX)	DC_2	" (4)	2	B	R	b	r
0	0	1	1	3	TC_3 (ETX)	DC_3	#	3	C	S	c	s
0	1	0	0	4	TC_4 (EOT)	DC_4	¤ (2)	4	D	T	d	t
0	1	0	1	5	TC_5 (ENQ)	TC_8 (NAK)	%	5	E	U	e	u
0	1	1	0	6	TC_6 (ACK)	TC_9 (SYN)	&	6	F	V	f	v
0	1	1	1	7	BEL	TC_{10} (ETB)	' (4)	7	G	W	g	w
1	0	0	0	8	FE_0 (BS)	CAN	(	8	H	X	h	x
1	0	0	1	9	FE_1 (HT)	EM	)	9	I	Y	i	y
1	0	1	0	10	FE_2 (1) (LF)	SUB	*	:	J	Z	j	z
1	0	1	1	11	FE_3 (VT)	ESC	+	;	K	[	k	{
1	1	0	0	12	FE_4 (FF)	IS_4 (FS)	, (4)	<	L	\	l	|
1	1	0	1	13	FE_5 (1) (CR)	IS_3 (GS)	—	=	M	]	m	}
1	1	1	0	14	SO	IS_2 (RS)	.	>	N	^ (4)	n	‾ (3)
1	1	1	1	15	SI	IS_1 (US)	/	?	O	_	o	DEL

NOTES

Note 1.— The format effectors are intended for equipment in which horizontal and vertical movements are effected separately. If equipment requires the action of CARRIAGE RETURN to be combined with a vertical movement, the format effector for that vertical movement may be used to effect the combined movement. Use of FE 2 for a combined CR and LF operation is not allowed for international transmission on AFS networks.

Note 2.— The symbol ¤ does not designate the currency of a specific country.

Note 3.— Position 7/14 is used for graphic character ‾ (OVERLINE), the graphical representation of which may vary according to national use to represent (TILDE) or another diacritical sign provided that there is no risk of confusion with another graphic character included in the table.

Note 4.— The graphic characters in position 2/2, 2/7, 2/12 and 5/14 have respectively the significance of QUOTATION MARK, APOSTROPHE, COMMA and UPWARD ARROW HEAD; however, these characters take on the significance of the diacritical signs DIAERESIS, ACUTE ACCENT, CEDILLA and CIRCUMFLEX ACCENT when they are preceded or followed by the BACKSPACE character (0/8).

Note 5.— When graphical representation of the control characters of IA-5 is required, it is permissible to use the symbols specified in International Organization for Standardization (ISO) Standard 2047-1975.

Table 4-4 (cont.)

CONTROL CHARACTERS

Abbreviation	*Meaning*	*Position in the code table*
ACK	Acknowledge	0/6
BEL	Bell	0/7
BS	Backspace	0/8
CAN	Cancel	1/8
CR	Carriage return*	0/13
DC	Device control	—
DEL	Delete	7/15
DLE	Data link escape	1/0
EM	End of medium	1/9
ENQ	Enquiry	0/5
EOT	End of transmission	0/4
ESC	Escape	1/11
ETB	End of transmission block	1/7
ETX	End of text	0/3
FE	Format effector	—
FF	Form feed	0/12
FS	File separator	1/12
GS	Group separator	1/13
HT	Horizontal tabulation	0/9
IS	Information separator	—
LF	Line feed*	0/10
NAK	Negative acknowledge	1/5
NUL	Null	0/0
RS	Record separator	1/14
SI	Shift-in	0/15
SO	Shift-out	0/14
SOH	Start of heading	0/1
SP	Space	2/0
STX	Start of text	0/2
SUB	Substitute character	1/10
SYN	Synchronous idle	1/6
TC	Transmission control	—
US	Unit separator	1/15
VT	Vertical tabulation	0/11

* See Note 1.

GRAPHIC CHARACTERS

Graphic	*Note*	*Name*	*Position in the code table*
(space)		Space (*see* 7.2)	2/0
!		Exclamation mark	2/1
"	4	Quotation mark, Diaeresis	2/2
#		Number sign	2/3
¤	2	Currency sign	2/4
%		Percent sign	2/5
&		Ampersand	2/6
'	4	Apostrophe, Acute accent	2/7
(		Left parenthesis	2/8
)		Right parenthesis	2/9
*		Asterisk	2/10
+		Plus sign	2/11
,	4	Comma, Cedilla	2/12
—		Hyphen, Minus sign	2/13
.		Full stop (period)	2/14
/		Solidus	2/15
:		Colon	3/10
;		Semi-colon	3/11
<		Less-than sign	3/12
=		Equal sign	3/13
>		Greater-than sign	3/14
?		Question mark	3/15
@		Commercial 'at'	4/0
[		Left square bracket	5/11
\		Reverse solidus	5/12
]		Right square bracket	5/13
^	4	Upward arrow head, Circumflex accent	5/14
_		Underline	5/15
`		Grave accent	6/0
{		Left curly bracket	7/11
|		Vertical line	7/12
}		Right curly bracket	7/13
‾	3	Overline, Tilde	7/14

DIACRITICAL SIGNS

In the character set, some printing symbols may be designed to permit their use for the composition of accented letters when necessary for general interchange of information. A sequence of three characters, comprising a letter, BACKSPACE and one of these symbols, is needed for this composition, and the symbol is then regarded as a diacritical sign. It should be noted that these symbols take on their diacritical significance only when they are preceded or followed by the BACKSPACE character; for example, the symbol corresponding to the code combination 2/7 (') normally has the significance of APOSTROPHE, but becomes the diacritical sign ACUTE ACCENT when it precedes or follows the BACKSPACE character.

NAMES, MEANINGS AND FONTS OF GRAPHIC CHARACTERS

At least one name is assigned to denote each of the graphic characters. These names are intended to reflect their customary meanings and are not intended to define or restrict the meanings of graphic characters. No particular style or font design is specified for the graphic characters.

UNIQUENESS OF CHARACTER ALLOCATION

A character allocated to a position in the table may not be placed elsewhere in the table.

Table 4-4 (cont.)

FUNCTIONAL CHARACTERISTICS RELATED TO CONTROL CHARACTERS

Some definitions given below are stated in general terms and more explicit definitions of use may be needed for specific implementation of the code table on recording media or on transmission channels. These more explicit definitions and the use of these characters are the subject of ISO publications.

General designations of control characters

The general designation of control characters involves a specific class name followed by a subscript number.

They are defined as follows:

TC — *Transmission control characters* — Control characters intended to control or facilitate transmission of information over telecommunication networks.

The use of the TC characters on the general telecommunication networks is the subject of ISO publications.

The transmission control characters are:

ACK, DLE, ENQ, EOT, ETB, ETX, NAK, SOH, STX and SYN.

FE — *Format effectors* — Control characters mainly intended for the control of the layout and positioning of information on printing and /or display devices. In the definitions of specific format effectors, any reference to printing devices should be interpreted as including display devices. The definitions of format effectors use the following concept:

a) a page is composed of a number of lines of characters;

b) the characters forming a line occupy a number of positions called character positions;

c) the active position is that character position in which the character about to be processed would appear if it were to be printed. The active position normally advances one character position at a time.

The format effector characters are:

BS, CR, FF, HT, LF and VT (see also Note 1 to Table 4-4.)

DC — *Device control characters* — Control characters for the control of a local or remote ancillary device (or devices) connected to a data processing and/or telecommunication system. These control characters are not intended to control telecommunication systems; this should be achieved by the use of TCs.

Certain preferred uses of the individual DCs are given below under *Specific control characters.*

IS — *Information separators* — Control characters that are used to separate and qualify data logically. There are four such characters. They may be used either in hierarchical order or non-hierarchically; in the latter case their specific meanings depend on their applications.

When they are used hierarchically, the ascending order is: US, RS, GS, FS.

In this case data normally delimited by a particular separator cannot be split by a higher order separator but will be considered as delimited by any higher order separator.

Specific control characters

Individual members of the classes of controls are sometimes referred to by their abbreviated class name and a subscript number (e.g. TC_5) and sometimes by a specific name indicative of their use (e.g. ENQ).

Different but related meanings may be associated with some of the control characters but in an interchange of data this normally requires agreement between the sender and the recipient.

ACK — *Acknowledge* — A transmission control character transmitted by a receiver as an affirmative response to the sender.

BEL — *Bell* — A control character that is used when there is a need to call for attention; it may control alarm or attention devices.

BS — *Backspace* — A format effector which moves the active position one character position backwards on the same line.

CAN — *Cancel* — A character, or the first character of a sequence, indicating that the data preceding it are in error. As a result these data are to be ignored. The specific meaning of this character must be defined for each application and/or between sender and recipient.

CR — *Carriage return* — A format effector which moves the active position to the first character position on the same line.

Device controls

DC_1 — A device control character which is primarily intended for turning on or starting an ancillary device. If it is not required for this purpose, it may be used to restore a device to the basic mode of operation (*see also* DC_2 and DC_3), or for any other device control function not provided by other DCs.

DC_2 — A device control character which is primarily intended for turning on or starting an ancillary device. If it is not required for this purpose, it may be used to set a device to a special mode of operation (in which case DC_1 is used to restore the device to the basic mode), or for any other device control function not provided by other DCs.

DC_3 — A device control character which is primarily intended for turning off or stopping an ancillary device. This function may be a secondary level stop, e.g. wait, pause, stand-by or halt (in which case DC_1 is used to restore normal operation). If it is not required for this purpose, it may be used for any other device control function not provided by other DCs.

DC_4 — A device control character which is primarily intended for turning off, stopping or interrupting an ancillary device. If it is not required for this purpose, it may be used for any other device control function not provided by other DCs.

Examples of use of the device controls

1)	One switching	on — DC_2	off — DC_4
2)	Two independent switchings		
	First one	on — DC_2	off — DC_4
	Second one	on — DC_1	off — DC_3
3)	Two dependent switchings		
	General	on — DC_2	off — DC_4
	Particular	on — DC_1	off — DC_3
4)	Input and output switching		
	Output	on — DC_2	off — DC_4
	Input	on — DC_1	off — DC_3

DEL — *Delete* — A character used primarily to erase or obliterate an erroneous or unwanted character in punched tape. DEL characters may also serve to accomplish media-fill or time-fill. They may be inserted into or removed from a stream of data without affecting the information content of that stream, but then the addition or removal of these characters may affect the information layout and/or the control of equipment.

Table 4-4 (cont.)

DLE — *Data link escape* — A transmission control character which will change the meaning of a limited number of contiguously following characters. It is used exclusively to provide supplementary data transmission control functions. Only graphic characters and transmission control characters can be used in DLE sequences.

EM — *End of medium* — A control character that may be used to identify the physical end of a medium, or the end of the used portion of a medium, or the end of the wanted portion of data recorded on a medium. The position of this character does not necessarily correspond to the physical end of the medium.

ENQ — *Enquiry* — A transmission control character used as a request for a response from a remote station — the response may include station identification and/or station status. When a "Who are you?" function is required on the general switched transmission network, the first use of ENQ after the connection is established shall have the meaning "Who are you?" (station identification). Subsequent use of ENQ may, or may not, include the function "Who are you?", as determined by agreement.

EOT — *End of transmission* — A transmission control character used to indicate the conclusion of the transmission of one or more texts.

ESC — *Escape* — A control character which is used to provide an additional control function. It alters the meaning of a limited number of contiguously following bit combinations which constitute the escape sequence.

Escape sequences are used to obtain additional control functions which may provide among other things graphic sets outside the standard set. Such control functions must not be used as additional transmission controls.

The use of the character ESC and of the escape sequences in conjunction with code extension techniques is the subject of an ISO Standard.

ETB — *End of transmission block* — A transmission control character used to indicate the end of a transmission block of data where data are divided into such blocks for transmission purposes.

ETX — *End of text* — A transmission control character which terminates a text.

FF — *Form feed* — A format effector which advances the active position to the same character position on a pre-determined line of the next form or page.

HT — *Horizontal tabulation* — A format effector which advances the active position to the next pre-determined character position on the same line.

Information separators

IS_1 (US) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a UNIT.

IS_2 (RS) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a RECORD.

IS_3 (GS) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a GROUP.

IS_4 (FS) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a FILE.

LF — *Line feed* — A format effector which advances the active position to the same character position of the next line.

NAK — *Negative acknowledge* — A transmission control character transmitted by a receiver as a negative response to the sender.

NUL — *Null* — A control character used to accomplish media-fill or time-fill. NUL characters may be inserted into or removed from a stream of data without affecting the information content of that stream, but then the addition or removal of these characters may affect the information layout and/or the control of equipment.

SI — *Shift-in* — A control character which is used in conjunction with SHIFT-OUT and ESCAPE to extend the graphic character set of the code. It may reinstate the standard meanings of the bit combinations which follow it. The effect of this character when using code extension techniques is described in an ISO Standard.

SO — *Shift-out* — A control character which is used in conjunction with SHIFT-IN and ESCAPE to extend the graphic character set of the code. It may alter the meaning of the bit combinations of columns 2 to 7 which follow it until a SHIFT-IN character is reached. However, the characters SPACE (2/0) and DELETE (7/15) are unaffected by SHIFT-OUT. The effect of this character when using code extension techniques is described in an ISO Standard.

SOH — *Start of heading* — A transmission control character used as the first character of a heading of an information message.

SP — *Space* — A character which advances the active position one character position on the same line. This character is also regarded as a non-printing graphic.

STX — *Start of text* — A transmission control character which precedes a text and which is used to terminate a heading.

SUB — *Substitute character* — A control character used in the place of a character that has been found to be invalid or in error. SUB is intended to be introduced by automatic means.

SYN — *Synchronous idle* — A transmission control character used by a synchronous transmission system in the absence of any other character (idle condition) to provide a signal from which synchronism may be achieved or retained between data-terminal equipment.

VT — *Vertical tabulation* — A format effector which advances the active position to the same character position on the next pre-determined line.

4.11.3.3 Three system categories are specified in terms of their respective circuit characteristics, terminal configurations, and message transfer procedures as follows:

System category A: two-way alternate, multipoint allowing either centralized or non-centralized operation and single or multiple message-oriented information transfers without replies (but with delivery verification).

System category B: two-way simultaneous, point-to-point employing message associated blocking and modulo 8 numbering of blocks and acknowledgements.

System category C: two-way alternate, multipoint allowing only centralized (computer-to-terminal) operation, single or multiple message transfers with replies.

4.11.3.3.1 In addition to the characteristics prescribed in the paragraphs that follow for both system categories A and B, other parameters that shall be accounted for in order to ensure viable, operationally reliable communications include:

a) the number of SYN characters required to establish and maintain synchronization;

Note.— Normally the transmitting station sends three contiguous SYN characters and the receiving station detects at least two before any action is taken.

b) the values of system time-outs for such functions as "idle line" and "no response" as well as the number of automatic retries that are to be attempted before manual intervention is signalled;

c) the composition of prefixes within a 15 character maximum.

Note.— By agreement between the administrations concerned, it is permissible for supervisory signals to contain a station identification prefix using characters selected from columns 4 through 7 of IA-5.

4.11.3.3.2 **Recommendation.—** *For multipoint implementations designed to permit only centralized (computer-to-terminal) operations, the provisions of Section 4.11.3.7 should be employed.*

4.11.3.4 *Block check character*

4.11.3.4.1 Both system category A and B shall utilize a block check character to determine the validity of a transmission.

4.11.3.4.2 The block check character shall be composed of 7 bits plus a parity bit.

4.11.3.4.3 Each of the first 7 bits of the block check character shall be the modulo 2 binary sum of every element in the same bit 1 to bit 7 column of the successive characters of the transmitted block.

4.11.3.4.4 The longitudinal parity of each column of the block, including the block check character, shall be even.

4.11.3.4.5 The sense of the parity bit of the block check character shall be the same as for the information characters (see 4.11.1.2.3 above).

4.11.3.4.6 *Summation*

4.11.3.4.6.1 The summation to obtain the block check character shall be started by the first appearance of either SOH (start of heading) or STX (start of text).

4.11.3.4.6.2 The starting character shall not be included in the summation.

4.11.3.4.6.3 If an STX character appears after the summation has been started by SOH, then the STX character shall be included in the summation as if it were a text character.

4.11.3.4.6.4 With the exception of SYN (synchronous idle), all the characters which are transmitted after the start of the block check summation shall be included in the summation, including the ETB (end of transmission/block) or ETX (end of text) control character which signals that the following character is the block check character.

4.11.3.4.7 No character, SYN or otherwise, shall be inserted between the ETB or ETX character and the block check character.

4.11.3.5 *Description of system category A.* System category A is one in which a number of stations are connected by a multipoint link and one station is permanently designated as the control station which monitors the link at all times to ensure orderly operation.

4.11.3.5.1 *Link establishment procedure*

4.11.3.5.1.1 To establish the link for transmission, the control station shall either:

a) poll one of the tributary stations to assign it master status; or

b) assume master status and select one or more tributary (slave) stations to receive a transmission.

4.11.3.5.1.2 Polling shall be accomplished by the control station sending a polling supervisory sequence consisting of a prefix identifying a single tributary station and ending in ENQ.

4.11.3.5.1.3 A tributary station detecting its assigned polling supervisory sequence shall assume master status and respond in one of two ways:

a) if the station has a message to send, it shall initiate a selection supervisory sequence as described in 4.11.3.5.1.5 below;

b) if the station has no message to send, it shall send EOT, and master status shall revert to the control station.

4.11.3.5.1.4 If the control station detects an invalid or no response resulting from a poll, it shall terminate by sending EOT prior to resuming polling or selection.

4.11.3.5.1.5 Selection shall be accomplished by the designated master station sending a selection supervisory sequence consisting of a prefix identifying a single station and ending in ENQ.

4.11.3.5.1.6 A station detecting its assigned selection supervisory sequence shall assume slave status and send one of two replies:

a) if the station is ready to receive, it shall send a prefix followed by ACK. Upon detecting this reply, the master station shall either select another station or proceed with message transfer;

b) if the station is not ready to receive, it shall send a prefix followed by NAK and thereby relinquish slave status. If the master station receives NAK, or no reply, it shall either select another or the same tributary station or terminate;

c) it shall be permissible for N retries ($N \geq 0$) to be made to select a station for which NAK, an invalid reply, or no response has been received.

4.11.3.5.1.7 If one or more stations have been selected and have properly responded with ACK, the master station shall proceed with message transfer.

4.11.3.5.2 *Message transfer procedure*

4.11.3.5.2.1 The master station shall send a message or series of messages, with or without headings to the selected slave station(s).

4.11.3.5.2.2 The transmission of a message shall:

a) begin with:

— SOH if the message has a heading,
— STX if the message has no heading;

b) be continuous, ending with ETX, immediately followed by a block check character (BCC).

4.11.3.5.2.3 After transmitting one or more messages, the master station shall verify successful delivery at each selected slave station.

4.11.3.5.3 *Delivery verification procedure*

4.11.3.5.3.1 The master station shall send a delivery verification supervisory sequence consisting of a prefix identifying a single slave station and ending in ENQ.

4.11.3.5.3.2 A slave station detecting its assigned delivery verification supervisory sequence shall send one of two replies:

a) if the slave station properly received all of the transmission, it shall send an optional prefix followed by ACK;

b) if the slave station did not receive all of the transmission properly, it shall send an optional prefix followed by NAK.

4.11.3.5.3.3 If the master station receives no reply or an invalid reply, it shall request a reply from the same or another slave station until all selected stations have been properly accounted for.

4.11.3.5.3.4 If the master station receives a negative reply (NAK) or, after $N \geq 0$ repeat attempts, no reply, it shall repeat that transmission to the appropriate slave stations at a later opportunity.

4.11.3.5.3.5 After all messages have been sent and delivery verified, the master station shall proceed with link termination.

4.11.3.5.4 *Link termination procedure*

4.11.3.5.4.1 The terminate function, negating the master or slave status of all stations and returning master status to the control station, shall be accomplished by the master station transmitting EOT.

4.11.3.6 *Description of system category B.* System category B is one in which two stations are on a point-to-point, full-duplex link and each station has the capability to maintain concurrent master and slave status, i.e. master status on its transmit side and slave status on its receive side and both stations can transmit simultaneously.

4.11.3.6.1 *Link establishment procedure*

4.11.3.6.1.1 To establish the link for message transfers (from the calling to the called station), the calling station shall request the identity of the called station by sending an identification supervisory sequence consisting of a DLE character followed by a colon character, an optional prefix, and ENQ.

4.11.3.6.1.2 The called station, upon detecting ENQ, shall send one of two replies:

a) if ready to receive, it shall send a sequence consisting of a DLE followed by a colon, a prefix which includes its identity and ended by ACK0 (see 4.11.3.6.2.5 below). This establishes the link for message transfers from the calling to the called station;

b) if not ready to receive, it shall send the above sequence with the ACK0 replaced by NAK.

4.11.3.6.1.3 Establishment of the link for message transfers in the opposite direction can be initiated at any time following circuit connection in a similar manner to that described above.

4.11.3.6.2 *Message transfer procedure*

4.11.3.6.2.1 System category B message transfer provides for message associated blocking with longitudinal checking and modulo 8 numbered acknowledgements.

4.11.3.6.2.2 It is permissible for a transmission block to be a complete message or a portion of a message. The sending station shall initiate the transmission with SOTB N followed by:

a) SOH if it is the beginning of a message that contains a heading;

b) STX if it is the beginning of a message that has no heading;

c) SOH if it is an intermediate block that continues a heading;

d) STX if it is an intermediate block that continues a text.

Note.— SOTB N is the two-character transmission control sequence DLE = (characters 1/0, and 3/13) followed by the block number, N, where N is one of the IA-5 characters 0, 1 ... 7 (characters 3/0, 3/1 ... 3/7).

4.11.3.6.2.3 A block which ends at an intermediate point within a message shall be ended with ETB; a block which ends at the end of a message shall be ended with ETX.

4.11.3.6.2.4 It shall be permissible for each station to initiate and continue to send messages to the other concurrently according to the following sequence.

a) It shall be permissible for the sending station (master side) to send blocks, containing messages or parts of messages, continuously to the receiving station (slave side) without waiting for a reply.

b) It shall be permissible for replies, in the form of slave responses, to be transmitted by the receiving station while the sending station is sending subsequent blocks.

   Note.— By use of modulo 8 numbering of blocks and replies, it shall be permissible for the sending station to send as many as seven blocks ahead of the received replies before being required to stop transmission until six or less blocks are outstanding.

c) If a negative reply is received, the sending station (master side) shall start retransmission with the block following the last block for which the proper affirmative acknowledgement was received.

4.11.3.6.2.5 Slave responses shall be according to one of the following:

a) if a transmission block is received without error and the station is ready to receive another block, it shall send DLE, a colon, an optional prefix, and the appropriate acknowledgement ACKN (referring to the received block beginning with SOTB N, e.g. ACK0, transmitted as DLE0 is used as the affirmative reply to the block numbered SOTB0, DLE1 for SOTB1, etc.);

b) if a transmission block is not acceptable, the receiving station shall send DLE, a colon, an optional prefix, and NAK.

4.11.3.6.2.6 **Recommendation.—** *Slave responses should be interleaved between message blocks and transmitted at the earliest possible time.*

4.11.3.6.3 *Link termination procedure*

4.11.3.6.3.1 If the link has been established for message transfers in either or both directions, the sending of EOT by a station shall signal the end of message transfers in that direction. To resume message transfers after sending EOT, the link shall be re-established in that direction.

4.11.3.6.3.2 EOT shall only be transmitted by a station after all outstanding slave responses have been received or otherwise accounted for.

4.11.3.6.4 *Circuit disconnection*

4.11.3.6.4.1 On switched connections, the data links in both directions shall be terminated before the connection is cleared. In addition, the station initiating clearing of the connection shall first announce its intention to do so by transmitting the two-character sequence DLE EOT, followed by any other signals required to clear the connection.

4.11.3.7 *Description of system category C (centralized).* System category C (centralized) is one (like system category A) in which a number of stations are connected by a multipoint link and one station is designated as the control station but (unlike system category A) provides only for centralized (computer-to-terminal) operations where message interchange (with replies) shall be constrained to occur only between the control and a selected tributary station.

4.11.3.7.1 *Link establishment procedure*

4.11.3.7.1.1 To establish the link for transmission the control station shall either:

a) poll one of the tributary stations to assign it master status; or

b) assume master status and select a tributary station to assume slave status and receive a transmission according to either of two prescribed selection procedures:

   1) selection with response (see 4.11.3.7.1.5 below); or

   2) fast select (see 4.11.3.7.1.7 below).

4.11.3.7.1.2 Polling is accomplished by the control station sending a polling supervisory sequence consisting of a prefix identifying a single tributary station and ending in ENQ.

4.11.3.7.1.3 A tributary station detecting its assigned polling supervisory sequence shall assume master status and respond in one of two ways:

a) if the station has a message to send, it shall initiate message transfer. The control station assumes slave status;

b) if the station has no message to send, it shall send EOT and master status shall revert to the control station.

4.11.3.7.1.4 If the control station detects an invalid or no response resulting from a poll, it shall terminate by sending EOT prior to resuming polling or selection.

4.11.3.7.1.5 Selection with response is accomplished by the control station assuming master status and sending a selection supervisory sequence consisting of a prefix identifying a single tributary station and ending in ENQ.

4.11.3.7.1.6 A tributary station detecting its assigned selection supervisory sequence shall assume slave status and send one of two replies:

a) if the station is ready to receive, it shall send an optional prefix followed by ACK. Upon detecting this reply, the master station shall proceed with message transfer;

b) if the station is not ready to receive, it shall send an optional prefix followed by NAK. Upon detecting NAK, it shall be permissible for the master station to again attempt selecting the same tributary station or initiate termination by sending EOT.

Note.— If the control station receives an invalid or no reply, it is permitted to attempt again to select the same tributary or after N retries (N ≥ 0) either to exit to a recovery procedure or to initiate termination by sending EOT.

4.11.3.7.1.7 Fast select is accomplished by the control station assuming master status and sending a selection supervisory sequence, and without ending this transmission with ENQ or waiting for the selected tributary to respond, proceeding directly to message transfer.

4.11.3.7.2 *Message transfer procedure*

4.11.3.7.2.1 The station with master status shall send a single message to the station with slave status and wait for a reply.

4.11.3.7.2.2 The message transmission shall:

a) begin with:

— SOH if the message has a heading,
— STX if the message has no heading;

and

b) be continuous, ending with ETX, immediately followed by BCC.

4.11.3.7.2.3 The slave station, upon detecting ETX followed by BCC, shall send one of two replies:

a) if the messages were accepted and the slave station is ready to receive another message, it shall send an optional prefix followed by ACK. Upon detecting ACK, the master station shall be permitted either to transmit the next message or initiate termination;

b) if the message was not accepted and the slave station is ready to receive another message, it shall send an optional prefix followed by NAK. Upon detecting NAK, the master station may either transmit another message or initiate termination. Following the NAK reply, the next message transmitted need not be a retransmission of the message that was not accepted.

4.11.3.7.2.4 If the master station receives an invalid or no reply to a message, it shall be permitted to send a delivery verification supervisory sequence consisting of an optional prefix followed by ENQ. Upon receipt of a delivery verification supervisory sequence, the slave station repeats its last reply.

4.11.3.7.2.5 N retries (N ≥ 0) may be made by the master station in order to get a valid slave reply. If a valid reply is not received after N retries, the master station exits to a recovery procedure.

4.11.3.7.3 *Link termination procedure*

4.11.3.7.3.1 The station with master status shall transmit EOT to indicate that it has no more messages to transmit. EOT shall negate the master/slave status of both stations and return master status to the control station.

4.11.4 Ground-ground bit-oriented data link control procedures

Note.— The provisions of this section pertain to ground-ground data interchange applications using bit-oriented data link control procedures enabling transparent, synchronous transmission that is independent of any encoding; data link control functions are accomplished by interpreting designated bit positions in the transmission envelope of a frame.

4.11.4.1 The following descriptions shall apply to data link applications contained in this section.

a) Bit-oriented data link control procedures enable transparent transmission that is independent of any encoding.

b) A data link is the logical association of two interconnected stations, including the communication control capability of the interconnected stations.

c) A station is a configuration of logical elements, from or to which messages are transmitted on a data link, including those elements which control the message flow on the link via communication control procedures.

d) A combined station sends and receives both commands and responses and is responsible for control of the data link.

e) Data communication control procedures are the means used to control and protect the orderly interchange of information between stations on a data link.

f) A component is defined as a number of bits in a prescribed order within a sequence for the control and supervision of the data link.

g) An octet is a group of 8 consecutive bits.

h) A sequence is one or more components in prescribed order comprising an integral number of octets.

i) A field is a series of a specified number of bits or specified maximum number of bits which performs the functions of data link or communications control or constitutes data to be transferred.

j) A frame is a unit of data to be transferred over the data link, comprising one or more fields in a prescribed order.

k) A common ICAO data interchange network (CIDIN) switching centre is that part of an automatic AFTN switching centre which provides for the entry, relay, and exit centre functions using the bit-oriented link and CIDIN network procedures specified in this section and includes the appropriate interface(s) with other parts of the AFTN and with other networks.

4.11.4.2 *Bit-oriented data link control procedures for point-to-point, ground-ground data interchange applications employing synchronous transmission facilities*

Note.— The following link level procedures are the same as the LAPB link level procedures described in ITU CCITT Recommendation X.25, Section 2, Yellow Book (1981 version). Later versions of Recommendation X.25 will be reviewed as they are released to ascertain whether or not they should be adopted.

4.11.4.2.1 *Frame format.* Frames shall contain not less than 32 bits, excluding the opening and closing flags, and shall conform to the following format:

FLAG F	ADDRESS A	CONTROL C	INFORMATION I	FCS	FLAG F

4.11.4.2.1.1 A frame shall consist of an opening flag (F), an address field (A), a control field (C), an optional information field (I), a frame check sequence (FCS), and a closing flag sequence (F), and shall be transmitted in that order.

Note.— In relation to CIDIN, the opening flag, the fields A and C, the FCS and the closing flag form together the Data Link Control Field (DLCF). The field I is denoted as the Link Data Field (LDF).

4.11.4.2.1.1.1 The flag (F) shall be the 8-bit sequence 01111110 which delimits the beginning and ending of each frame. It shall be permissible for the closing flag of a frame to also serve as the opening flag of the next frame.

4.11.4.2.1.1.2 The address (A) field shall consist of one octet, excluding 0 bits added to achieve transparent transmission, which shall contain the link address of the combined station.

4.11.4.2.1.1.3 The control (C) field shall consist of one octet, excluding 0 bits added to achieve transparent transmission, and shall contain the commands, responses, and frame sequence number components for the control of the data link.

4.11.4.2.1.1.4 The information (I) field shall contain digital data which may be presented in any code or sequence but shall not exceed a maximum of 259 octets, excluding 0 bits added to achieve transparent transmission. The I field shall always be a multiple of 8 bits in length.

4.11.4.2.1.1.5 The frame check sequence (FCS) shall consist of two octets, excluding 0 bits added to achieve transparent transmission, and shall contain the error detecting bits.

4.11.4.2.2 A frame check sequence (FCS) shall be included in each frame for the purpose of error checking.

4.11.4.2.2.1 The error checking algorithm shall be a cyclic redundancy check (CRC).

4.11.4.2.2.2 The CRC polynominal (P(x)) shall be

$$x^{16} + x^{12} + x^5 + 1.$$

4.11.4.2.2.3 The FCS shall be a 16-bit sequence. This FCS shall be the ones' complement of the remainder, R(x), obtained from the modulo 2 division of

$$x^{16}[G(x)] + x^K(x^{15} + x^{14} + x^{13} + ... + x^2 + x^1 + 1)$$

by the CRC polynomial, P(x).

G(x) shall be the contents of the frame existing between, but including neither, the final bit of the opening flag nor the first bit of the FCS, excluding bits inserted for transparent transmission.

K shall be the length of G(x) (number of bits).

4.11.4.2.2.4 The generation and checking of the FCS accumulation shall be as follows:

a) the transmitting station shall initiate the FCS accumulation with the first (least significant) bit of the address (A) field and shall include all bits up to and including the last bit preceding the FCS sequence, but shall exclude all 0 bits (if any) inserted to achieve transparent transmission;

b) upon completion of the accumulation the FCS shall be transmitted, starting with bit b1 (highest order coefficient) and proceeding in sequence to bit b16 (lowest order coefficient) as shown below;

First bit transmitted ↓

b16	b15	b14	---	b3	b2	b1
x^0	x^1	x^2	---	x^{13}	x^{14}	x^{15}

c) the receiving station shall carry out the cyclic redundancy check (CRC) on the content of the frame commencing with the first bit received following the opening flag, and shall include all bits up to and including the last bit preceding the closing flag, but shall exclude all 0 bits (if any) deleted according to the rules for achievement of transparency;

d) upon completion of the FCS accumulation, the receiving station shall examine the remainder. In the absence of transmission error, the remainder shall be 1111000010111000 (x^0 through x^{15}, respectively).

4.11.4.2.3 *Achievement of transparency.* The frame format contents (A, C, link data field, and FCS) shall be capable of containing any bit configuration.

4.11.4.2.3.1 The following rules shall apply to all frame contents, except flag sequences:

a) the transmitting station shall examine the frame contents before transmission, and shall insert a single 0 bit immediately following each sequence of 5 consecutive 1 bits;

b) the receiving station shall examine the received frame contents for patterns consisting of 5 consecutive 1 bits immediately followed by one (or more) 0 bit(s) and shall remove the 0 bit which directly follows 5 consecutive 1 bits.

4.11.4.2.4 *Special transmission sequences and related link states.* In addition to employing the prescribed repertoire of commands and responses to manage the interchange of data and control information, stations shall use the following conventions to signal the indicated conditions:

a) *Abort* is the procedure by which a station in the process of sending a frame ends the frame in an unusual manner such that the receiving station shall ignore the frame. The conventions for aborting a frame shall be:

   1) transmitting at least seven, but less than fifteen, one bits (with no inserted zeros);

   2) receiving seven one bits.

b) *Active link state.* A link is in an active state when a station is transmitting a frame, an abort sequence, or interframe time fill. When the link is in the active state, the right of the transmitting station to continue transmission shall be reserved.

c) *Interframe time fill.* Interframe time fill shall be accomplished by transmitting continuous flags between frames. There is no provision for time fill within a frame.

d) *Idle link state.* A link is in an idle state when a continuous one condition is detected that persists for 15 bit times, or longer. Idle link time fill shall be a continuous one condition on the link.

e) *Invalid frame.* An invalid frame is one that is not properly bounded by two flags or one which is shorter than 32 bits between flags.

4.11.4.2.5 *Modes*

4.11.4.2.5.1 *Operational mode.* The operational mode shall be the asynchronous balanced mode (ABM).

4.11.4.2.5.1.1 It shall be permissible for a combined station in ABM to transmit without invitation from the associated station.

4.11.4.2.5.1.2 A combined station in ABM shall be permitted to transmit any command or response type frame except DM.

4.11.4.2.5.2 *Non-operational mode.* The non-operational mode shall be the asynchronous disconnected mode (ADM) in which a combined station is logically disconnected from the data link.

4.11.4.2.5.2.1 It shall be permissible for a combined station in ADM to transmit without invitation from the associated station.

4.11.4.2.5.2.2 A combined station in ADM shall transmit only SABM, DISC, UA and DM frames. (See 4.11.4.2.7 below for a description of the commands and responses to which these frame types refer.)

4.11.4.2.5.2.3 A combined station in ADM shall transmit a DM when a DISC is received, and shall discard all other received command frames except SABM. If a discarded command frame has the P bit set to "1", the combined station shall transmit a DM with the F bit set to "1".

4.11.4.2.6 *Control field functions and parameters.* Control fields contain a command or a response and sequence numbers where applicable. Three types of control fields shall be used to perform:

a) numbered information transfer (I-frames);

b) numbered supervisory functions (S-frames); and

c) unnumbered control functions (U-frames).

The control field formats shall be as shown in Table 4-5. The functional frame designation associated with each type control field as well as the control field parameters employed in performing these functions shall be described in the following paragraphs.

4.11.4.2.6.1 The I-frame type is used to perform information transfers. Except for some special cases it is the only format which shall be permitted to contain an information field.

Table 4-5. Control field formats

Control field format for	Control field bits 1	2	3	4	5	6	7	8
Information transfer (I frame)	0	N(S)			P	N(R)		
Supervisory commands/responses (S frame)	1	0	S	S	P/F	N(R)		
Unnumbered commands/responses	1	1	M	M	P/F	M	M	M

where:

N(S) = send sequence count (bit 2 = low order bit)
N(R) = receive sequence count (bit 6 = low order bit)
S = supervisory function bits
M = modifier function bits
P = poll bit (in commands)
F = final bit (in responses)

4.11.4.2.6.2 The S-frame type is used for supervisory commands and responses that perform link supervisory control functions such as acknowledge information frames, request transmission or retransmission of information frames, and to request a temporary suspension of transmission of I-frames. No information field shall be contained in the S-frame.

4.11.4.2.6.3 The U-frame type is used for unnumbered commands and responses that provide additional link control functions. One of the U-frame responses, the frame reject (FRMR) response, shall contain an information field; all other frames of the U-frame type shall not contain an information field.

4.11.4.2.6.4 The station parameters associated with the three control field types shall be as follows:

a) *Modulus.* Each I-frame shall be sequentially numbered with a send sequence count, N(S), having value 0 through modulus minus one (where modulus is the modulus of the sequence numbers). The modulus shall be 8. The maximum number of sequentially numbered I-frames that a station shall have outstanding (i.e. unacknowledged) at any given time shall never exceed one less than the modulus of the sequence numbers. This restriction on the number of outstanding frames is to prevent any ambiguity in the association of transmission frames with sequence numbers during normal operation and/or error recovery.

b) The send state variable V(S) shall denote the sequence number of the next in-sequence I-frame to be transmitted.

   1) The send state variable shall take on the value 0 through modulus minus one (modulus is the modulus of the sequence numbering and the numbers cycle through the entire range).

   2) The value of V(S) shall be incremented by one with each successive in-sequence I-frame transmission, but shall not exceed the value of N(R) contained in the last received frame by more than the maximum permissible number of outstanding I-frames (k). See i) below for the definition of k.

c) Prior to transmission of an in-sequence I-frame, the value of N(S) shall be updated to equal the value of V(S).

d) The receive state variable V(R) shall denote the sequence number of the next in-sequence I-frame to be received.

   1) V(R) shall take on the values 0 through modulus minus one.

   2) The value of V(R) shall be incremented by one after the receipt of an error-free, in-sequence I-frame whose send sequence number N(S), equals V(R).

e) All I-frames and S-frames shall contain N(R), the expected sequence number of the next received frame. Prior to transmission of either an I or an S type frame, the value of N(R) shall be updated to equal the current value of the receive state variable. N(R) indicates that the station transmitting the N(R) has correctly received all I-frames numbered up to and including N(R) – 1.

f) Each station shall maintain an independent send state variable, V(S), and receive state variable, V(R), on the I-frames it sends and receives. That is, each combined station shall maintain a V(S) count on the I-frames it transmits and a V(R) count on the I-frames it has correctly received from the remote combined station.

g) The poll (P/F) bit shall be used by a combined station to solicit (poll) a response or sequence of responses from the remote combined station.

h) The final (P/F) bit shall be used by the remote combined station to indicate the response frame transmitted as the result of a soliciting (poll) command.

i) The maximum number (k) of sequentially numbered I-frames that a station may have outstanding (i.e. unacknowledged) at any given time is a station parameter which shall never exceed the modulus.

Note.— k is determined by station buffering limitations and should be the subject of bilateral agreement at the time of circuit establishment.

4.11.4.2.7 *Commands and responses.* It shall be permissible for a combined station to generate either commands or responses. A command shall contain the remote station address while a response shall contain the sending station address. The mnemonics associated with all of the commands and responses prescribed for each of the three frame types (I, S, and U) and the corresponding encoding of the control field are as shown in Table 4-6.

4.11.4.2.7.1 The I-frame command provides the means for transmitting sequentially numbered frames, each of which shall be permitted to contain an information field.

4.11.4.2.7.2 The S-frame commands and responses shall be used to perform numbered supervisory functions (such as acknowledgement, polling, temporary suspension of information transfer, or error recovery).

4.11.4.2.7.2.1 The receive ready command or response (RR) shall be used by a station to:

a) indicate that it is ready to receive an I-frame;

b) acknowledge previously received I-frames numbered up to and including N(R) – 1;

c) clear a busy condition that was initiated by the transmission of RNR.

Note.— It is permissible for a combined station to use the RR command to solicit a response from the remote combined station with the poll bit set to "1".

4.11.4.2.7.2.2 It shall be permissible to issue a reject command or response (REJ) to request retransmission of frames starting with the I-frame numbered N(R) where:

a) I-frames numbered N(R) – 1 and below are acknowledged;

b) additional I-frames pending initial transmission are to be transmitted following the retransmitted I-frame(s);

c) only one REJ exception condition, from one given station to another station, shall be established at any given time: another REJ shall not be issued until the first REJ exception condition has been cleared;

d) the REJ exception condition is cleared (reset) upon the receipt of an I-frame with an N(S) count equal to the N(R) of the REJ command/response.

Table 4-6. Commands and responses

Type	*Commands*		*Responses*		*C field encoding* 1	2	3	4	5	6	7	8
Information transfer	I	(information)			0		N(S)		P		N(R)	
Supervisory	RR	(receive ready)	RR	(receive ready)	1	0	0	0	P/F		N(R)	
	RNR	(receive not ready)	RNR	(receive not ready)	1	0	1	0	P/F		N(R)	
	REJ	(reject)	REJ	(reject)	1	0	0	1	P/F		N(R)	
Unnumbered			DM	(disconnected mode)	1	1	1	1	P/F	0	0	0
	SABM	(set asynchronous balanced mode)			1	1	1	1	P	1	0	0
	DISC	(disconnect)			1	1	0	0	P	0	1	0
			UA	(unnumbered acknowledgement)	1	1	0	0	F	1	1	0
			FRMR	(frame reject)	1	1	1	0	F	0	0	1

4.11.4.2.7.2.3 The receive not ready command or response (RNR) shall be used to indicate a busy condition, i.e. temporary inability to accept additional incoming I-frames, where:

a) frames numbered up to and including N(R) – 1 are acknowledged;

b) frame N(R) and any subsequent I-frames received, if any, are not acknowledged (the acceptance status of these frames shall be indicated in subsequent exchanges);

c) the clearing of a busy condition shall be indicated by the transmission of an RR, REJ, SABM, or UA with or without the P/F bit set to "1".

4.11.4.2.7.2.3.1 **Recommendation.—**

a) A station receiving an RNR frame when in the process of transmitting should stop transmitting I-frames at the earliest possible time.

b) Any REJ command or response which was received prior to the RNR should be actioned before the termination of transmission.

c) It should be permissible for a combined station to use the RNR command with the poll bit set to "1" to obtain a supervisory frame with the final bit set to "1" from the remote combined station.

4.11.4.2.7.2.4 It shall be permissible for the selective reject command or response (SREJ) to be used to request retransmission of the single I-frame numbered N(R) where:

a) frames numbered up to N(R) – 1 are acknowledged; frame N(R) is not accepted; the only I-frames accepted are those received correctly and in sequence following the I-frame requested; the specific I-frame to be retransmitted is indicated by the N(R) in the SREJ command/response;

b) the SREJ exception condition is cleared (reset) upon receipt of an I-frame with an N(S) count equal to the N(R) of the SREJ;

c) after a station transmits a SREJ it is not permitted to transmit SREJ or REJ for an additional sequence error until the first SREJ error condition has been cleared;

d) I-frames that have been permitted to be transmitted following the I-frame indicated by the SREJ are not retransmitted as the result of receiving a SREJ; and

e) it is permissible for additional I-frames pending initial transmission to be transmitted following the retransmission of the specific I-frame requested by the SREJ.

4.11.4.2.7.3 The U-frame commands and responses shall be used to extend the number of link control functions. Transmitted U-frames do not increment the sequence counts at either the transmitting or receiving station.

a) The U-frame mode-setting commands (SABM, and DISC) shall be used to place the addressed station in the appropriate response mode (ABM or ADM) where:

1) upon acceptance of the command, the station send and receive state variables, V(S) and V(R), are set to zero;

2) the addressed station confirms acceptance at the earliest possible time by transmission of a single unnumbered acknowledgement, UA;

3) previously transmitted frames that are unacknowledged when the command is actioned remain unacknowledged;

4) the DISC command is used to perform a logical disconnect, i.e. to inform the addressed combined station that the transmitting combined station is suspending operation. No information field shall be permitted with the DISC command.

b) The unnumbered acknowledge response (UA) shall be used by a combined station to acknowledge the receipt and acceptance of an unnumbered command. Received unnumbered commands are not actioned until the UA response is transmitted. No information field shall be permitted with the UA response.

c) The frame reject response (FRMR), employing the information field described below, shall be used by a combined station in the operational mode (ABM) to report that one of the following conditions resulted from the receipt of a frame without an FCS error:

1) a command/response that is invalid or not implemented;

2) a frame with an information field that exceeds the size of the buffer available;

3) a frame having an invalid N(R) count.

Note.— An invalid N(R) is a count which points to an I-frame which has previously been transmitted and acknowledged or to an I-frame which has not been transmitted and is not the next sequential I-frame pending transmission.

d) The disconnected mode response (DM) shall be used to report a non-operational status where the station is logically disconnected from the link. No information field shall be permitted with the DM response.

Note.— The DM response shall be sent to request the remote combined station to issue a mode-setting command or, if sent in response to the reception of a mode-setting command, to inform the remote combined station that the transmitting station is still in ADM and cannot action the mode-setting command.

4.11.4.3 Exception condition reporting and recovery. This section specifies the procedures that shall be employed to effect recovery following the detection or occurrence of an exception condition at the link level. Exception conditions described are those situations that may occur as the result of transmission errors, station malfunction, or operational situations.

FRMR INFORMATION FIELD BITS FOR BASIC (SABM) OPERATION

First bit transmitted

1 8	9	10 12	13	14 16	17	18	19	20	21 24
rejected basic control field	0	V(S)	v	V(R)	w	x	y	z	set to zero

where:

rejected basic control field is the control field of the received frame which caused the frame reject;

V(S) is the current value of the send state variable at the remote combined station reporting the error condition (bit 10 = low order bit);

V(R) is the current value of the receive state variable at the remote combined station reporting the error condition (bit 14 = low order bit);

v set to "1" indicates that the received frame which caused rejection was a response;

w set to "1" indicates that the control field received and returned in bits 1 through 8 are invalid or not implemented;

x set to "1" indicates that the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted with this command. Bit w must be set to "1" in conjunction with this bit;

y set to "1" indicates that the information field received exceeded the maximum information field length which can be accommodated by the station reporting the error condition. This bit is mutually exclusive with bits w and x above;

z set to "1" indicates that the control field received and returned in bits 1 through 8 contained an invalid N(R) count. This bit is mutually exclusive with bit w.

4.11.4.3.1 *Busy condition.* A busy condition occurs when a station temporarily cannot receive or continue to receive I-frames due to internal constraints, e.g. due to buffering limitations. The busy condition shall be reported to the remote combined station by the transmission of an RNR frame with the N(R) number of the next I-frame that is expected. It shall be permissible for traffic pending transmission at the busy station to be transmitted prior to or following the RNR.

Note.— The continued existence of a busy condition must be reported by retransmission of RNR at each P/F frame exchange.

4.11.4.3.1.1 Upon receipt of an RNR, a combined station in ABM shall cease transmitting I-frames at the earliest possible time by completing or aborting the frame in process. The combined station receiving an RNR shall perform a time-out operation before resuming asynchronous transmission of I-frames unless the busy condition is reported as cleared by the remote combined station. If the RNR was received as a command with the P bit set to "1", the receiving station shall respond with an S-frame with the F bit set to "1".

4.11.4.3.1.2 The busy condition shall be cleared at the station which transmitted the RNR when the internal constraint ceases. Clearance of the busy condition shall be reported to the remote station by transmission of an RR, REJ, SABM, or UA frame (with or without the P/F bit set to "1").

4.11.4.3.2 *N(S) sequence error.* An N(S) sequence exception shall be established in the receiving station when an I-frame that is received error free (no FCS error) contains an N(S) sequence number that is not equal to the receive variable V(R) at the receiving station. The receiving station shall not acknowledge (shall not increment its receive variable V(R)) the frame causing the sequence error, or any I-frames which may follow, until an I-frame with the correct N(S) number is received. A station that receives one or more I-frames having sequence errors, but which are otherwise error free, shall accept the control information contained in the N(R) field and the P/F bit to perform link control functions, e.g. to receive acknowledgement of previously transmitted I-frames (via the N(R)), to cause the station to respond (P bit set to "1").

4.11.4.3.2.1 The means specified in 4.11.4.3.2.1.1 and 4.11.4.3.2.1.2 below shall be available for initiating the retransmission of lost or errored I-frames following the occurrence of a sequence error.

4.11.4.3.2.1.1 Where the REJ command/response is used to initiate an exception recovery following the detection of a sequence error, only one "sent REJ" exception condition, from one station to another station, shall be established at a time. A "sent REJ" exception shall be cleared when the requested I-frame is received. A station receiving REJ shall initiate sequential (re)transmission of I-frames starting with the I-frame indicated by the N(R) contained in the REJ frame.

4.11.4.3.2.1.2 In the event a receiving station, due to a transmission error, does not receive (or receives and discards) a single I-frame or the last I-frame(s) in a sequence of I-frames, it shall not detect an out-of-sequence exception and, therefore, shall not transmit REJ. The station which transmitted the unacknowledged I-frame(s) shall, following the completion of a system-specified time-out period, take appropriate recovery action to determine the sequence number at which retransmission must begin.

4.11.4.3.2.1.3 **Recommendation.**— *A combined station which has timed out waiting for a response should not retransmit all unacknowledged frames immediately. The station may enquire about status with a supervisory frame.*

Note 1.— If a station does retransmit all unacknowledged I-frames after a time-out, it must be prepared to receive a subsequent REJ frame with an N(R) greater than its send variable V(S).

Note 2.— Since contention may occur in the case of two-way alternate communications in ABM or ADM, the time-out interval employed by one combined station must be greater than that employed by the other combined station so as to permit contention to be resolved.

4.11.4.3.3 *FCS error.* Any frame with an FCS error shall not be accepted by the receiving station and will be discarded. No action shall be taken by the receiving station as the result of that frame.

4.11.4.3.4 *Frame reject exception condition.* A frame reject exception condition shall be established upon the receipt of an error-free frame which contains an invalid or unimplemented control field, an invalid N(R), or an information field which has exceeded the maximum established storage capability. If a frame reject exception condition occurs in a combined station, the station shall either:

a) take recovery action without reporting the condition to the remote combined station; or

b) report the condition to the remote combined station with a FRMR response. The remote station will then be expected to take recovery action; if, after waiting an appropriate time, no recovery action appears to have been taken, the combined station reporting the frame reject exception condition may take recovery action.

Recovery action for balanced operation includes the transmission of an implemented mode-setting command. Higher level functions may also be involved in the recovery.

4.11.4.3.5 *Mode-setting contention.* A mode-setting contention situation exists when a combined station issues a mode-setting command and, before receiving an appropriate response (UA or DM), receives a mode-setting command from the remote combined station. Contention situations shall be resolved in the following manner:

a) when the send and receive mode-setting commands are the same, each combined station shall send a UA response at the earliest respond opportunity. Each combined station shall either enter the indicated mode immediately or defer entering the indicated mode until receiving a UA response. In the latter case, if the UA response is not received:

   1) the mode may be entered when the response timer expires; or

   2) the mode-setting command may be reissued;

b) when the mode-setting commands are different, each combined station shall enter ADM and issue a DM response at the earliest respond opportunity. In the case of DISC contention with a different mode-setting command, no further action is required.

4.11.4.3.6 *Time-out functions.* Time-out functions shall be used to detect that a required or expected acknowledging action or response to a previously transmitted frame has not been received. Expiration of the time-out function shall initiate appropriate action, e.g. error recovery or reissuance of the P bit. The duration of the following time-out functions is system dependent and subject to bilateral agreement:

a) combined stations shall provide a time-out function to determine that a response frame with F bit set to "1" to a command frame with the P bit set to "1" has not been received. The time-out function shall automatically cease upon receipt of a valid frame with the F bit set to "1";

b) a combined station which has no P bit outstanding, and which has transmitted one or more frames for which responses are anticipated shall start a time-out function to detect the no-response condition. The time-out function shall cease when an I- or S-frame is received with the N(R) higher than the last received N(R) (actually acknowledging one or more I-frames).

4.11.5 Common ICAO data interchange network (CIDIN)

Note.— The common ICAO data interchange network (CIDIN) is one part of the aeronautical fixed service which uses bit-oriented procedures and packet switching techniques.

4.11.5.1 *CIDIN protocol levels*

4.11.5.1.1 There shall be four protocol levels defined to control the transfer of messages between CIDIN switching centres:

— the data link protocol level

— the X.25 packet protocol level

— the CIDIN packet protocol level

— the transport protocol level

Note.— The relationship of the terms used is shown in Figures 4-3 and 4-4.

4.11.5.1.2 *The data link protocol level*

4.11.5.1.2.1 X.25 packets to be transferred between two CIDIN switching centres or a CIDIN switching centre and a packet switched data network shall be formatted into data link frames.

4.11.5.1.2.2 Each data link frame shall consist of a data link control field (DLCF), possibly followed by a link data field, and shall be terminated by a frame check sequence and flag (being the second part of the DLCF). If a link data field is present, the frame shall be denoted as an information frame.

4.11.5.1.2.3 X.25 packets shall be transmitted within the link data field of information frames. Only one packet shall be contained in the link data field.

4.11.5.1.2.4 The data link protocol shall be as described in 4.11.4 above.

4.11.5.1.3 *The X.25 packet protocol level (permanent virtual circuit procedure)*

4.11.5.1.3.1 Each CIDIN packet to be transferred on CIDIN circuits between CIDIN switching centres shall be formatted into one X.25 packet. When a packet switched data network is used to interconnect two CIDIN switching centres, it shall be permissible to format the CIDIN packet into more than one X.25 packet.

4.11.5.1.3.2 The integrity of each CIDIN packet shall be preserved by the X.25 packet protocol by mapping each CIDIN packet onto one complete X.25 packet sequence, as defined in CCITT Recommendation X.25 (1981).

4.11.5.1.3.3 Each X.25 packet shall consist of an X.25 packet header, possibly followed by a user data field (UDF).

4.11.5.1.3.4 The X.25 packet protocol is based on the application of permanent virtual circuit (PVC) procedures. A permanent virtual circuit shall be defined as a logical path between two CIDIN switching centres. If a packet switched data network is used to interconnect two CIDIN switching centres, the procedure shall provide full compatibility with the procedures to be followed for PVCs according to CCITT Recommendation X.25 (1981). A packet switched data network providing an X.25 interface to a CIDIN switching centre may offer a number of options. The following options shall be selected if available:

a) maximum user data field length of 256 octets; and

b) default window size of seven, or maximum available.

4.11.5.1.3.5 The X.25 packet procedures shall be as described in 4.11.6.2 below.

4.11.5.1.4 *The CIDIN packet protocol level*

4.11.5.1.4.1 Each transport header and the associated segment shall be preceded by a CIDIN packet header. No further segmentation of the CIDIN message shall be used between transport protocol level and CIDIN packet protocol level. Both headers, therefore, shall be used in combination. Together they shall be referred to as the Communications Control Field (CCF). Together with the message segment they form CIDIN packets that shall be transmitted from entry centre to exit centre(s), when necessary through one or more relay centres, as an entity.

4.11.5.1.4.2 CIDIN packets of one CIDIN message shall be relayed independently via predetermined routes through the network thus allowing alternative routing on a CIDIN packet basis as necessary.

4.11.5.1.4.3 The CIDIN packet header shall contain information to enable relay centres to handle CIDIN packets in the order of priority, to transmit the CIDIN packets on the proper outgoing circuit(s) and to duplicate or multiplicate CIDIN packets when required for multiple dissemination purposes. The information shall be sufficient to apply address stripping on the exit addresses as well as on the addressee indicators of messages in AFTN format.

Note.— Guidance material on address stripping in the CIDIN is contained in the Manual on the Planning and Engineering of the Aeronautical Fixed Telecommunication Network *(Doc 8259).*

4.11.5.1.4.4 The CIDIN packet procedures shall be as described in 4.11.6.3 below.

4.11.5.1.5 *The transport protocol level*

4.11.5.1.5.1 Information exchanged over the CIDIN shall be transmitted as CIDIN messages.

4.11.5.1.5.2 The length of a CIDIN message shall be defined by the CIDIN packet sequence number (CPSN). The maximum permissible length is 2^{15} packets which in effect results in no practical limitation.

4.11.5.1.5.3 If the length of a CIDIN message and its transport and packet headers (as defined below) exceeds 256 octets the message shall be divided into segments and placed in the CIDIN user data field of CIDIN packets. Each segment shall be preceded by a transport header containing information to enable the re-assembly of the CIDIN message at the exit centre(s) from individually received segments and to determine further handling of the received complete CIDIN message.

4.11.5.1.5.4 All segments of one CIDIN message shall be provided with the same message identification information in the transport header. Only the CPSN and final CIDIN packet (FCP) indicator shall be different.

4.11.5.1.5.5 Recovery of messages shall be performed at the transport level.

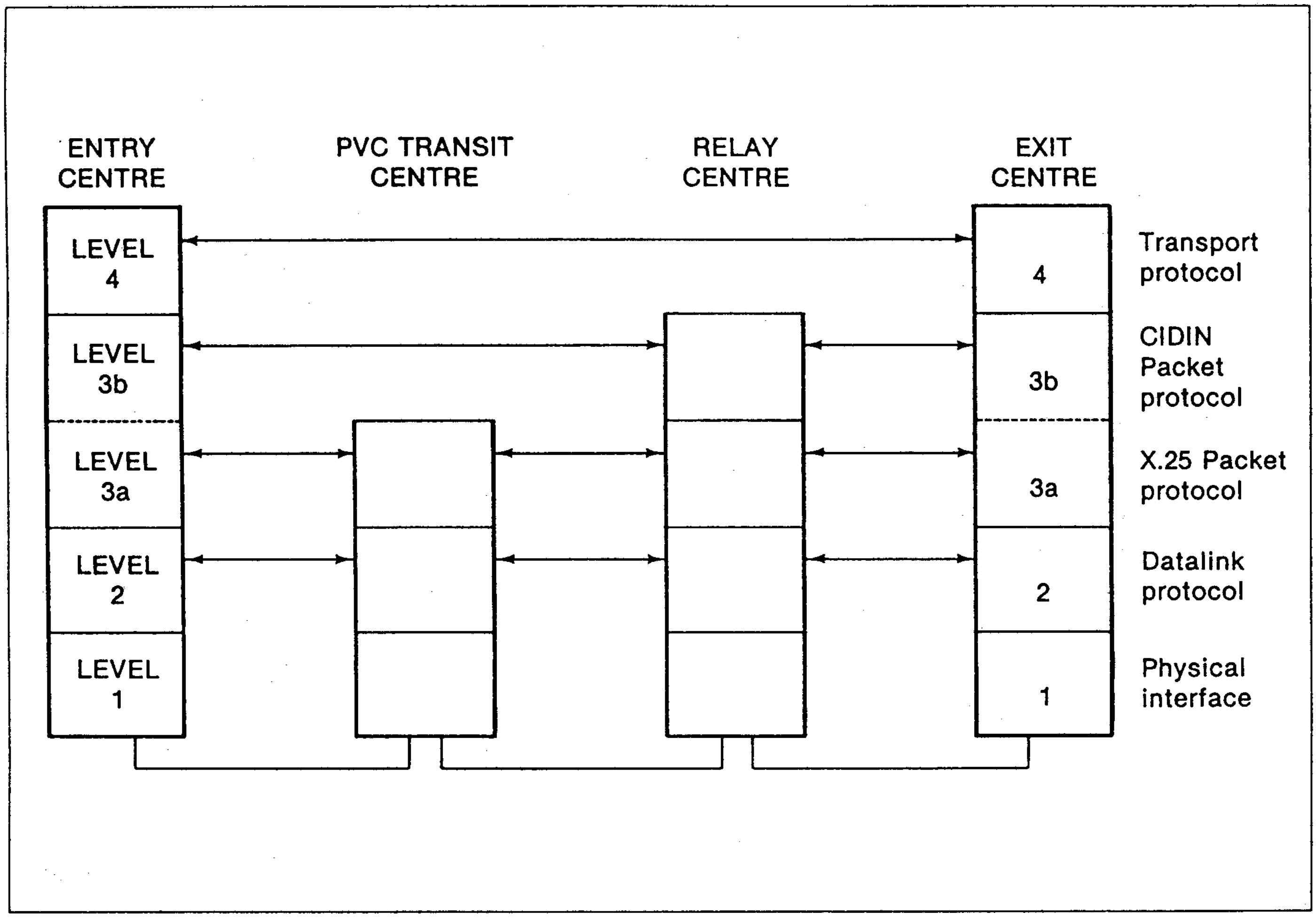

Figure 4-3. CIDIN Protocol Levels

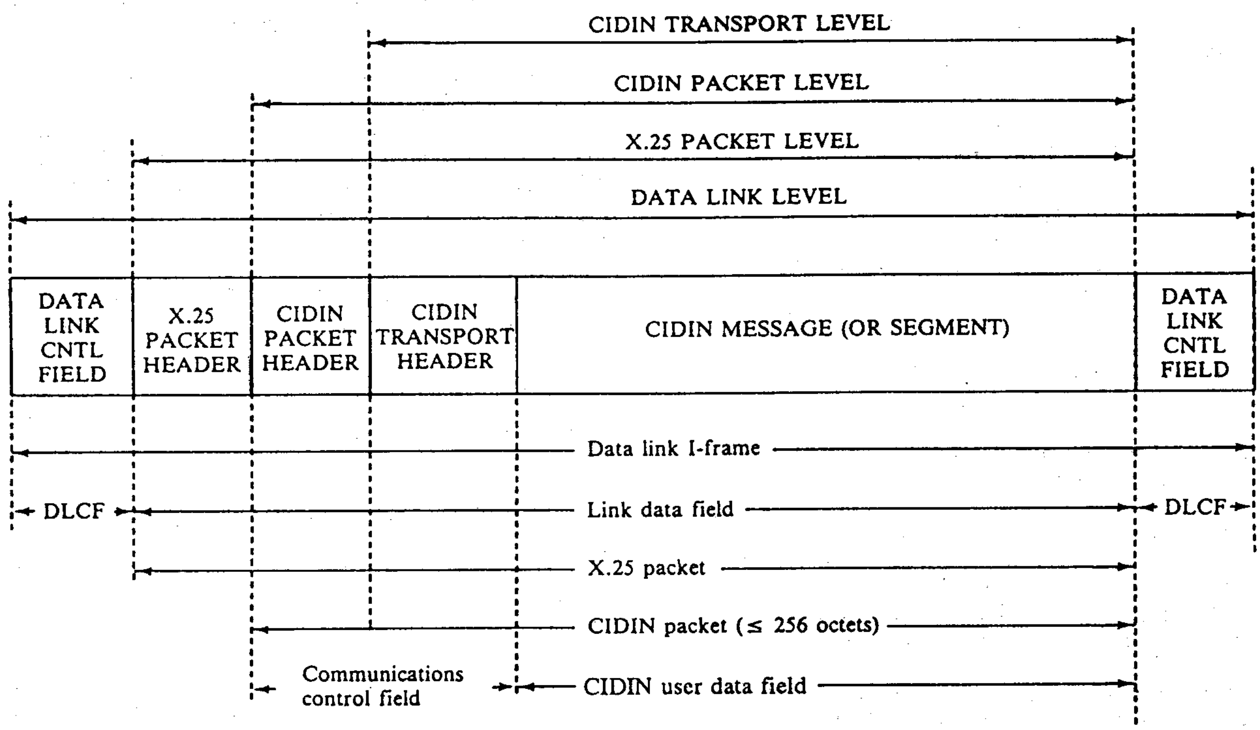

Figure 4-4. CIDIN Terminology

4.11.5.1.5.6 **Recommendation.—** *When an entry centre or station has to make separate transmissions of the same message to more than one exit centre or station, the same message identification number (MIN) should be used for each transmission.*

4.11.5.1.5.7 The transport protocol shall be as described in 4.11.6.4 below.

4.11.6 CIDIN procedures

4.11.6.1 *The data link procedures*

4.11.6.1.1 The data link procedures shall be as described in 4.11.4 above.

4.11.6.2 *The X.25 packet procedures for permanent virtual circuits*

4.11.6.2.1 The following descriptions shall apply to the packet level procedures for permanent virtual circuits.

a) A permanent virtual circuit (PVC) is a logical path which conveys data solely from one PVC termination centre, optionally through PVC transit centres to a single distant PVC termination centre via an assigned logical channel on each of one or more data links.

b) A PVC termination centre is a centre which introduces data into, and receives data from, a PVC.

c) A PVC transit centre is a centre which relays data for a PVC from one assigned logical channel on one data link to another assigned logical channel on another data link.

d) For each PVC within a PVC transit centre, the logical channel assigned to that PVC on one data link can be viewed as the corresponding logical channel with respect to the logical channel assigned to that PVC on another data link.

e) An octet is a group of 8 consecutive bits.

f) In the over-all centre architecture, packet level procedures are considered to exist above the link procedures and below the transport level procedures.

4.11.6.2.2 *Packet format*

4.11.6.2.2.1 The packet format used shall be one of the following:

4.11.6.2.2.1.1 Data packet, comprising:

a) the general format identifier;

b) the logical channel identifier, comprising a logical channel group number and a logical channel number;

c) the packet type identifier, including the packet receive sequence number P(R), the packet send sequence number P(S), and the more data bit M which has no significance on CIDIN circuits and shall be set to zero;

d) the user data field, comprising up to 256 octets and ending on an integral octet boundary.

Note.— Data networks operating in the packet mode and connected with CIDIN using procedures described in ITU CCITT Recommendation X.25-1981 that limit the user data field to not more than 128 octets may require the use of the M bit. Later versions of Recommendation X.25 will be reviewed as they are released to ascertain whether or not they should be adopted.

4.11.6.2.2.1.2 RECEIVE READY packet (RR), comprising:

a) the general format identifier;

b) the logical channel identifier, comprising a logical channel group number and a logical channel number;

c) the packet type identifier, including P(R).

4.11.6.2.2.1.3 RECEIVE NOT READY packet (RNR), comprising:

a) the general format identifier;

b) the logical channel identifier, comprising a logical channel group number and a logical channel number;

c) the packet type identifier, including P(R).

4.11.6.2.2.1.4 RESET REQUEST packet, comprising:

a) the general format identifier;

b) the logical channel identifier, comprising a logical channel group number and a logical channel number;

c) the packet type identifier;

d) the resetting cause field (see 4.11.6.2.11 below);

e) the diagnostic code (see 4.11.6.2.10 below).

4.11.6.2.2.1.5 RESET CONFIRMATION packet, comprising:

a) the general format identifier;

b) the logical channel identifier, comprising a logical channel group number and a logical channel number;

c) the packet type identifier.

4.11.6.2.2.1.6 RESTART REQUEST packet, comprising:

a) the general format identifier;

b) the logical channel identifier, comprising a logical channel group number and a logical channel number;

c) the packet type identifier;

d) the restarting cause field;

e) the diagnostic code (see 4.11.6.2.10 below).

4.11.6.2.2.1.7 RESTART CONFIRMATION packet, comprising:

a) the general format identifier;

b) the logical channel identifier, comprising a logical channel group number and a logical channel number;

c) the packet type identifier.

4.11.6.2.2.2 Each packet shall be completely contained in the link data field of a frame.

4.11.6.2.2.3 Only one packet shall be contained in the link data field of a frame.

4.11.6.2.2.4 The octets of each packet shall be transferred beginning with octet 1.

4.11.6.2.2.5 The bits of each octet shall be transferred beginning with bit 1.

4.11.6.2.2.6 The first bit transferred of the logical channel group number, logical channel number, P(R) and P(S) shall be the arithmetically least significant bit.

4.11.6.2.3 *Logical channels*

4.11.6.2.3.1 Each data link shall carry up to 4 096 logical channels.

4.11.6.2.3.2 Each logical channel shall be designated by a logical channel identifier, a number between 0 and 4 095, inclusive, which equals the logical channel group number multiplied by 2^8 and added to the logical channel number.

4.11.6.2.3.3 On each data link used to construct a PVC, a logical channel identifier between 1 and 4 095, inclusive, shall be assigned solely to that PVC.

4.11.6.2.3.4 The logical channel identifier assigned to a PVC on each data link shall not be required to be identical to the logical channel identifiers assigned to the same PVC on other data links.

4.11.6.2.3.5 On each data link, and when specified by the procedures described below, a centre shall transfer RESTART REQUEST and RESTART CONFIRMATION before transferring any other packets.

4.11.6.2.3.6 On each logical channel, and when specified by the procedures described below, a centre shall transfer RESET REQUEST and RESET CONFIRMATION before transferring any other packets on that logical channel.

4.11.6.2.3.7 A logical channel shall be in one of the following states:

a) unassigned, indicating the logical channel has not been assigned to carry a PVC;

b) restart, indicating that the procedure for restart has been initiated but not completed;

c) reset, indicating that the procedure for reset has been initiated but not completed;

d) flow control ready, indicating that the procedure for data transfer is being executed.

4.11.6.2.3.8 In the event of a restart, reset, reset or restart time-out procedure error, outage or restoration of service, the operator shall be informed, along with the meaning of resetting or restarting cause fields and diagnostic codes as required.

4.11.6.2.4 *Receiving unknown packets and packets of less than three octets in length*

4.11.6.2.4.1 Unknown packets, packets of less than three octets in length and over-long packets are non-valid packets.

4.11.6.2.4.2 A centre which receives a packet with a general format identifier not equal to one of the general format identifiers specified in 4.11.6.2.2.1 above shall discard the packet.

4.11.6.2.4.3 A centre which receives a packet of less than two octets in length shall discard the packet.

4.11.6.2.4.4 A centre which receives a packet of at least two but less than three octets in length shall:

a) if the logical channel is in the unassigned, restart or reset state: discard the packet;

b) if the logical channel is in the flow control ready state: execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic field indicating "packet type invalid when in flow control ready state";

c) if the logical channel is in the flow control ready state, and the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state: execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic field indicating "packet type invalid when in flow control ready state".

transmission order of bits within each octet

8	7	6	5	4	3	2	1	octet sequence
general format identifier				logical channel group number				
0	0	0	1					1
logical channel number								2
packet type identifier								
P(R)			M	P(S)			0	3
user data field (< = 256 octets*)								4
								< = 259†

* Data networks operating in the packet mode and connected with CIDIN using procedures described in ITU CCITT Recommendation X.25-1981 may limit the user data field to not more than 128 octets. Later versions of Recommendation X.25 will be reviewed as they are released to ascertain whether or not they should be adopted.

† Data networks operating in the packet mode and connected with CIDIN using procedures described in ITU CCITT Recommendation X.25-1981 may limit data packets to not more than 131 octets. Later versions of Recommendation X.25 will be reviewed as they are released to ascertain whether or not they should be adopted.

Data packet format

transmission order of bits within each octet

8	7	6	5	4	3	2	1	octet sequence
general format identifier				logical channel group number				
0	0	0	1					1
logical channel number								2
packet type identifier								
P(R)			0	0	0	0	1	3

RR packet format

transmission order of bits within each octet

8	7	6	5	4	3	2	1	octet sequence
general format identifier				logical channel group number				
0	0	0	1					1
logical channel number								2
packet type identifier								
P(R)			0	0	1	0	1	3

RNR packet format

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transmission order of bits within each octet

8	7	6	5	4	3	2	1	octet sequence
general format identifier				logical channel group number				1
0	0	0	1					
logical channel number								2
packet type identifier								3
0	0	0	1	1	0	1	1	
resetting cause field								4
diagnostic code								5

Reset request packet format

transmission order of bits within each octet

8	7	6	5	4	3	2	1	octet sequence
general format identifier				logical channel group number				1
0	0	0	1	0	0	0	0	
logical channel number								2
0	0	0	0	0	0	0	0	
packet type identifier								3
1	1	1	1	1	0	1	1	
restarting cause field								4
0	0	0	0	0	0	0	0	
diagnostic code								5

Restart request packet format

transmission order of bits within each octet

8	7	6	5	4	3	2	1	octet sequence
general format identifier				logical channel group number				1
0	0	0	1					
logical channel number								2
packet type identifier								3
0	0	0	1	1	1	1	1	

Reset confirmation packet format

transmission order of bits within each octet

8	7	6	5	4	3	2	1	octet sequence
general format identifier				logical channel group number				1
0	0	0	1	0	0	0	0	
logical channel number								2
0	0	0	0	0	0	0	0	
packet type identifier								3
1	1	1	1	1	1	1	1	

Restart confirmation packet format

4.11.6.2.4.5 A centre which receives a packet with a packet type identifier not defined in 4.11.6.2.2.1 above shall:

a) if the logical channel is in the unassigned, restart or reset state: discard the packet;

b) if the logical channel is in the flow control ready state: execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic field indicating "packet type invalid on PVCs";

c) if the logical channel is in the flow control ready state, and the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state: execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic field indicating "packet type invalid on PVCs".

4.11.6.2.5 *Procedure for initialization*

4.11.6.2.5.1 To simultaneously initialize all logical channels conveyed over a single data link, a centre shall execute the procedure for restart with the diagnostic code indicating "no additional information".

4.11.6.2.6 *Procedure for data transfer*

4.11.6.2.6.1 The following descriptions shall apply to the data transfer procedure:

a) The transfer lower window edge is the oldest P(S) number associated with the transfer (outgoing) direction of packets whose corresponding data packet has not yet been acknowledged by a P(R) transferred from the receiving centre.

b) The receive lower window edge is the oldest P(S) number associated with the receive (incoming) direction of packets whose corresponding data packet has not yet been acknowledged by a P(R) transferred from the receiving centre.

c) The window size W is the maximum number of packets which shall be transferred in a given direction on a logical channel before waiting for an acknowledgement from the receiving centre of the data packet with P(S) equal to the transfer lower window edge.

4.11.6.2.6.2 The data transfer procedure shall operate on each logical channel in the flow control ready state, independently from any other logical channel on that data link.

4.11.6.2.6.3 The data transfer procedure shall operate in each direction of data flow, independently from the opposite direction of data flow.

4.11.6.2.6.4 When a logical channel enters the flow control ready state, the receive and transfer lower window edges shall be set to 0.

4.11.6.2.6.5 W shall normally be 7 but other window sizes may be negotiated on a bilateral basis.

Note.— Data networks operating in the packet mode and connected with CIDIN using procedures described in ITU CCITT Recommendation X.25-1981 may require W to be some other value between 2 and 6, inclusive. Later versions of Recommendation X.25 will be reviewed as they are released to ascertain whether or not they should be adopted.

4.11.6.2.6.6 Arithmetic on lower window edges, P(S) and P(R) shall be performed modulo 8.

4.11.6.2.6.7 *Receiving data packets*

4.11.6.2.6.7.1 A centre which receives a data packet on a logical channel which is not in the flow control ready state shall discard the data packet.

4.11.6.2.6.7.2 A PVC transit centre which receives a data packet on a logical channel which is in the flow control ready state, and the corresponding logical channel is not in the flow control ready state, shall:

a) discard the data packet;

b) execute the procedure for reset on the logical channel from which the data packet was received, with the resetting cause field indicating "network congestion" and the diagnostic code indicating "no additional information".

4.11.6.2.6.7.3 A centre shall expect the first data packet received after a logical channel enters the flow control ready state to contain P(S) equal to 0.

4.11.6.2.6.7.4 A PVC transit centre which receives a data packet which is less than or equal to the maximum established length for data packets, and which contains P(S) equal to the next expected value of P(S), and which contains P(S) less than the receive lower window edge plus W, shall:

a) increment its next expected value of P(S) and, if this value differs from the receive lower window edge by more than one-half W, execute the procedure to update the receive lower window edge given in 4.11.6.2.6.13;

b) queue the data packet for transfer on the corresponding logical channel, without waiting for subsequent data packets;

c) if the P(R) is greater than or equal to the transfer lower window edge, and less than or equal to the P(S) to be assigned to the next data packet for transfer:

1) set the transfer lower window edge to equal P(R);

2) if there exist any unacknowledged data packets which were transferred with P(S) less than the new value of the transfer lower window edge, execute the procedure to update the receive lower window edge on the corresponding logical channel;

3) consider all unacknowledged data packets which have been transferred with P(S) less than the new value of the transfer lower window edge as acknowledged and delivered to the next centre;

d) if the P(R) is not greater than or equal to the transfer lower window edge, and not less than or equal to the P(S) to be assigned to the next data packet for transfer:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code field indicating "invalid P(R)";

2) execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "invalid P(R)".

4.11.6.2.6.7.5 A PVC termination centre which receives a data packet which is less than or equal to the maximum established length for data packets, and which contains P(S) equal to the next expected value of P(S), and which contains P(S) less than the receive lower window edge plus W, shall:

a) increment its next expected value of P(S) and, if this value differs from the receive lower window edge by more than one-half W, execute the procedure to update the receive lower window edge given in 4.11.6.2.6.13;

b) queue the data packet for processing by the CIDIN packet level procedures;;

c) if the P(R) is greater than or equal to the transfer lower window edge, and less than or equal to the P(S) to be assigned to the next data packet for transfer:

1) set the transfer lower window edge to equal P(R);

2) consider all unacknowledged data packets which have been transferred with P(S) less than the new value of the transfer lower window edge as acknowledged and delivered to the next centre;

d) if the P(R) is not greater than or equal to the transfer lower window edge, and not less than or equal to the P(S) to be assigned to the next data packet for transfer: execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code field indicating "invalid P(R)".

4.11.6.2.6.7.6 A centre which receives a data packet which is less than or equal to the maximum established length for data packets, and which contains P(S) equal to the next expected value of P(S), and which contains P(S) equal to or beyond the receive lower window edge plus W, shall:

a) discard the data packet;

b) execute the procedure for reset, with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "invalid P(S)";

c) if the centre is a PVC transit centre for the PVC assigned to the logical channel, execute the procedure for reset on the corresponding logical channel, with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "invalid P(S)".

4.11.6.2.6.7.7 A centre which receives a data packet which is less than or equal to the maximum established length for data packets, and which contains P(S) not equal to the next expected value of P(S), shall:

a) discard the data packet;

b) execute the procedure for reset, with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "invalid P(S)";

c) if the centre is a PVC transit centre for the PVC assigned to the logical channel, execute the procedure for reset on the corresponding logical channel, with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "invalid P(S)".

4.11.6.2.6.7.8 A centre which receives a data packet greater than the maximum established length for data packets shall:

a) discard the data packet;

b) execute the procedure for reset, with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "packet too long";

c) if the centre is a PVC transit centre for the PVC assigned to the logical channel, execute the procedure for reset on the corresponding logical channel, with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "packet too long".

4.11.6.2.6.8 *Transferring RECEIVE NOT READY*

4.11.6.2.6.8.1 A centre which is becoming temporarily unable to accept further data packets shall transfer a RECEIVE NOT READY with P(R) equal to the receive lower window edge.

4.11.6.2.6.9 *Receiving RECEIVE NOT READY*

4.11.6.2.6.9.1 A centre which receives a RECEIVE NOT READY on a logical channel which is not in the flow control ready state shall discard the RECEIVE NOT READY.

4.11.6.2.6.9.2 A centre which receives a valid RECEIVE NOT READY shall:

a) if the P(R) is greater than or equal to the transfer lower window edge, and less than or equal to the P(S) to be assigned to the next data packet for transfer:

1) set the transfer lower window edge to equal P(R);

2) consider all unacknowledged data packets which have been transferred with P(S) less than the new value of the transfer lower window edge as acknowledged and delivered to the next centre;

3) stop transferring data packets until a RECEIVE READY is received or the logical channel re-enters the flow control ready state;

b) if the P(R) is not greater than or equal to the transfer lower window edge, and not less than or equal to the P(S) to be assigned to the next data packet for transfer:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code field indicating "invalid P(R)";

2) if the centre is a PVC transit centre for the PVC assigned to the logical channel, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code field indicating "invalid P(R)".

4.11.6.2.6.9.3 A centre which receives a non-valid RECEIVE NOT READY shall:

a) execute the procedure for reset, with the resetting cause field indicating "local procedure error" and the appropriate diagnostic code;

b) if the centre is a PVC transit centre for the PVC assigned to the logical channel, execute the procedure for reset on the corresponding logical channel, with the resetting cause field indicating "remote procedure error" and the appropriate diagnostic code.

4.11.6.2.6.10 *Transferring RECEIVE READY*

4.11.6.2.6.10.1 A centre which was becoming temporarily unable to accept further data packets and thus transferred one or more RECEIVE NOT READYs, and which subsequently has become able to accept further data packets, shall transfer a RECEIVE READY with P(R) equal to the receive lower window edge.

4.11.6.2.6.11 *Receiving RECEIVE READY*

4.11.6.2.6.11.1 A centre which receives a RECEIVE READY on a logical channel which is not in the flow control ready state shall discard the RECEIVE READY.

4.11.6.2.6.11.2 A centre which receives a valid RECEIVE READY shall:

a) if the P(R) is greater than or equal to the transfer lower window edge, and less than or equal to the P(S) to be assigned to the next data packet for transfer:

1) set the transfer lower window edge to equal P(R);

2) consider all unacknowledged data packets which have been transferred with P(S) less than the new value of the transfer lower window edge as acknowledged and delivered to the next centre;

3) resume transferring data packets;

b) if the P(R) is not greater than or equal to the transfer lower window edge, and not less than or equal to the P(S) to be assigned to the next data packet for transfer:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code field indicating "invalid P(R)";

2) if the centre is a PVC transit centre for the PVC assigned to the logical channel, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code field indicating "invalid P(R)".

4.11.6.2.6.11.3 A centre which receives a non-valid RECEIVE READY shall:

a) execute the procedure for reset, with the resetting cause field indicating "local procedure error" and the appropriate diagnostic code;

b) if the centre is a PVC transit centre for the PVC assigned to the logical channel, execute the procedure for reset on the corresponding logical channel, with the resetting cause field indicating "remote procedure error" and the appropriate diagnostic code.

4.11.6.2.6.12 *Transferring data packets*

4.11.6.2.6.12.1 The first data packet transferred in each direction after a logical channel re-enters the flow control ready state shall have P(S) equal to 0, and each subsequent data packet shall have a P(S) equal to the P(S) of the preceding data packet plus one.

4.11.6.2.6.12.2 When transferring a data packet, the procedure for updating the receive lower window edge shall be executed and the P(R) shall then be set equal to the value of the receive lower window edge.

4.11.6.2.6.12.3 A data packet shall not be transferred when the P(S) is equal to or beyond the transfer lower window edge plus W.

4.11.6.2.6.13 *Procedures for updating the receive lower window edge (see 4.11.6.2.6.7.4 a) and 4.11.6.2.6.7.5 a))*

4.11.6.2.6.13.1 A PVC transit centre shall set the receive lower window edge equal to the next expected P(S).

4.11.6.2.6.13.2 A PVC termination centre shall set the receive lower window edge to equal the next expected P(S).

4.11.6.2.6.13.3 A centre which has changed the value of the receive lower window edge, and which cannot send a data packet, and which remains temporarily unable to accept further data packets, shall transfer a RECEIVE NOT READY.

4.11.6.2.6.13.4 A centre which has changed the value of the receive lower window edge, and which cannot send a data packet, and which is able to accept further data packets, shall transfer a RECEIVE READY.

4.11.6.2.7 *Procedure for reset*

4.11.6.2.7.1 The procedure for reset shall be used to reinitialize a logical channel.

4.11.6.2.7.2 A centre shall not initiate the procedure for reset when the logical channel is in the restart or unassigned state.

4.11.6.2.7.3 A centre shall initiate the procedure for reset as follows:

a) discard all packets waiting to be transferred or acknowledged on the logical channel;

b) cause the logical channel to enter the reset state;

c) transfer a RESET REQUEST;

d) start a 180-second timer T22; and

e) if the centre is a PVC termination centre for the PVC assigned to the logical channel, notify the CIDIN packet level that the PVC assigned to the logical channel is not usable.

4.11.6.2.7.4 *Receiving RESET REQUEST*

4.11.6.2.7.4.1 A centre which receives a valid RESET REQUEST when the logical channel is in the flow control ready state shall:

a) discard all packets waiting to be transferred or acknowledged on the logical channel;

b) immediately transfer a RESET CONFIRMATION;

c) cause the logical channel to re-enter the flow control ready state;

d) if the centre is a PVC transit centre for the PVC assigned to the logical channel and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with an identical diagnostic code and with a resetting cause field as follows:

Resetting cause field received	*Resetting cause field transferred*
centre-originated reset	centre-originated reset
out of order	out of order
remote procedure error	remote procedure error
local procedure error	local procedure error
network congestion	network congestion
remote centre operational	remote centre operational
network operational	network operational

e) if the centre is a PVC termination centre for the PVC assigned to the logical channel, and the resetting cause field is "out of order", notify the CIDIN packet level that the PVC is not usable; and

f) if the centre is a PVC termination centre for the PVC assigned to the logical channel and the resetting cause field is "network operational", notify the CIDIN packet level that the PVC is usable.

4.11.6.2.7.4.2 A centre which receives a valid RESET REQUEST when the logical channel is in the reset state shall:

a) cancel T22;

b) cause the logical channel to enter the flow control ready state;

c) if the centre is a PVC termination centre for the PVC assigned to the logical channel, notify the CIDIN packet level that the PVC assigned to the logical channel is usable.

4.11.6.2.7.4.3 A centre which receives a valid RESET REQUEST when the logical channel is in the restart or unassigned state shall discard the RESET REQUEST.

4.11.6.2.7.4.4 A centre which receives a non-valid RESET REQUEST shall:

a) if the logical channel is in the flow control ready or reset state:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the appropriate diagnostic code;

2) if the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the appropriate diagnostic code;

b) if the logical channel is in the restart or unassigned state, discard the RESET REQUEST.

4.11.6.2.7.5 *Receiving RESET CONFIRMATION*

4.11.6.2.7.5.1 A centre which receives a valid RESET CONFIRMATION when the logical channel is in the flow control ready state shall:

a) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "packet type invalid when in flow control ready state";

b) if the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "packet type invalid when in flow control ready state".

4.11.6.2.7.5.2 A centre which receives a valid RESET CONFIRMATION when the logical channel is in the reset state shall:

a) cancel T22;

b) cause the logical channel to enter the flow control ready state;

c) if the centre is a PVC termination centre for the PVC assigned to the logical channel, notify the CIDIN packet level that the PVC assigned to the logical channel is usable.

4.11.6.2.7.5.3 A centre which receives a valid RESET CONFIRMATION when the logical channel is in the restart or unassigned state shall discard the RESET CONFIRMATION.

4.11.6.2.7.5.4 A centre which receives a non-valid RESET CONFIRMATION shall:

a) if the logical channel is in the reset state:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the appropriate diagnostic code;

2) if the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the appropriate diagnostic code;

b) if the logical channel is in the flow control ready state:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "packet type invalid when in flow control ready state";

2) if the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "packet type invalid when in flow control ready state";

c) if the logical channel is in the restart or unassigned state, discard the RESET CONFIRMATION.

4.11.6.2.7.6 When T22 expires, the centre shall:

a) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "timer expired for reset";

b) if the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "timer expired for reset".

Note.— After unsuccessful retries, the logical channel should be considered out of order. The RESTART procedure should only be invoked for recovery if reinitialization of all logical channels is acceptable.

4.11.6.2.8 *Procedure for restart*

4.11.6.2.8.1 The procedure for RESTART shall be used to reinitialize a link.

4.11.6.2.8.2 A centre shall initiate the procedure for restart as follows:

a) transfer a RESTART REQUEST;

b) discard all packets waiting to be transferred or acknowledged on each logical channel;

c) cause each logical channel to enter the restart state;

d) start a 180-second timer T20; and

e) if the centre is a PVC termination centre, notify the CIDIN packet level that all PVCs assigned to logical channels carried on the data link are not usable.

4.11.6.2.8.3 *Receiving RESTART REQUEST*

4.11.6.2.8.3.1 A centre which receives a valid RESTART REQUEST with a logical channel identifier equal to 0, and whose logical channels are not in the restart state shall:

a) discard all packets waiting to be transferred or acknowledged;

b) immediately transfer a RESTART CONFIRMATION;

c) cause each logical channel assigned to carry a PVC to re-enter the flow control ready state;

d) cause each logical channel not assigned to carry a PVC to re-enter the unassigned state;

e) for each PVC assigned to a logical channel carried on the data link:

1) if the centre is a PVC transit centre, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "network operational" and the diagnostic code equalling the diagnostic code of the RESTART REQUEST;

2) if the centre is a PVC termination centre, notify the CIDIN packet level that a restart is occurring.

4.11.6.2.8.3.2 A centre which receives a valid RESTART REQUEST with a logical channel identifier equal to 0, and whose logical channels are in the restart state, shall:

a) cancel T20;

b) cause each logical channel assigned to carry a PVC to enter the flow control ready state;

c) cause each logical channel not assigned to carry a PVC to enter the unassigned state;

d) for each PVC assigned to a logical channel carried on the data link:

1) if the centre is a PVC transit centre, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "network operational" and the diagnostic code equalling the diagnostic code of the RESTART REQUEST;

2) if the centre is a PVC termination centre, notify the CIDIN packet level that a restart is occurring.

4.11.6.2.8.3.3 A centre which receives a non-valid RESTART REQUEST with a logical channel identifier equal to 0 shall execute the procedure for restart with the appropriate diagnostic code.

4.11.6.2.8.3.4 A centre which receives a RESTART REQUEST with a logical channel identifier not equal to 0 shall:

a) if the indicated logical channel is in the flow control ready state:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "restart packet received with non-zero logical channel identifier";

2) if the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "restart packet received with non-zero logical channel identifier";

b) if the indicated logical channel is in the restart, reset or unassigned state, discard the RESTART REQUEST.

4.11.6.2.8.4 *Receiving RESTART CONFIRMATION*

4.11.6.2.8.4.1 A centre which receives a valid RESTART CONFIRMATION with a logical channel identifier equal to 0, and whose logical channels are not in the restart state, shall execute the procedure for restart with the diagnostic code indicating "packet type invalid when not in restart state".

4.11.6.2.8.4.2 A centre which receives a valid RESTART CONFIRMATION with a logical channel identifier equal to 0, and whose logical channels are in the restart state, shall:

a) cancel T20;

b) cause each logical channel assigned to carry a PVC to enter the flow control ready state;

c) cause each logical channel not assigned to carry a PVC to enter the unassigned state;

d) for each PVC assigned to a logical channel carried on the data link:

1) if the centre is a PVC transit centre and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "network operational" and the diagnostic code equalling the diagnostic code of the RESTART REQUEST;

2) if the centre is a PVC termination centre, notify the the CIDIN packet level that all PVCs assigned to logical channels carried on the data link are usable.

4.11.6.2.8.4.3 A centre which receives a non-valid RESTART CONFIRMATION with a logical channel identifier equal to 0 shall execute the procedure for restart with the appropriate diagnostic code.

4.11.6.2.8.4.4 A centre which receives a RESTART CONFIRMATION with a logical channel identifier not equal to 0 shall:

a) if the indicated logical channel is in the flow control ready state:

1) execute the procedure for reset with the resetting cause field indicating "local procedure error" and the diagnostic code indicating "restart packet received with non-zero logical channel identifier";

2) if the centre is a PVC transit centre for the PVC assigned to the logical channel, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "remote procedure error" and the diagnostic code indicating "restart packet received with non-zero logical channel identifier";

b) if the indicated logical channel is in the restart, reset or unassigned state, discard the packet.

4.11.6.2.8.5 When T20 expires, the centre shall execute the procedure for restart with the diagnostic code indicating "timer expired for restart".

Note.— After unsuccessful retries, recovery decisions should be taken at higher levels.

4.11.6.2.9 *Procedure when link level is out of order*

4.11.6.2.9.1 A centre which determines link level is out of order on a particular data link shall:

a) discard all packets waiting to be transferred on any logical channel carried on the data link;

b) for each PVC assigned to a logical channel carried on the data link:

1) if the centre is a PVC transit centre, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "out of order" and the diagnostic code indicating "no additional information";

2) if the centre is a PVC termination centre, notify the CIDIN packet level that all PVCs assigned to logical channels carried on the data link are not usable.

4.11.6.2.9.2 A centre which determines that the link level is no longer out of order shall:

a) execute the procedure for restart;

b) for each PVC assigned to a logical channel carried on the data link:

1) if the centre is a PVC transit centre, and the corresponding logical channel is in the flow control ready state, execute the procedure for reset on the corresponding logical channel with the resetting cause field indicating "network operational" and the diagnostic code indicating "no additional information";

2) if the centre is a PVC termination centre, notify the CIDIN packet level that the PVC assigned to each logical channel carried on the data link is usable.

4.11.6.2.10 *Diagnostic code values*

Diagnostic indication	*Bits of diagnostic code* 8	7	6	5	4	3	2	1
No additional information	0	0	0	0	0	0	0	0
Invalid P(S)	0	0	0	0	0	0	0	1
Invalid P(R)	0	0	0	0	0	0	1	0
Packet type invalid when not in restart state	0	0	0	1	0	0	0	1
Packet type invalid when in flow control ready state	0	0	0	1	1	0	1	1
Packet type invalid on PVCs	0	0	1	0	0	0	1	1
Packet too short	0	0	1	0	0	1	1	0
Packet too long	0	0	1	0	0	1	1	1
Restart packet with non-zero logical channel identifier	0	0	1	0	1	0	0	1
Timer expired for reset	0	0	1	1	0	0	1	1
Timer expired for restart	0	0	1	1	0	1	0	0

Note.— Other bit combinations reserved.

4.11.6.2.11 *Resetting cause field values*

4.11.6.2.11.1 When using a packet switched data network to provide a communication path between CIDIN switching centres, the resetting cause field in reset packets transferred from a CIDIN switching centre to the data network shall always be equal to 0. Resetting cause fields received by a CIDIN switching centre from such a network shall be handled in accordance with 4.11.6.2.7.

Resetting cause indication	*Bits of resetting cause field* 8	7	6	5	4	3	2	1
Centre-originated reset	0	0	0	0	0	0	0	0
Out of order	0	0	0	0	0	0	0	1
Remote procedure error	0	0	0	0	0	0	1	1
Local procedure error	0	0	0	0	0	1	0	1
Network congestion	0	0	0	0	0	1	1	1
Remote centre operational	0	0	0	0	1	0	0	1
Network operational	0	0	0	0	1	1	1	1

Note.— Other bit combinations reserved.

4.11.6.2.12 *Restarting cause field values*

4.11.6.2.12.1 A centre shall always set the restarting cause field to equal 0.

Note.— Data networks operating in the packet mode and connected with CIDIN using procedures described in ITU CCITT Recommendation X.25-1981 may also transfer restarting cause fields of the following values:

Restarting cause indication	Bits of restarting cause field 8	7	6	5	4	3	2	1
Local procedure error	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
Network congestion	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*1*
Network operational	*0*	*0*	*0*	*0*	*0*	*1*	*1*	*1*

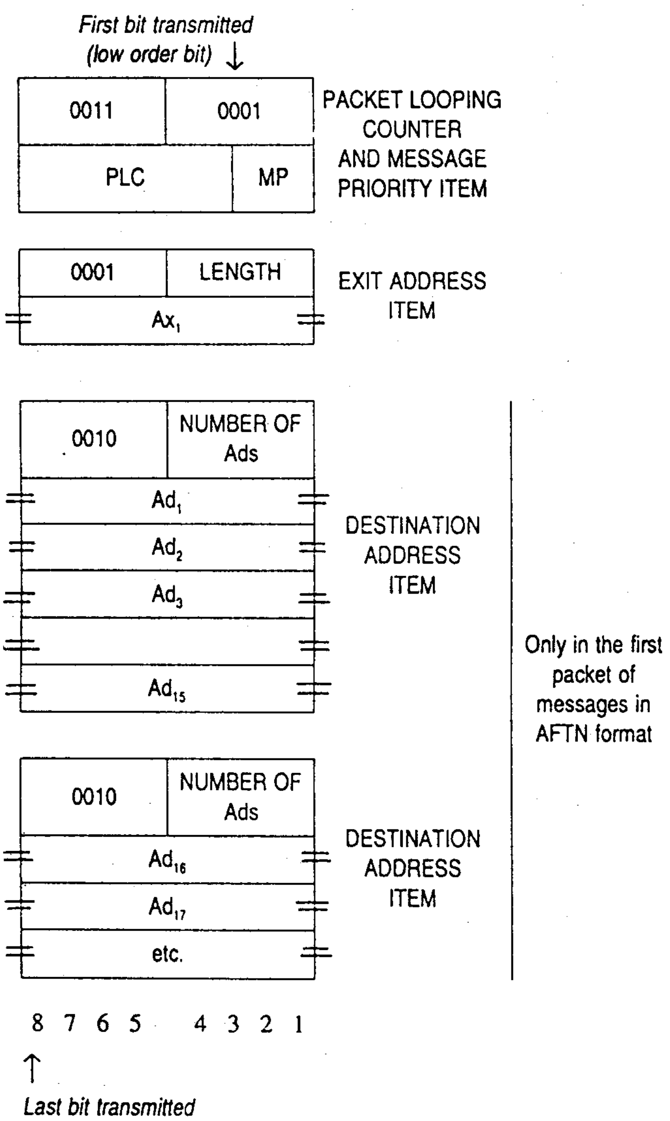
4.11.6.3 *The CIDIN packet protocol*

4.11.6.3.1 *The CIDIN packet header format*

4.11.6.3.1.1 The CIDIN packet header shall contain the following components:

— Packet looping counter and message priority indicator	(PLC & MP)
— Exit address(es)	(Ax)
— Destination address(es)	(Ad)

4.11.6.3.1.2 The CIDIN packet header shall be generated by the entry centre or station and shall be interpreted by relay centre(s) and exit centre(s) or station(s) receiving the CIDIN packets.



Note.— Axs and Ads are specified as IA-5 in 4.11.2.5.

4.11.6.3.1.3 The components contained in the octets of the CIDIN packet header shall be the following.

4.11.6.3.1.3.1 The first item shall contain a five bit packet looping counter (PLC, bits 8, 7, 6, 5 and 4) and a three bit message priority indicator (MP, bits 3, 2 and 1) which shall be interpreted as follows:

000	Priority 1 (highest)
001	Priority 2
010	Priority 3
011	Priority 4
100	Priority 5
101	Priority 6
110	Priority 7
111	Priority 8

The five bit packet looping counter (PLC) shall be set to 31 by the entry centre or station.

4.11.6.3.1.3.1.1 The highest CIDIN priority shall be reserved for CIDIN network management messages. The remaining priorities shall be available for user messages.

4.11.6.3.1.3.2 The following item of the CIDIN packet header shall contain the exit address(es). The exit address normally consists of the first two characters of the location indicator of the concerned exit centre. In those cases where a user is directly connected to CIDIN, the exit address shall consist of the first two characters of the location indicator of the concerned CIDIN station followed by as many additional characters as necessary to uniquely identify the user. The total number of characters in an exit address shall not exceed 8. The Ax values of all binary ones and all binary zeros shall be reserved. The number of octets used by each Ax shall be indicated in bits 1-4 of the first octet of each exit address item. There shall be an exit address item for each Ax to which the CIDIN packet is to be transmitted. The maximum number of exit addresses in a CIDIN message shall be 16.

4.11.6.3.1.3.3 If destination addresses (Ads) are used they shall be inserted in the first packet and shall be inserted immediately following each associated exit address (see 4.11.6.3.1.2 above).

4.11.6.3.1.3.4 The number of destination addresses associated with an exit centre address shall be indicated in bits 1-4 of each destination address item. The length of each destination address shall be 8 octets.

4.11.6.3.1.3.5 When the number of destination addresses associated with an exit centre address exceeds 15 an additional destination address item shall be added following the item containing the first 15 destination addresses.

4.11.6.3.2 *CIDIN packet procedures*

4.11.6.3.2.1 *General.* The CIDIN packet procedures shall be defined for:

a) entry centres and stations;

b) relay centres;

c) exit centres and stations.

4.11.6.3.2.2. *CIDIN packet header generation*

4.11.6.3.2.2.1 For each information message submitted, the CIDIN packet level shall accept the following elements from the transport level:

a) message content, segmented such that the maximum packet length would not be exceeded if the routing analysis were to require output on a single CIDIN circuit;

b) exit address(es);

c) CIDIN message priority;

d) destination address(es), for inclusion in the first packet of messages in AFTN format only.

4.11.6.3.2.2.2 The entry centre or station shall generate the packet header based on the information given in b), c) and d), and based on the information derived in the routing analysis process.

4.11.6.3.2.3 *Routing and relay of CIDIN packets*

4.11.6.3.2.3.1 All packets shall be sent by the predetermined route available to effect delivery to the exit centre(s) or station(s). Where the routing requires that a CIDIN packet be sent to the relay/entry centre or station from which it was received, the next most expeditious route shall be used.

4.11.6.3.2.3.2 Centres shall be interconnected by one or more PVCs. The route shall be defined as that which requires the least number of PVC traversals to reach the exit centre.

4.11.6.3.2.3.2.1 It shall be permissible to choose between two or more equally expeditious predetermined routes by any suitable method.

4.11.6.3.2.4 *Selection of PVC for transmission of a CIDIN packet*

4.11.6.3.2.4.1 Each CIDIN switching centre shall maintain a routing table relating exit addresses with primary and, if applicable, secondary outgoing PVCs.

4.11.6.3.2.5 *Transmission of CIDIN packets*

4.11.6.3.2.5.1 Higher priority packets shall be transmitted before lower priority packets.

4.11.6.3.2.5.2 The relay of CIDIN packets shall not be delayed unnecessarily.

4.11.6.3.2.5.2.1 The relay of CIDIN packets shall not wait for complete CIDIN message receipt.

4.11.6.3.2.5.3 Packets having the same priority shall be transmitted in the order in which they are received.

4.11.6.3.2.6 *Action on packets with errors*

4.11.6.3.2.6.1 When a centre or station receives a packet that does not contain a valid packet header, it shall discard that packet.

4.11.6.3.2.7 *Loss of communication*

4.11.6.3.2.7.1 When a relay centre is notified that a PVC is not usable it shall:

a) discard all packets addressed to exit centres for which both primary and secondary outgoing PVCs are not usable;

b) transmit all packets addressed to exit centres for which the primary outgoing PVC is not usable along the secondary outgoing PVC to the exit centres;

c) discard all packets which the routing requires to be sent to the relay/entry centre from which they were received (see 4.11.6.3.2.3.1);

d) for multi-addressed packets, transmit the packets to those addresses for which communication is possible; and

e) inform the operator of the action taken.

4.11.6.3.2.7.2 If a CIDIN switching centre ceases operation because of an equipment failure, it shall, when it resumes operations, discard all packets which are neither originated by, nor addressed to it. The action on packets addressed to or originated by the failed centre will be left for national determination.

4.11.6.3.2.8 *Handling of multiple dissemination*

4.11.6.3.2.8.1 A centre which receives a CIDIN packet for multiple dissemination shall determine the outgoing PVC on which the CIDIN packets of the CIDIN message shall be transmitted for each Ax.

4.11.6.3.2.8.2 The CIDIN packet header of packets transmitted on each outgoing PVC shall contain only the exit centre addresses and destination addresses (first packet of messages in AFTN format only) to be reached via the particular PVC. The relay of CIDIN packets shall not result in unnecessary multiplication of packets. Exit centre addresses and destination addresses (messages in AFTN format only) not to be reached via the particular PVC shall be stripped. This process shall be called address stripping.

Note.— Guidance material on address stripping is contained in Volume II, Attachment C.

4.11.6.3.2.8.3 Relay centres shall not alter the received CIDIN packet headers of CIDIN packets that are transmitted on a single outgoing PVC for all Axs specified.

4.11.6.3.2.8.4 Relay centres shall compose new CIDIN packet headers for CIDIN packets that are transmitted on more than one outgoing PVC and apply address stripping.

4.11.6.3.2.8.5 Centres detecting address(es) for which they are responsible among the Axs shall act as exit centre for those address(es), and as relay centre for the other Axs.

4.11.6.3.2.9 *Action to be taken with packet looping counter*

4.11.6.3.2.9.1 When a relay centre receives a packet with a PLC value of greater than zero it shall decrement the PLC by 1 and transmit the packet. If, on receipt, the value of the PLC is zero the packet shall be discarded.

4.11.6.4 *The transport protocol*

4.11.6.4.1 *The transport header format*

4.11.6.4.1.1 The transport header shall contain the following components:

— Message identification number	(MIN)
— CIDIN packet sequence number	(CPSN)
— Final CIDIN packet indicator	(FCP)
— Message code and format or network management field	(MCF/NMF)
— Message type indicator	(MT)
— Conversation protect indicator	(CP)
— Network acknowledgement indicator	(NA)
— Entry address	(Ae)
— End of header	(EOH)

4.11.6.4.1.2 The transport header shall be generated by the entry centre or station and shall be interpreted by the exit centre(s) or station(s) receiving the CIDIN packet.

4.11.6.4.1.3 The transport header shall consist of:

First bit transmitted (low order bit) ↓

0	1	0	0	LENGTH	MIN ITEM
MIN					

0	1	0	1	LENGTH	CPSN ITEM
CPSN					
FCP					

0	1	1	0	0	0	0	1	MESSAGE CHARACTERISTICS ITEM
NA	CP	MT	MCF/NMF					

0	0	0	0	LENGTH	ENTRY ADDRESS ITEM
Ae					

1	0	0	0	0	0	0	0	END OF HEADER ITEM
8	7	6	5	4	3	2	1	

↑
Last bit transmitted

4.11.6.4.1.4 The components contained within the transport header shall be as follows:

4.11.6.4.1.4.1 The first item of the transport header shall contain the message identification number (MIN) expressed in binary form. The low order bit of the MIN shall be bit 1 in the second octet of the item. Any number of octets between one and fifteen shall be employed to provide the MIN. The number of octets used by the MIN shall be indicated in bits 1-4 of the first octet of this item. The MIN shall identify the number of a CIDIN message transmitted by a specific entry centre or station.

4.11.6.4.1.4.2 **Recommendation.—** *Where the volume of traffic requiring acknowledgement so permits, the number of MINs used should be limited.*

4.11.6.4.1.4.2.1 At each entry centre or station only one pool of MINs shall be used for information and network management messages.

4.11.6.4.1.4.3 The second item of the transport header shall contain the following two components:

1) A CIDIN packet sequence number (CPSN), beginning in the second octet of this item, shall identify the sequence number of each CIDIN packet of a message. The CPSN shall be assigned in sequence beginning with X0000000. The low order bit of the CPSN shall be bit 1 of the second octet of this item.

Note.—

a) If the CPSN item consists of two octets including the header item then the X (bit 8) in the second octet is the FCP component.

b) In the header item a length indication of 0000 is not used and one octet of information is represented by a length indication of 0001.

2) A final CIDIN packet (FCP) component (bit 8 of the last octet of this item) which shall be set to:

1 to indicate the last CIDIN packet of a multipacket message, or the only packet of a single-packet message;
0 to indicate all other packets.

3) The number of octets used by the CPSN and FCP shall be a maximum of two and shall be indicated in bits 1-4 of the first octet of this item.

4.11.6.4.1.4.4 The third item of the transport header shall contain the following four components:

1) A five bit component contained in bits 1 to 5, interpreted according to the setting of bit 6 as either:

— a message code and format (MCF) component, designating which one of the code and format types specified (see Table 4-7) is employed in the CUDF for CIDIN information messages; or

— a network management function (NMF) component, designating one of 32 network management message types and the means for interpreting the CUDF (see Table 4-7).

2) A message type (MT) component (bit 6) which shall be set to:

0 to indicate an information message;
1 to indicate a network management message.

3) A one bit conversation protect (CP) component (bit 7) is reserved for future use.

Table 4-7. Significance of MCF and NMF indicators

MCF/NMF value					*Meaning*	
b_5	b_4	b_3	b_2	b_1	*MCF (MT = 0)*	*NMF (MT = 1)*
0	0	0	0	0	Reserved	Reserved
0	0	0	0	1	Network management messages	Network management messages
0	0	0	1	0	AFTN	Enquiry
0	0	0	1	1	Not yet allocated	Acknowledgement
0	0	1	0	0	"	Enquiry response
0	0	1	0	1	"	Not yet allocated
0	0	1	1	0	"	"
0	0	1	1	1	"	"
0	1	0	0	0	"	MCF error
0	1	0	0	1	Not yet allocated	Not yet allocated
0	1	0	1	0	"	"
0	1	0	1	1	"	"
0	1	1	0	0	"	"
0	1	1	0	1	"	"
0	1	1	1	0	"	"
0	1	1	1	1	Not yet allocated	Not yet allocated
1	0	0	0	0	"	"
1	0	0	0	1	"	"
1	0	0	1	0	"	"
1	0	0	1	1	"	"
1	0	1	0	0	"	"
1	0	1	0	1	Not yet allocated	Not yet allocated
1	0	1	1	0	"	"
1	0	1	1	1	"	"
1	1	0	0	0	"	"
1	1	0	0	1	"	"
1	1	0	1	0	"	"
1	1	0	1	1	"	"
1	1	1	0	0	"	"
1	1	1	0	1	Reserved for regional use	"
1	1	1	1	0	"	"
1	1	1	1	1	"	Reserved

4) A network acknowledgement (NA) component (bit 8) which shall be set to:

   0 to indicate acknowledgement not required;
   1 to indicate acknowledgement required.

4.11.6.4.1.4.5 The fourth item of the transport header shall contain the entry address (Ae) which identifies the CIDIN entry centre or station that originates the CIDIN message on the CIDIN. The total number of characters in an entry address shall not exceed 8. The Ae values of all binary ones and all binary zeros shall be reserved. The number of octets used by the Ae shall be indicated in bits 1-4 of the first octet of this item and a length of 0000 shall not be used.

4.11.6.4.1.4.6 The last item of the transport header shall be the end of header (EOH) item, as shown in 4.11.6.4.1.3 above.

4.11.6.4.2 *Transport procedures*

4.11.6.4.2.1 *General.* The transport procedures shall be defined for:

a) entry centres and stations;

b) exit centres and stations.

Relay centres shall not perform processing functions at the transport level.

4.11.6.4.2.2 *Transport header generation*

4.11.6.4.2.2.1 For each information message submitted, the entry centre or station shall accept the following elements:

a) message content (any approved code and format);

b) exit address(es);

c) destination addresses applicable to each exit address;

d) message priority;

e) message code/format;

f) requirement for acknowledgement;

g) requirement for uninterrupted conversation (future use);

h) requirement for priority interruptable conversation (future use).

Item c) shall be provided for messages in AFTN format.

4.11.6.4.2.2.2 The entry centre or station shall generate the appropriate transport header based on the information given in e), f), g) and h).

4.11.6.4.2.2.3 *Message identification number assignment*

4.11.6.4.2.2.3.1 The entry centre or station shall assign a MIN value to each message, from a pool of available numbers. MIN values shall be assigned in continuous numerical sequence.

4.11.6.4.2.2.3.2 For CIDIN messages which require network acknowledgement, a given MIN value shall not be reassigned to a new message until the corresponding network acknowledgement has been received by the entry centre or station.

4.11.6.4.2.2.4 The entry address normally consists of the first two characters of the location indicator of the concerned entry centre. In those cases where a station is directly connected to CIDIN, i.e. performs entry/exit functions, the entry address shall consist of the first two characters of the location indicator of the concerned CIDIN station followed by as many additional characters as necessary to uniquely identify the station.

4.11.6.4.2.3 *Information message handling*

4.11.6.4.2.3.1 The information message content received from the applications software shall be placed in one or more CUDF, with no addition or modification (see Figure 4-4). This shall be the responsibility of the entry centre or station.

4.11.6.4.2.4 *Network management message handling*

4.11.6.4.2.4.1 The entry centre or station shall generate and respond to network management messages using the standard format. Network management CUDF contents are generated by the entry centre or station.

Note.— The format of the network management messages is contained in Table 4-8.

4.11.6.4.2.5 *Recovery procedure for messages on CIDIN*

4.11.6.4.2.5.1 *Handling of messages requiring acknowledgement on the transport level*

4.11.6.4.2.5.1.1 For messages requiring network acknowledgement the entry centre or station shall, before initiating transmission, set the NA bit to "1" and temporarily store the message for possible retransmission. After sending the last frame of the message a response time-out (TMR), based on the transit time to the most remote exit centre or station, shall be initiated.

4.11.6.4.2.5.1.2 After complete and error free receipt of the first packet to arrive of any message requiring network acknowledgement, the exit centre or station shall start a time-out (TNMA) for that message; the time-out shall be restarted each time a further CIDIN packet of the same message is received. The time-out shall be stopped when all packets of the message have been completely received.

4.11.6.4.2.5.1.3 At the exit centre or station, once a message with the NA bit set to "1" has been completely assembled and recorded, a network acknowledgement message shall be sent back to the entry centre or station.

Note.— The format of the acknowledgement message is contained in Table 4-8.

4.11.6.4.2.5.1.4 Upon receiving a valid network acknowledgement response from all addressed exit centres or stations for the complete message, the entry centre or station shall remove the corresponding message from retransmission storage, and shall release the MIN value for future use.

4.11.6.4.2.5.2 *Action on detection of message loss*

4.11.6.4.2.5.2.1 If an entry centre or station does not receive a network acknowledgement message for a message sent with the NA bit set to "1", within a period of time (TMR) it shall retransmit the message with the same MIN value.

4.11.6.4.2.5.2.2 If a network acknowledgement message is still not obtained, the entry centre or station shall send an

Table 4-8. Format for network management messages

<table>
<tr><th colspan="3">NETWORK MANAGEMENT MESSAGE</th><th colspan="2">ACK</th><th>ENQ</th><th>Enquiry response</th><th colspan="2">MCF error</th></tr>
<tr><td rowspan="11">COMMUNICATIONS CONTROL FIELD</td><td rowspan="2">CIDIN PACKET HEADER</td><td>MP</td><td colspan="6">000</td></tr>
<tr><td>Ax</td><td colspan="2">Note a)</td><td>Note b)</td><td>Note c)</td><td colspan="2">Note a)</td></tr>
<tr><td rowspan="9">TRANSPORT HEADER</td><td>MIN</td><td colspan="6">next available</td></tr>
<tr><td>CPSN</td><td colspan="6">all zero</td></tr>
<tr><td>FCP</td><td colspan="6">1</td></tr>
<tr><td>MCF/NMF</td><td colspan="6">see Table 4-7</td></tr>
<tr><td>MT</td><td colspan="6">1</td></tr>
<tr><td>CP</td><td colspan="6">0</td></tr>
<tr><td>NA</td><td colspan="6">0</td></tr>
<tr><td>Ae</td><td colspan="2">Note b)</td><td>Note a)</td><td>Note d)</td><td colspan="2">Note b)</td></tr>
<tr><td>EOH</td><td colspan="6">1000 0000</td></tr>
<tr><td colspan="3" rowspan="6">CIDIN USER DATA FIELD</td><td>0100</td><td>LENGTH</td><td rowspan="6">NONE</td><td rowspan="6">NONE</td><td>0100</td><td>LENGTH</td></tr>
<tr><td colspan="2">e</td><td colspan="2">e</td></tr>
<tr><td>0001</td><td>LENGTH</td><td>0001</td><td>LENGTH</td></tr>
<tr><td colspan="2">f</td><td colspan="2">f</td></tr>
<tr><td>0101</td><td>LENGTH</td><td>0101</td><td>LENGTH</td></tr>
<tr><td colspan="2">g</td><td colspan="2">g</td></tr>
</table>

NOTES:

a) Use the Ae of the original information message.
b) Use the Ax of the original information message.
c) Use the Ae of the original information message.
d) Use the Ax identifier of own centre or station.
e) Use the MIN of original information message.
f) Use the Ax of original information message.
g) Use the CPSN of the last packet of the received CIDIN message. Bit 8 shall be set to 0.

enquiry message to that exit centre or station, initiate a message response time out (TEM) and shall stop transmissions of information messages to that exit centre or station.

4.11.6.4.2.5.2.3 When an entry centre or station fails to obtain an acknowledgement even after a retry to the exit centre or station, it shall inform the application level of the unsuccessful attempt to communicate. No information messages shall be sent to that exit centre or station until one of the ENQ messages periodically sent to that exit centre or station is acknowledged by that centre or station.

4.11.6.4.2.5.2.4 When a multiply disseminated message is not acknowledged by all the exit centres or stations addressed, the entry centre or station, on expiry of time out (TMR) shall retransmit the message only to those exit centres or stations which did not acknowledge the message. In this instance the exit centres or stations shall retain packets of a message for a period of time (TNMA) and discard these packets if the message is not completed. This time TNMA shall be shorter than or equal to TMR.

Note.— The format of the enquiry message is contained in Table 4-8.

4.11.6.4.2.5.2.5 On receipt of an enquiry message, the exit centre or station shall acknowledge the enquiry message by transmitting an enquiry response message back to the entry centre or station.

Note.— The format of the enquiry response message is contained in Table 4-8.

4.11.6.4.2.5.2.6 Once the entry centre or station has received the enquiry response message, it shall resume sending information messages to that exit centre or station.

4.11.6.4.2.5.2.7 When a response to an enquiry message is not received within a period of time (TEM), the entry centre or station shall retransmit the enquiry message.

4.11.6.4.2.5.2.8 When the exit centre or station time out period expires before all packets of the message have been completely received, the exit centre or station shall discard the incomplete message.

4.11.6.4.2.6 *Handling of messages not requiring acknowledgement on the transport level*

4.11.6.4.2.6.1 After complete and error-free receipt of the first packet to arrive of any message not requiring network acknowledgement, the exit centre or station shall start a time out (TNMA) for that message. The time out shall be restarted each time a further CIDIN packet of the same message is received. The time out shall be stopped when all packets of the message have been completely received.

4.11.6.4.2.6.2 When the exit centre or station time out period expires before all packets of the message have been completely received, the exit centre or station shall discard the incomplete message.

4.11.6.4.2.7 *Handling of messages with unacceptable code/format combinations*

4.11.6.4.2.7.1 When an exit centre or station receives a message, requiring or not requiring an acknowledgement, which is in a code and format for which it has no applications software, it shall discard the message, and send an MCF error message to the entry centre or station.

Note.— The format of the MCF error message is contained in Table 4-8.

4.11.6.4.2.7.2 On receipt of an MCF error message, the entry centre or station shall notify the application level.

4.11.6.4.2.8 *Handling of multiple dissemination messages*

4.11.6.4.2.8.1 For messages requiring multiple dissemination, the recovery procedures shall take place between the entry centre or station and all exit centres or stations concerned.

4.12 Technical provisions relating to international air-ground data interchange

4.12.1 When operating in the synchronous mode, the data link shall be capable of code and byte independent transmission of digital data.

4.12.2 **Recommendation.—** *The data signalling rate should be chosen from among the following:*

600 bits/s
1 200 bits/s
*2 400 bits/s**
4 800 bits/s
9 600 bits/s

* *preferred minimum data signalling rate.*

Note.— Application to high frequency aeronautical mobile channels may be looked upon as a special case where the convention 75 × 2^n bits/s is to be employed in the choice of a data signalling rate, where "n" is zero or a positive integer value.

4.12.3 **Recommendation.—** *When alphanumeric characters are used the International Alphabet No. 5 (IA-5), in whole or in parts thereof, shown in 4.11.1.2 above, should be used for the transmission of air-ground data.*

4.12.4 The serial transmission of units comprising an individual character of IA-5 shall be with the low order unit (b_1) transmitted first.

4.12.5 **Recommendation.—** *When IA-5 is used, each character should include an additional unit for parity in the eighth level position.*

4.12.6 When the provisions of 4.12.5 are applied, the sense of the character parity bit shall produce even parity in links which operate on the start-stop principle and odd parity in links using end-to-end synchronous operation.

4.12.7 **Recommendation.**— *The type of transmission for each data signalling rate should be chosen as follows:*

Data signalling rate	Type of transmission
600 bits/s	*Synchronous or asynchronous serial transmission*
1 200 bits/s	*Synchronous or asynchronous serial transmission*
2 400 bits/s	*Synchronous serial transmission*
4 800 bits/s	*Synchronous serial transmission*
9 600 bits/s	*Synchronous serial transmission*

4.13 Technical provisions relating to international aeronautical speech circuit switching and signalling

Note.— Guidance material on aeronautical speech circuit switching and signalling is contained in ICAO Circular 183.

4.13.1 The use of circuit switching and signalling to provide point-to-point speech circuits to interconnect area control centres not interconnected by dedicated circuits shall be by agreement between the Administrations concerned.

4.13.2 The application of aeronautical speech circuit switching and signalling shall be made on the basis of regional air navigation agreements.

4.13.3 **Recommendation.**— *Where implemented, aeronautical speech circuit switching and signalling should provide:*

a) priority access;

b) automatic call-back;

c) conference calling;

d) through switching facilities;

e) the capability of alternate routing, when necessary and feasible;

f) identification of originator for incoming calls, when necessary and feasible; and

g) call forwarding, when necessary and feasible.

Note 1.— Identification of originator is done by analysis of the originator's code which is transmitted on both signalling systems R2 and No. 5.

Note 2.— Call forwarding ensures that calls to operating positions which are temporarily not manned will be rerouted automatically to an appropriate operating position.

4.13.4 **Recommendation.**— *The characteristics of signalling tones used in aeronautical speech circuit switching and signalling should conform to ITU CCITT Signalling System No. 5 or to ITU CCITT Signalling System R2 as appropriate. Signalling tones on interregional trunks should conform to one of these ITU CCITT specifications as determined by agreement between the Administrations concerned.*

Note.— Details of ITU CCITT Signalling System No. 5 are contained in CCITT Yellow Book, Volume VI — Fascicle VI-2; details of ITU CCITT Signalling System R2 are contained in CCITT Yellow Book, Volume VI — Fascicle VI-4.

4.13.5 **Recommendation.**— *The characteristics of the ringing tone, the busy tone and the congestion tone used in aeronautical speech circuit switching and signalling should conform to ITU CCITT Recommendation E.180.*

Note.— Details of ITU CCITT Recommendation E.180 are contained in CCITT Yellow Book, Volume II — Fascicle II-2.

4.13.6 **Recommendation.**— *The numbering plan used in aeronautical speech circuit switching and signalling should consist of six digits whereby the first two digits identify the area, the third and fourth digits the control centre and the fifth and sixth digits the working position or correspondent within the control centre. Up to two additional digits may be added following the sixth digit to allow a larger number of positions within a control centre to be uniquely addressed.*

Note.— The area identifier may be used to identify either a country or a group of countries.

4.13.6.1 **Recommendation.**— *It should not be necessary to dial the area identifier code on calls between stations sharing a common area identifier.*

4.14 Technical provisions relating to international point-to-multipoint telecommunication service via satellite to support the dissemination of aeronautical information

4.14.1 Point-to-multipoint telecommunication service via satellite to support the dissemination of aeronautical information shall be based on full-time, non pre-emptible, protected services as defined in the relevant CCITT Recommendations.

4.14.2 Point-to-multipoint telecommunication service via satellite for the dissemination of WAFS products

4.14.2.1 **Recommendation.**— *System characteristics should include the following:*

a) frequency — C-band, earth-to-satellite, 6 GHz band, satellite-to-earth, 4 GHz band;

b) capacity with effective signalling rate of not less than 9 600 bits/s;

c) bit error rates — better than 1 in 10^7;

d) forward error correction; and

e) availability 99.95 per cent.

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CHAPTER 5. EMERGENCY LOCATOR TRANSMITTER (ELT) FOR SEARCH AND RESCUE

5.1 General

5.1.1 Emergency locator transmitters shall operate either on both 406 MHz and 121.5 MHz or on 121.5 MHz.

Note.— ELTs operating on 121.5 MHz will be required to meet the improved technical characteristics contained in 5.2.1.8, not later than 1 January 2000.

5.1.2 All installations of emergency locator transmitters operating on 406 MHz shall meet the provisions of 5.3.

5.1.3 All installations of emergency locator transmitters operating on 121.5 MHz shall meet the provisions of 5.2.

5.1.4 **Recommendation.—** *All installations of emergency locator transmitters should operate on 406 MHz and 121.5 MHz simultaneously.*

5.1.5 The technical characteristics for the 406 MHz component of an integrated ELT shall be in accordance with 5.3.

5.1.6 The technical characteristics for the 121.5 MHz component of an integrated ELT shall be in accordance with 5.2.

5.1.7 States shall make arrangements for a 406 MHz ELT register. Register information regarding the ELT shall be immediately available to search and rescue authorities.

5.2 Specification for emergency locator transmitters (ELT) for search and rescue operating on 121.5 MHz

Note.— Information on technical characteristics and operational performance of 121.5 MHz ELTs is contained in RTCA Document DO-183 and European Organization for Civil Aviation Electronics (EUROCAE) Document ED.62.

5.2.1 Technical characteristics

5.2.1.1 Emergency locator transmitters (ELT) shall operate on 121.5 MHz. The frequency tolerance shall not exceed plus or minus 0.005 per cent.

5.2.1.2 The emission from an ELT under normal conditions and attitudes of the antenna shall be vertically polarized and essentially omnidirectional in the horizontal plane.

5.2.1.3 Over a period of 48 hours of continuous operation, at an operating temperature of minus 20°C, the peak effective radiated power (PERP) shall at no time be less than 50 mW.

5.2.1.4 The type of emission shall be A3X. Any other type of modulation that meets the requirements of 5.2.1.5, 5.2.1.6 and 5.2.1.7 below may be used provided that it will not prejudice precise location of the beacon by homing equipment.

Note.— Some ELTs are equipped with an optional voice capability (A3E) in addition to the A3X emission.

5.2.1.5 The carrier shall be amplitude modulated at a modulation factor of at least 0.85.

5.2.1.6 The modulation applied to the carrier shall have a minimum duty cycle of 33 per cent.

5.2.1.7 The emission shall have a distinctive audio characteristic achieved by amplitude modulating the carrier with an audio frequency sweeping downward over a range of not less than 700 Hz within the range 1 600 Hz to 300 Hz and with a sweep repetition rate of between 2 Hz and 4 Hz.

5.2.1.8 After 1 January 2000 the emission shall include a clearly defined carrier frequency distinct from the modulation sideband components; in particular, at least 30 per cent of the power shall be contained at all times within plus or minus 30 Hz of the carrier frequency on 121.5 MHz.

5.3 Specification for UHF emergency locator transmitter (ELT) operating on 406 MHz

5.3.1 Technical characteristics

Note 1.— Transmission characteristics for emergency locator transmitters operating on 406 MHz are contained in CCIR Recommendation 633.

Note 2.— Information on technical characteristics and operational performance of 406 MHz ELTs is contained in RTCA Document DO-204 and European Organization for Civil Aviation Electronics (EUROCAE) Document ED.62.

5.3.1.1 UHF emergency locator transmitters shall operate on a frequency of 406.025 MHz plus or minus 2 kHz. The transmitted frequency shall not vary more than plus or minus 5 kHz in five years including the initial frequency offset. It shall not vary more than 2 parts in 10^9 in 100 milliseconds.

5.3.1.2 The period between transmissions shall be 50 seconds plus or minus 5 per cent.

5.3.1.3 Over a period of 24 hours of continuous operation at an operating temperature of −20°C, the transmitter power output shall be within the limits of 5 W plus or minus 2 dB.

5.3.1.4 The 406 MHz ELT shall be capable of transmitting a digital message.

5.3.2 Transmitter identification coding

5.3.2.1 Emergency locator transmitters operating on 406 MHz shall be assigned a unique coding for identification of the transmitter or aircraft on which it is carried.

5.3.2.2 The emergency locator transmitter shall be coded in accordance with either the aviation user protocol or one of the serialized user protocols described in Appendix D to Part I, and shall be registered with the appropriate authority.

APPENDIX A TO PART I. — MICROWAVE LANDING SYSTEM (MLS) CHARACTERISTICS

Table A-1.— Preamble timing*
(see 3.11.4.3.4)

Event	Event time slot begins at: 15.625 kHz Clock pulse (number)	Time (milli-seconds)
Carrier acquisition (CW transmission)	0	0
Receiver reference time code		
$I_1 = 1$	13	0.832
$I_2 = 1$	14	0.896
$I_3 = 1$	15	0.960
$I_4 = 0$	16	1.024
$I_5 = 1$	17	1.088**
Function identification		
I_6	18	1.152
I_7	19	1.216
I_8	20	1.280
I_9 (see 3.11.4.4.3.3)	21	1.344
I_{10}	22	1.408
I_{11}	23	1.472
I_{12}	24	1.536
End preamble	25	1.600

* Applies to all functions transmitted.
** Reference time for receiver synchronization for all function timing.

Table A-2.— Approach azimuth function timing *(see 3.11.4.3.4)*

Event	Event time slot begins at: 15.625 kHz Clock pulse (number)	Time (milli-seconds)
Preamble	0	0
Morse Code (see 3.11.4.6.2.1.2)	25	1.600
Antenna select	26	1.664
Rear OCI	32	2.048
Left OCI	34	2.176
Right OCI	36	2.304
TO test	38	2.432
TO scan*	40	2.560
Pause		8.760
Midscan point		9.060
FRO scan*		9.360
FRO test		15.560
End function (airborne)		15.688
End guard time; end function (ground)		15.900

* The actual commencement and completion of the TO and FRO scan transmissions are dependent on the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of plus or minus 62.0 degrees. Scan timing shall be compatible with accuracy requirements.

Table A-3.— High rate approach azimuth and back azimuth function timing *(see 3.11.4.3.4)*

Event	Event time slot begins at: 15.625 kHz Clock pulse (number)	Time (milli-seconds)
Preamble	0	0
Morse Code (see 3.11.4.6.2.1.2)	25	1.600
Antenna select	26	1.664
Rear OCI	32	2.048
Left OCI	34	2.176
Right OCI	36	2.304
TO test	38	2.432
TO scan*	40	2.560
Pause		6.760
Midscan point		7.060
FRO scan*		7.360
FRO test pulse		11.560
End function (airborne)		11.688
End guard time; end function (ground)		11.900

* The actual commencement and completion of the TO and FRO scan transmissions are dependent on the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of plus or minus 42.0 degrees. Scan timing shall be compatible with accuracy requirements.

Table A-4.— Approach elevation function timing *(see 3.11.4.3.4)*

Event	Event time slot begins at: 15.625 kHz Clock pulse (number)	Time (milli-seconds)
Preamble	0	0
Processor pause	25	1.600
OCI	27	1.728
TO scan*	29	1.856
Pause		3.406
Midscan point		3.606
FRO scan*		3.806
End function (airborne)		5.356
End guard time; end function (ground)		5.600

* The actual commencement and completion of the TO and FRO scan transmissions are dependent on the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of minus 1.5 degrees to plus 29.5 degrees. Scan timing shall be compatible with accuracy requirements.

Table A-5.— Flare function timing *(see 3.11.4.3.4)*

Event	Event time slot begins at 15.625 kHz Clock pulse (number)	Time (milli-seconds)
Preamble	0	0
Processor pause	25	1.600
TO scan*	29	1.856
Pause		3.056
Midscan point		3.456
FRO scan*		3.856
End function (airborne)		5.056
End guard time; end function (ground)		5.300

* The actual commencement and completion of the TO and FRO scan transmissions are dependent on the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of minus 2.0 degrees to plus 10.0 degrees. Scan timing shall be compatible with accuracy requirements.

Table A-6.— Basic data function timing *(see 3.11.4.3.4)*

Event	Event time slot begins at 15.625 kHz Clock pulse (number)	Time (milli-seconds)
Preamble	0	0
Data transmission (Bits I_{13} - I_{30})	25	1.600
Parity transmission (Bits I_{31} - I_{32})	43	2.752
End function (airborne)	45	2.880
End guard time; end function (ground)		3.100

Table A-7.— Basic data *(see 3.11.4.3.3)*

Word	Data content	Maximum time between transmissions (seconds)	Bits used	Range of values	Least significant bit	Bit number
1	PREAMBLE	1.0	12			I_1 — I_{12}
	Approach azimuth antenna to threshold distance		6	0 m to 6 300 m	100 m	I_{13} — I_{18}
	Approach azimuth proportional coverage negative limit		5	0° to 62°	2°	I_{19} — I_{23}
	Approach azimuth proportional coverage positive limit		5	0° to 62°	2°	I_{24} — I_{28}
	Clearance signal type		1	see Note 9		I_{29}
	SPARE		1			I_{30}
	PARITY		2	see Note 1		I_{31} — I_{32}
2	PREAMBLE	0.16	12			I_1 — I_{12}
	Minimum glide path		7	2° to 14.7°	0.1°	I_{13} — I_{19}
	Back azimuth status		1	see Note 2		I_{20}
	DME status		2	see Note 7		I_{21} — I_{22}
	Approach azimuth status		1	see Note 2		I_{23}
	Approach elevation status		1	see Note 2		I_{24}
	SPARE		6	see Note 6		I_{25} — I_{30}
	PARITY		2	see Note 1		I_{31} — I_{32}

Table A-7.— Basic data *(cont.)*

Word	Data content	Maximum time between transmissions (seconds)	Bits used	Range of values	Least significant bit	Bit number
3	PREAMBLE	1.0	12			$I_1 — I_{12}$
	Approach azimuth beamwidth		3	0.5° to 4° See Note 8	0.5°	$I_{13} — I_{15}$
	Approach elevation beamwidth		3	0.5° to 2.5° See Note 8	0.5°	$I_{16} — I_{18}$
	DME distance		9	0 m to 6387.5 m	12.5 m	$I_{19} — I_{27}$
	SPARE		3			$I_{28} — I_{30}$
	PARITY		2	see Note 1		$I_{31} — I_{32}$
4	PREAMBLE	1.0	12	see Note 4		$I_1 — I_{12}$
	Approach azimuth magnetic orientation		9	0° to 359°	1°	$I_{13} — I_{21}$
	Back azimuth magnetic orientation		9	0° to 359°	1°	$I_{22} — I_{30}$
	PARITY		2	see Note 1		$I_{31} — I_{32}$
5	PREAMBLE	1.0	12	see Note 5		$I_1 — I_{12}$
	Back azimuth proportional coverage negative limit		5	0° to 42°	2°	$I_{13} — I_{17}$
	Back azimuth proportional coverage positive limit		5	0° to 42°	2°	$I_{18} — I_{22}$
	Back azimuth beamwidth		3	0.5° to 4.0° see Note 8	0.5°	$I_{23} — I_{25}$
	Back azimuth status		1	see Note 2		I_{26}
	SPARE		4	see Note 3		$I_{27} — I_{30}$
	PARITY		2	see Note 1		$I_{31} — I_{32}$
6	PREAMBLE	1.0	12	see Note 4		$I_1 — I_{12}$
	MLS ground equipment identification			Letters A to Z		
	Character 2		6			$I_{13} — I_{18}$
	Character 3		6			$I_{19} — I_{24}$
	Character 4		6			$I_{25} — I_{30}$
	PARITY		2	see Note 1		$I_{31} — I_{32}$

Table A-7.— Basic data *(cont.)*

Note 1 Parity bits I_{31} and I_{32} are chosen to satisfy the equations:

$$I_{13} + I_{14} \ldots + I_{29} + I_{30} + I_{31} = ODD$$

$$I_{14} + I_{16} + I_{18} \ldots + I_{28} + I_{30} + I_{32} = ODD$$

Note 2 Coding for status bit:
0 = function not radiated, or radiated in test mode (not reliable for navigation)
1 = function radiated in normal mode (for back azimuth, this also indicates that back azimuth transmission to follow)

Note 3 These bits are reserved for future applications. One possible application is to define the back azimuth deviation scale factor.

Note 4 Data words 4 and 6 are transmitted in both approach azimuth and back azimuth coverages if back azimuth guidance is provided, according to the following percentages: 75 per cent of the transmissions in the approach azimuth coverage and 25 per cent in the back azimuth coverage.

Note 5 Data word 5 is transmitted in both approach azimuth and back azimuth coverages if back azimuth guidance is provided, according to the following percentages: 75 per cent of the transmissions in the back azimuth coverage and 25 per cent in the approach azimuth coverage.

Note 6 These bits are reserved for future applications requiring high transmission rates.

Note 7 Coding for I_{21} and I_{22}:

I_{21}	I_{22}	
0	0	DME transponder inoperative or not available
1	0	Only IA mode or DME/N available
0	1	FA mode, Standard 1, available
1	1	FA mode, Standard 2, available

Note 8 The value coded should be the actual beamwidth (as defined in Part I, 3.11.1) rounded to the nearest 0.5 degrees.

Note 9 Code for I_{29} is:
0 = pulse clearance signal
1 = scanning clearance signal

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Table A-8.— Auxiliary data function timing *(see 3.11.4.3.4)*

Event	Event time slot begins at: 15.625 kHz Clock pulse (number)	Time (milli-seconds)
Preamble	0	0
Address transmission (Bits I_{13} − I_{20})	25	1.600
Data transmission (Bits I_{21} − I_{72})	33	2.112
Parity transmission (Bits I_{73} − I_{76})	85	5.440
End function (airborne)	89	5.696
End guard time; end function (ground)		5.900

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Table A-9.— Auxiliary data words address codes

No.	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}	I_{20}	No.	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}	I_{20}
1	0	0	0	0	0	1	1	1	33	1	0	0	0	0	1	0	1
2	0	0	0	0	1	0	1	0	34	1	0	0	0	1	0	0	0
3	0	0	0	0	1	1	0	1	35	1	0	0	0	1	1	1	1
4	0	0	0	1	0	0	1	1	36	1	0	0	1	0	0	0	1
5	0	0	0	1	0	1	0	0	37	1	0	0	1	0	1	1	0
6	0	0	0	1	1	0	0	1	38	1	0	0	1	1	0	1	1
7	0	0	0	1	1	1	1	0	39	1	0	0	1	1	1	0	0
8	0	0	1	0	0	0	1	0	40	1	0	1	0	0	0	0	0
9	0	0	1	0	0	1	0	1	41	1	0	1	0	0	1	1	1
10	0	0	1	0	1	0	0	0	42	1	0	1	0	1	0	1	0
11	0	0	1	0	1	1	1	1	43	1	0	1	0	1	1	0	1
12	0	0	1	1	0	0	0	1	44	1	0	1	1	0	0	1	1
13	0	0	1	1	0	1	1	0	45	1	0	1	1	0	1	0	0
14	0	0	1	1	1	0	1	1	46	1	0	1	1	1	0	0	1
15	0	0	1	1	1	1	0	0	47	1	0	1	1	1	1	1	0
16	0	1	0	0	0	0	1	1	48	1	1	0	0	0	0	0	1
17	0	1	0	0	0	1	0	0	49	1	1	0	0	0	1	1	0
18	0	1	0	0	1	0	0	1	50	1	1	0	0	1	0	1	1
19	0	1	0	0	1	1	1	0	51	1	1	0	0	1	1	0	0
20	0	1	0	1	0	0	0	0	52	1	1	0	1	0	0	1	0
21	0	1	0	1	0	1	1	1	53	1	1	0	1	0	1	0	1
22	0	1	0	1	1	0	1	0	54	1	1	0	1	1	0	0	0
23	0	1	0	1	1	1	0	1	55	1	1	0	1	1	1	1	1
24	0	1	1	0	0	0	0	1	56	1	1	1	0	0	0	1	1
25	0	1	1	0	0	1	1	0	57	1	1	1	0	0	1	0	0
26	0	1	1	0	1	0	1	1	58	1	1	1	0	1	0	0	1
27	0	1	1	0	1	1	0	0	59	1	1	1	0	1	1	1	0
28	0	1	1	1	0	0	1	0	60	1	1	1	1	0	0	0	0
29	0	1	1	1	0	1	0	1	61	1	1	1	1	0	1	1	1
30	0	1	1	1	1	0	0	0	62	1	1	1	1	1	0	1	0
31	0	1	1	1	1	1	1	1	63	1	1	1	1	1	1	0	1
32	1	0	0	0	0	0	1	0	64	0	0	0	0	0	0	0	0

Note.— Parity bits I_{19} and I_{20} are chosen to satisfy the equations:

$$I_{13} + I_{14} + I_{15} + I_{16} + I_{17} + I_{18} + I_{19} = EVEN$$

$$I_{14} + I_{16} + I_{18} + I_{20} = EVEN$$

Table A-10.— Auxiliary data *(see 3.11.4.3.3)*

Word	*Data content*	*Type of data*	*Maximum time between trans-missions (seconds)*	*Bits used*	*Range of values*	*Least significant bit*	*Bit number*
A1	PREAMBLE	digital	1.0	12			I_1 — I_{12}
	Address			8			I_{13} — I_{20}
	Approach azimuth antenna offset			10	−511 m to +511 m (see Note 3)	1 m	I_{21} — I_{30}
	Approach azimuth antenna to MLS datum point distance			13	0 m to 8 191 m	1 m	I_{31} — I_{43}
	Approach azimuth alignment with runway centre line			12	−20.47° to 20.47° (see Note 3)	0.01°	I_{44} — I_{55}
	Approach azimuth antenna co-ordinate system			1	(see Note 2)		I_{56}
	SPARE			13			I_{57} — I_{69}
	PARITY			7	(see Note 1)		I_{70} — I_{76}
A2	PREAMBLE	digital	1.0	12			I_1 — I_{12}
	Address			8			I_{13} — I_{20}
	Approach elevation antenna offset			10	−511 m to +511 m (see Note 3)	1 m	I_{21} — I_{30}
	MLS datum point to threshold distance			10	0 m to 1 023 m	1 m	I_{31} — I_{40}
	Approach elevation antenna height			7	−6.3 m to +6.3 m (see Note 3)	0.1 m	I_{41} — I_{47}
	SPARE			22			I_{48} — I_{69}
	PARITY			7	(see Note 1)		I_{70} — I_{76}
A3	PREAMBLE (see Note 4)	digital	1.0	12			I_1 — I_{12}
	Address			8			I_{13} — I_{20}
	DME offset			10	−511 m to +511 m (see Note 3)	1 m	I_{21} — I_{30}
	DME to MLS datum point distance			14	−8 191 m to +8 191 m (see Note 3)	1 m	I_{31} — I_{44}
	SPARE			25			I_{45} — I_{69}
	PARITY			7	(see Note 1)		I_{70} — I_{76}

Table A-10.— Auxiliary data *(cont.)*

Word	*Data content*	*Type of data*	*Maximum time between transmissions (seconds)*	*Bits used*	*Range of values*	*Least significant bit*	*Bit number*
A4	PREAMBLE (see Note 5)	digital	1.0	12			$I_1 — I_{12}$
	Address			8			$I_{13} — I_{20}$
	Back azimuth antenna offset			10	−511 m to +511 m (see Note 3)	1 m	$I_{21} — I_{30}$
	Back azimuth to MLS datum point distance			11	0 m to 2 047 m	1 m	$I_{31} — I_{41}$
	Back azimuth alignment with runway centre line			12	−20.47° to 20.47° (see Note 3)	0.01°	$I_{42} — I_{53}$
	SPARE			16			$I_{54} — I_{69}$
	PARITY			7	(see Note 1)		$I_{70} — I_{76}$

Note 1 Parity bits I_{70} to I_{76} are chosen to satisfy the equations which follow.

For bit I_{70}

$$\text{EVEN} = (I_{13} + \ldots + I_{18}) + I_{20} + I_{22} + I_{24} + I_{25} + I_{28} + I_{29} + I_{31} + I_{32} + I_{33} + I_{35} + I_{36} + I_{38} + I_{41} + I_{44} + I_{45} + I_{46} + I_{50} + (I_{52} + \ldots + I_{55}) + I_{58} + I_{60} + I_{64} + I_{65} + I_{70}$$

For bit I_{71}

$$\text{EVEN} = (I_{14} + \ldots + I_{19}) + I_{21} + I_{23} + I_{25} + I_{26} + I_{29} + I_{30} + I_{32} + I_{33} + I_{34} + I_{36} + I_{37} + I_{39} + I_{42} + I_{45} + I_{46} + I_{47} + I_{51} + (I_{53} + \ldots + I_{56}) + I_{59} + I_{61} + I_{65} + I_{66} + I_{71}$$

For bit I_{72}

$$\text{EVEN} = (I_{15} + \ldots + I_{20}) + I_{22} + I_{24} + I_{26} + I_{27} + I_{30} + I_{31} + I_{33} + I_{34} + I_{35} + I_{37} + I_{38} + I_{40} + I_{43} + I_{46} + I_{47} + I_{48} + I_{52} + (I_{54} + \ldots + I_{57}) + I_{60} + I_{62} + I_{66} + I_{67} + I_{72}$$

For bit I_{73}

$$\text{EVEN} = (I_{16} + \ldots + I_{21}) + I_{23} + I_{25} + I_{27} + I_{28} + I_{31} + I_{32} + I_{34} + I_{35} + I_{36} + I_{38} + I_{39} + I_{41} + I_{44} + I_{47} + I_{48} + I_{49} + I_{53} + (I_{55} + \ldots + I_{58}) + I_{61} + I_{63} + I_{67} + I_{68} + I_{73}$$

For bit I_{74}

$$\text{EVEN} = (I_{17} + \ldots + I_{22}) + I_{24} + I_{26} + I_{28} + I_{29} + I_{32} + I_{33} + I_{35} + I_{36} + I_{37} + I_{39} + I_{40} + I_{42} + I_{45} + I_{48} + I_{49} + I_{50} + I_{54} + (I_{56} + \ldots + I_{59}) + I_{62} + I_{64} + I_{68} + I_{69} + I_{74}$$

For bit I_{75}

$$\text{EVEN} = (I_{13} + \ldots + I_{17}) + I_{19} + I_{21} + I_{23} + I_{24} + I_{27} + I_{28} + I_{30} + I_{31} + I_{32} + I_{34} + I_{35} + I_{37} + I_{40} + I_{43} + I_{44} + I_{45} + I_{49} + (I_{51} + \ldots + I_{54}) + I_{57} + I_{59} + I_{63} + I_{64} + I_{69} + I_{75}$$

For bit I_{76}

$$\text{EVEN} = I_{13} + I_{14} + \ldots + I_{75} + I_{76}$$

Note 2 Code for I_{56} is: 0 = conical
1 = planar

Table A-10.— Auxiliary data *(cont.)*

Note 3 The convention for the coding of negative numbers is as follows:

MSB is the sign bit: 0 = positive
1 = negative

Other bits represent the absolute value.

The convention for the antenna location is as follows:

As viewed from the MLS approach reference datum looking toward the datum point, a positive number shall represent a location to the right of the runway centre line (lateral offset) or above the runway (vertical offset), or towards the stop end of the runway (longitudinal distance).

The convention for the alignment is as follows:

As viewed from above, a positive number shall represent clockwise rotation from the runway centre line to the respective zero-degree guidance radial.

Note 4 Data word A3 is transmitted in both approach azimuth and back azimuth coverages if back azimuth guidance is provided, according to the following percentages: 75 per cent of the transmissions in the approach azimuth coverage and 25 per cent in the back azimuth coverage.

Note 5 Data word A4 is transmitted in both approach azimuth and back azimuth coverages if back azimuth guidance is provided, according to the following percentages: 75 per cent of the transmissions in the back azimuth coverage and 25 per cent in the approach azimuth coverage.

APPENDIX B TO PART I.— ICAO ILS/MLS TRANSITION PLAN

(see Chapter 2, 2.1.1.4)

1. Introduction

1.1 For the first time in the history of ICAO, a completely new system, the microwave landing system (MLS), has been adopted for international standardization to replace the existing ICAO standard approach and landing aid, the instrument landing system (ILS). The transition from ILS to MLS should be governed by an ILS/MLS transition plan, finalized by the Communications/Operations (COM/OPS) Divisional Meeting (1985) and summarized in Table B-1.

2. Rationale for the plan

2.1 This transition plan is based on eight prime factors:

a) ILS will be withdrawn from international service by 1 January 2000 (*see* 2.1.1.3);

b) the objective to achieve MLS implementation by 1 January 1998 (*see* 2.1.1.1);

c) the need to retain at least the existing level or planned improved level of ILS service until 1 January 1998 unless otherwise determined by regional air navigation agreement or through the regional planning process in consultation with the aircraft operating agencies (*see* 2.1.1.2);

d) the need to provide MLS as soon as practicable where requirements for ILS cannot be met for operational, technical or economic reasons;

e) the need for early introduction of MLS to gain experience in an operational environment;

f) the need to avoid an unduly long transition period;

g) the need for regional planning based on coherent air route networks and for inter-regional co-ordination; and

h) recognition that some of the potential MLS benefits would not be realized until all users are MLS-equipped.

2.2 ILS protection date

2.2.1 The Standards of 2.1.1, including the Notes thereto, define the ILS protection date; provide both ILS and MLS as ICAO standard non-visual aids to final approach and landing; and establish 1 January 1998, the ILS protection date, as the date when MLS becomes the primary system.

2.2.2 The above-mentioned Standards further provide for the retention of ILS until 1 January 2000 on the basis of regional air navigation agreements, bearing in mind that by that date ILS will be withdrawn as an ICAO requirement.

2.2.3 The ILS protection date provides firm assurance that, until that date, no further capital investment in ILS because of modifications to the Annex 10 technical Standards is necessary. As far as ILS users are concerned, the ILS protection date also provides assurance concerning the continuing technical compatibility of airborne ILS equipment.

2.3 Retention of the existing level of ILS service

2.3.1 The ICAO ILS/MLS transition plan shows that it may become uneconomical to install ILS or to maintain an existing ILS during Phase II. Advance planning should endeavour to provide for existing ILS service to be maintained until 1998, unless regional agreement permits otherwise. In assessing economic criteria, ILS providers should take into account the needs of aircraft-operating agencies serving the locations concerned.

2.4 Early MLS introduction

2.4.1 Introduction of MLS at sites where precision approach service is desired and where it is not technically or economically feasible to provide a satisfactory ILS service, is encouraged during Phase I of the plan.

2.4.2 As soon as practicable, States are encouraged to install MLS equipment in order that, in co-operation with users, operational experience in an "in-service" environment may be gained. At this stage, the intention is to install the MLS in addition to the ILS rather than to replace the ILS. Currently operating instrument landing systems will not be withdrawn as a result of installing the MLS at this stage (*see* 2.1.1). Early MLS installations together with those operating in addition to the ILS should be sufficient to provide the significant operational experience required for the refinement of the operationally oriented documentation, as well as for identification of any "in-service" problems which may need attention.

2.5 Need to curtail transition phase

2.5.1 The actual duration of the transition phase from the ILS to the MLS has been chosen to minimize the economic impact on providers and users. This period is ten years, commencing 1 January 1990.

2.5.2 The intention is for the MLS to be in general use by 1 January 1998. Any prolongation of the use of the ILS should be discouraged after the ILS protection date, and ILS service will cease as an international standard by 1 January 2000.

2.5.3 The duration of the transition phase is based on an economic balancing of the desired amortization of the ILS installations, the benefits offered by the MLS, and the penalty of carrying and maintaining both systems at the same time. In particular, implementation of MLS by 1 January 1998 enables significant economic benefits which could accrue to users by eliminating the need for compliance with interference immunity performance standards for the ILS localizer receiving system in 3.1.4. In addition, providers could avoid the expenses related to determining and preventing potential interference to ILS service caused by VHF FM sound broadcast signals.

2.6 Need for regional planning and world-wide co-ordination

2.6.1 If maximum cost benefit and minimum operational disruption is to be achieved through the introduction of the MLS, it is essential to plan installations and develop a suitable programme both on a world-wide and on a regional basis. The use of the word "regional" in this context, although intended primarily in the ICAO sense, can also mean a smaller or larger geographical area to the extent that it includes a coherent air route network. The important objective is to ensure that, as far as practicable, each route or route sector is served by the MLS. This objective is as important for extensive domestic route networks served by national airlines as for long-haul international routes.

2.6.2 As in the past, when ICAO regional requirements for radionavigation aids have been agreed, it should be necessary to establish, as soon as practicable, criteria against which to assess the requirement to install the MLS and also to maintain existing instrument landing systems in operation during the ILS protection period. Traffic density is one criterion which has often been found useful. In the case of the MLS, it is suggested that where the ILS is justified there is also justification for its replacement by the MLS. Equally, where the ILS would have been installed had it been possible to operate it satisfactorily, there is a case for installing the MLS. In other cases, criteria should be based on a correlation between local traffic with instrument approach capability and the incidence of bad weather conditions.

2.7 Limitation of benefits during the transition period

2.7.1 During the time when ILS is still in service, the full benefits of MLS may not be realized. Some flight procedures possible with MLS may be difficult to implement when the flight paths conflict with existing ILS flight procedures. Implementation of these procedures should be carried out only after appropriate consultations including aircraft operating agencies serving the locations concerned.

3. Transition plan

3.1 The actual locations at which the MLS is required should be based on an over-all strategy which defines the framework and criteria for national, regional, and inter-regional requirements based on a coherent air route network and should take into account practical economic considerations for operators and providers.

3.2 Based upon the rationale described in paragraph 2 above, the transition plan is divided into four phases which, together with their timescales, are described in the following paragraphs. A summary of the plan is given in Table B-1.

4. Phase I (through 1989)

4.1 As the ILS is protected to 1 January 1998 (*see* 2.1.1), it may continue to be installed but at a decreasing rate throughout the period, bearing in mind the amortization period. The MLS may also be installed on an optional basis:

a) to provide precision non-visual guidance to approach and landing where ILS service has not been provided for operational, technical or economic reasons; and

b) in addition to ILS, provided that the existing level of ILS service is not affected or withdrawn.

4.2 When the economic and operational benefits so justify, some existing aircraft already fitted with the ILS may, in addition, be retrofitted with the MLS. New-generation aircraft and newly developed models of existing aircraft types may be fitted with the ILS, and provision should be made progressively for the MLS. This enables operational experience to be gained in an "in-service" environment that, in turn, enables development of the MLS-based procedures and further refinement of the related SARPs.

4.3 During this period, applications mainly concern "ILS-type" approaches, improved intercept procedures, higher elevation approaches for VTOL and STOL, as well as the limited use of segmented approaches in situations where the distance measuring equipment (DME) capability permits and where there is no conflict with the ILS operations.

5. Phase II (1990-1997)

5.1 The ILS service will remain protected until the end of this period in accordance with 2.1.1 and it is expected that the existing level of ILS service will continue to be provided except where, in accordance with 2.1.1.2, regional agreement has been reached on its withdrawal after 1 January 1995, in consultation with aircraft operating agencies, while ensuring proper inter-regional co-ordination. However, having regard to the limited period of protection afforded to the ILS, providers of the ILS service need to consider very carefully whether it is worthwhile to install any new ILS equipment. Any further installations during this period are discouraged, and the replacement of existing systems should be progressively discontinued. At the same time, there should be increasing use of the MLS in accordance with regional air navigation planning where it can offer operational, technical or economic benefits, and there should continue to be a build-up of operational in-service experience of MLS, facilitating the completion of certification of the MLS to the lowest operating minima. During this period, the main MLS installation phase should have been entered, and from the beginning of this period the MLS standards will be protected in accordance with 2.1.1.5.

5.2 Because of the increasing availability of MLS service, there should be a corresponding trend in the retrofitting of more existing aircraft with the MLS in addition to the ILS.

New aircraft of all types entering service during this period should be progressively delivered already fitted with the MLS in addition to the ILS.

5.3 A further implementation of MLS as indicated for the previous phase is expected. During this period, operational experience is gained to the extent that by the end of the phase, MLS operations are conducted to the operating minima existing immediately prior to withdrawal of the ILS.

5.4 This phase also includes limited introduction of more complex approach procedures.

6. Phase III (1998-1999)

6.1 As a result of the general implementation of the MLS, the use of ILS will continue only on the basis of regional agreements in accordance with 2.1.1.3, or to meet national requirements. During this period, the ILS will be withdrawn from international service.

6.2 Existing aircraft will be fitted with the MLS, and possibly with the ILS, depending on their age and the particular route network on which they are to be used. All new aircraft delivered during this period should be fitted with the MLS.

6.3 An increasing availability of lower operating minima and the general introduction of more complex applications requiring segmented or curved patterns to be flown are anticipated.

7. Phase IV (2000 onward)

7.1 By the year 2000 the ILS will be withdrawn as an ICAO requirement in accordance with 2.1.1.3 and the MLS should be universally installed. Consequently, all aircraft needing non-visual precision approach and landing guidance in the international service will be fitted with the MLS after this date.

Table B-1.— Summary of the ILS/MLS transition plan

PHASE	*I (through 1989)*	*II (1990-1997)*	*III (1998-1999)*	*IV (2000 onward)*
Status	Dual Standards exist. ILS ICAO primary system; use of MLS optional.	Dual Standards exist. ILS ICAO primary system; increased use of MLS is recommended.	MLS is the ICAO primary system. Continued use of ILS is optional, subject to regional air navigation agreements.	MLS sole ICAO Standard approach and landing guidance system.
Ground equipment	Continue installation of new or replacement ILS bearing in mind amortization period and need to provide service to 1998. Installation of MLS where ILS service has not been provided for operational, technical or economic reasons. Installation of MLS in addition to ILS provided ILS service is not affected or withdrawn as a result.	Main installation phase of MLS based on regional agreement. Existing ILS service to be continued except where regional agreement permits earlier withdrawal in consultation with aircraft operating agencies after 1 January 1995. Discourage further installation of ILS. Replacement of existing systems is progressively discontinued.	Continue use of ILS only on basis of regional agreement or for national requirements. ILS is being withdrawn from international service.	MLS universally installed. ILS withdrawn as an ICAO requirement.
Aircraft equipment	Existing aircraft fitted with ILS and some retrofitted with MLS in addition to ILS. New generation aircraft fitted with ILS and provision for MLS.	Continue retrofitting existing aircraft with MLS in addition to ILS. New aircraft fitted with MLS in addition to ILS.	Aircraft fitted with MLS and possibly ILS.	All aircraft in international service fitted with MLS.
Operational use of MLS	"ILS-type" MLS approaches. Higher glide path angles for STOL, VTOL. Improved intercept procedures. Introduction of segmented approaches for special applications.	Increased use of former applications down to lowest minima. Introduction of more complex approach procedures.	General introduction of complex applications to satisfy operational requirements.	Full implementation of MLS application.
Comments	Provide non-visual guidance to approach and landing where not previously available. Gain operational experience of MLS in an "in-service" environment.	Increasing use of MLS where benefits can be derived or to ensure timely transition. Continuing operational experience of MLS.	MLS in general use.	

Note 1. This summary is necessarily condensed, and the accompanying text should be referred to for a more complete treatment.

Note 2. This summary is in accordance with Annex 10, Volume I, Part I, 2.1.1.

APPENDIX C TO PART I.— A WORLD-WIDE SCHEME FOR THE ALLOCATION, ASSIGNMENT AND APPLICATION OF AIRCRAFT ADDRESSES

1. General

1.1 Global communications, navigation and surveillance systems shall use an individual aircraft address composed of 24 bits. At any one time, no address shall be assigned to more than one aircraft. The assignment of aircraft addresses requires a comprehensive scheme providing for a balanced and expandable distribution of aircraft addresses applicable world-wide.

2. Description of the scheme

2.1 Table C-1 provides for blocks of consecutive addresses available to States for assignment to aircraft. Each block is defined by a fixed pattern of the first 4, 6, 9, 12 or 14 bits of the 24-bit address. Thus, blocks of different sizes (1 048 576, 262 144, 32 768, 4 096 and 1 024 consecutive addresses respectively) are made available.

3. Management of the scheme

3.1 The International Civil Aviation Organization (ICAO) shall administer the scheme so that appropriate international distribution of aircraft addresses can be maintained.

4. Allocation of aircraft addresses

4.1 Blocks of aircraft addresses shall be allocated by ICAO to the State of Registry or common mark registering authority. Address allocations to States shall be as shown in Table C-1.

4.2 A State of Registry or common mark registering authority shall notify ICAO when allocation to that State of an additional block of addresses is required for assignment to aircraft.

4.3 In the future management of the scheme, advantage shall be taken of the blocks of aircraft addresses not yet allocated. These spare blocks shall be distributed on the basis of the relevant ICAO region:

Addresses starting with bit combination 00100: AFI region
Addresses starting with bit combination 00101: SAM region
Addresses starting with bit combination 0101: EUR and NAT regions
Addresses starting with bit combination 01100: MID region
Addresses starting with bit combination 01101: SEA region
Addresses starting with bit combination 1001: NAM and PAC regions
Addresses starting with bit combination 111011: CAR region

In addition, aircraft addresses starting with bit combinations 1011, 1101 and 1111 have been reserved for future use.

4.4 Any future requirement for additional aircraft addresses shall be accommodated through co-ordination between ICAO and the States of Registry or common mark registering authority concerned. A request for additional aircraft addresses shall only be made by a registering authority when at least 75 per cent of the number of addresses already allocated to that registering authority have been assigned to aircraft.

4.5 ICAO shall allocate blocks of aircraft addresses to non-Contracting States upon request.

5. Assignment of aircraft addresses

5.1 When required for use by suitably equipped aircraft entered on a national or international register, individual aircraft addresses within each block shall be assigned to aircraft by the State of Registry or common mark registering authority.

5.2 Aircraft addresses shall be assigned to aircraft in accordance with the following principles:

a) at any one time, no address shall be assigned to more than one aircraft;

b) only one address shall be assigned to an aircraft, irrespective of the composition of equipment on board;

c) the address shall not be changed except under exceptional circumstances and shall not be changed during flight;

d) when an aircraft changes its State of Registry, the previously assigned address shall be relinquished and a new address shall be assigned by the new registering authority;

e) the address shall serve only a technical role for addressing and identification of aircraft and shall not be used to convey any specific information; and

f) the addresses composed of 24 ZEROs or 24 ONEs shall not be assigned to aircraft.

6. Application of aircraft addresses

6.1 The aircraft addresses shall be used in applications which require the routing of information to or from individual suitably equipped aircraft.

Note 1.— Examples of such applications are the aeronautical telecommunication network (ATN), SSR Mode S and airborne collision avoidance system (ACAS).

Note 2.— This Standard does not preclude assigning the aircraft addresses for special applications associated with the general applications defined therein. Examples of such special applications are the utilization of the 24-bit address in a pseudo-aeronautical earth station to monitor the aeronautical mobile-satellite service ground earth station and in the fixed Mode S transponders (reporting the on-the-ground status as specified in 3.8.2.6.10.1.2) to monitor the Mode S ground station operation. Address assignments for special applications are to be carried out in conformance with the procedure established by the State to manage the 24-bit address assignments to aircraft.

6.2 An address consisting of 24 ZEROs shall not be used for any application.

Table C-1. Allocation of aircraft addresses to States

Note.— The left-hand column of the 24-bit address patterns represents the most significant bit (MSB) of the address.

State	Number of addresses in block					Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)
	1 024	4 096	32 768	262 144	1 048 576	
Afghanistan		*				0111 00 000 000 -- ----------
Albania	*					0101 00 000 001 00 ----------
Algeria			*			0000 10 100 --- -- ----------
Angola		*				0000 10 010 000 -- ----------
Antigua and Barbuda	*					0000 11 001 010 00 ----------
Argentina				*		1110 00 --- --- -- ----------
Armenia	*					0110 00 000 000 00 ----------
Australia				*		0111 11 --- --- -- ----------
Austria			*			0100 01 000 --- -- ----------
Azerbaijan	*					0110 00 000 000 10 ----------
Bahamas		*				0000 10 101 000 -- ----------
Bahrain		*				1000 10 010 100 -- ----------
Bangladesh		*				0111 00 000 010 -- ----------
Barbados	*					0000 10 101 010 00 ----------
Belarus	*					0101 00 010 000 00 ----------
Belgium			*			0100 01 001 --- -- ----------
Belize	*					0000 10 101 011 00 ----------
Benin	*					0000 10 010 100 00 ----------
Bhutan	*					0110 10 000 000 00 ----------
Bolivia		*				1110 10 010 100 -- ----------
Bosnia and Herzegovina	*					0101 00 010 011 00 ----------
Botswana	*					0000 00 110 000 00 ----------
Brazil				*		1110 01 --- --- -- ----------
Brunei Darussalam	*					1000 10 010 101 00 ----------
Bulgaria			*			0100 01 010 --- -- ----------
Burkina Faso		*				0000 10 011 100 -- ----------
Burundi		*				0000 00 110 010 -- ----------
Cambodia		*				0111 00 001 110 -- ----------
Cameroon		*				0000 00 110 100 -- ----------
Canada				*		1100 00 --- --- -- ----------
Cape Verde	*					0000 10 010 110 00 ----------
Central African Republic		*				0000 01 101 100 -- ----------
Chad		*				0000 10 000 100 -- ----------
Chile		*				1110 10 000 000 -- ----------
China				*		0111 10 --- --- -- ----------
Colombia		*				0000 10 101 100 -- ----------
Comoros	*					0000 00 110 101 00 ----------
Congo		*				0000 00 110 110 -- ----------
Cook Islands	*					1001 00 000 001 00 ----------
Costa Rica		*				0000 10 101 110 -- ----------
Côte d'Ivoire		*				0000 00 111 000 -- ----------
Croatia	*					0101 00 000 001 11 ----------
Cuba		*				0000 10 110 000 -- ----------
Cyprus	*					0100 11 001 000 00 ----------
Czech Republic			*			0100 10 011 --- -- ----------
Democratic People's Republic of Korea			*			0111 00 100 --- -- ----------
Denmark			*			0100 01 011 --- -- ----------
Djibouti	*					0000 10 011 000 00 ----------
Dominican Republic		*				0000 11 000 100 -- ----------
Ecuador		*				1110 10 000 100 -- ----------
Egypt			*			0000 00 010 --- -- ----------
El Salvador		*				0000 10 110 010 -- ----------
Equatorial Guinea		*				0000 01 000 010 -- ----------
Eritrea	*					0010 00 000 010 00 ----------
Estonia	*					0101 00 010 001 00 ----------

State	*Number of addresses in block*					*Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)*
	1 024	*4 096*	*32 768*	*262 144*	*1 048 576*	
Ethiopia		*				0000 01 000 000 -- ----------
Fiji		*				1100 10 001 000 -- ----------
Finland			*			0100 01 100 --- -- ----------
France				*		0011 10 --- --- -- ----------
Gabon		*				0000 00 111 110 -- ----------
Gambia		*				0000 10 011 010 -- ----------
Georgia	*					0101 00 010 100 00 ----------
Germany				*		0011 11 --- --- -- ----------
Ghana		*				0000 01 000 100 -- ----------
Greece			*			0100 01 101 --- -- ----------
Grenada	*					0000 11 001 100 00 ----------
Guatemala		*				0000 10 110 100 -- ----------
Guinea		*				0000 01 000 110 -- ----------
Guinea-Bissau	*					0000 01 001 000 00 ----------
Guyana		*				0000 10 110 110 -- ----------
Haiti		*				0000 10 111 000 -- ----------
Honduras		*				0000 10 111 010 -- ----------
Hungary			*			0100 01 110 --- -- ----------
Iceland		*				0100 11 001 100 -- ----------
India				*		1000 00 --- --- -- ----------
Indonesia			*			1000 10 100 --- -- ----------
Iran, Islamic Republic of			*			0111 00 110 --- -- ----------
Iraq			*			0111 00 101 --- -- ----------
Ireland		*				0100 11 001 010 -- ----------
Israel			*			0111 00 111 --- -- ----------
Italy				*		0011 00 --- --- -- ----------
Jamaica		*				0000 10 111 110 -- ----------
Japan				*		1000 01 --- --- -- ----------
Jordan			*			0111 01 000 --- -- ----------
Kazakhstan	*					0110 10 000 011 00 ----------
Kenya		*				0000 01 001 100 -- ----------
Kiribati	*					1100 10 001 110 00 ----------
Kuwait		*				0111 00 000 110 -- ----------
Kyrgyzstan	*					0110 00 000 001 00 ----------
Lao People's Democratic Republic		*				0111 00 001 000 -- ----------
Latvia	*					0101 00 000 010 11 ----------
Lebanon			*			0111 01 001 --- -- ----------
Lesotho	*					0000 01 001 010 00 ----------
Liberia		*				0000 01 010 000 -- ----------
Libyan Arab Jamahiriya			*			0000 00 011 --- -- ----------
Lithuania	*					0101 00 000 011 11 ----------
Luxembourg	*					0100 11 010 000 00 ----------
Madagascar		*				0000 01 010 100 -- ----------
Malawi		*				0000 01 011 000 -- ----------
Malaysia			*			0111 01 010 --- -- ----------
Maldives	*					0000 01 011 010 00 ----------
Mali		*				0000 01 011 100 -- ----------
Malta	*					0100 11 010 010 00 ----------
Marshall Islands	*					1001 00 000 000 00 ----------
Mauritania	*					0000 01 011 110 00 ----------
Mauritius	*					0000 01 100 000 00 ----------
Mexico			*			0000 11 010 --- -- ----------
Micronesia, Federated States of	*					0110 10 000 001 00 ----------
Monaco	*					0100 11 010 100 00 ----------
Mongolia	*					0110 10 000 010 00 ----------

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State	Number of addresses in block: 1 024	4 096	32 768	262 144	1 048 576	Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)
Morocco			*			0000 00 100 --- -- ----------
Mozambique		*				0000 00 000 110 -- ----------
Myanmar		*				0111 00 000 100 -- ----------
Namibia	*					0010 00 000 001 00 ----------
Nauru	*					1100 10 001 010 00 ----------
Nepal		*				0111 00 001 010 -- ----------
Netherlands, Kingdom of the			*			0100 10 000 --- -- ----------
New Zealand			*			1100 10 000 --- -- ----------
Nicaragua		*				0000 11 000 000 -- ----------
Niger		*				0000 01 100 010 -- ----------
Nigeria		*				0000 01 100 100 -- ----------
Norway			*			0100 01 111 --- -- ----------
Oman	*					0111 00 001 100 00 ----------
Pakistan			*			0111 01 100 --- -- ----------
Panama		*				0000 11 000 010 -- ----------
Papua New Guinea		*				1000 10 011 000 -- ----------
Paraguay		*				1110 10 001 000 -- ----------
Peru		*				1110 10 001 100 -- ----------
Philippines			*			0111 01 011 --- -- ----------
Poland			*			0100 10 001 --- -- ----------
Portugal			*			0100 10 010 --- -- ----------
Qatar	*					0000 01 101 010 00 ----------
Republic of Korea			*			0111 00 011 --- -- ----------
Republic of Moldova	*					0101 00 000 100 11 ----------
Romania			*			0100 10 100 --- -- ----------
Russian Federation					*	0001 -- --- --- -- ----------
Rwanda		*				0000 01 101 110 -- ----------
Saint Lucia	*					1100 10 001 100 00 ----------
Saint Vincent and the Grenadines	*					0000 10 111 100 00 ----------
San Marino	*					0101 00 000 000 00 ----------
Sao Tome and Principe	*					0000 10 011 110 00 ----------
Saudi Arabia			*			0111 00 010 --- -- ----------
Senegal		*				0000 01 110 000 -- ----------
Seychelles	*					0000 01 110 100 00 ----------
Sierra Leone	*					0000 01 110 110 00 ----------
Singapore			*			0111 01 101 --- -- ----------
Slovakia	*					0101 00 000 101 11 ----------
Slovenia	*					0101 00 000 110 11 ----------
Solomon Islands	*					1000 10 010 111 00 ----------
Somalia		*				0000 01 111 000 -- ----------
South Africa			*			0000 00 001 --- -- ----------
Spain				*		0011 01 --- --- -- ----------
Sri Lanka			*			0111 01 110 --- -- ----------
Sudan		*				0000 01 111 100 -- ----------
Suriname		*				0000 11 001 000 -- ----------
Swaziland	*					0000 01 111 010 00 ----------
Sweden			*			0100 10 101 --- -- ----------
Switzerland			*			0100 10 110 --- -- ----------
Syrian Arab Republic			*			0111 01 111 --- -- ----------
Tajikistan	*					0101 00 010 101 00 ----------

9/11/95
No. 70

State	Number of addresses in block					Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)
	1 024	4 096	32 768	262 144	1 048 576	
Thailand			*			1000 10 000 --- -- ----------
The former Yugoslav Republic of Macedonia	*					0101 00 010 010 00 ----------
Togo		*				0000 10 001 000 -- ----------
Tonga	*					1100 10 001 101 00 ----------
Trinidad and Tobago		*				0000 11 000 110 -- ----------
Tunisia			*			0000 00 101 --- -- ----------
Turkey			*			0100 10 111 --- -- ----------
Turkmenistan	*					0110 00 000 001 10 ----------
Uganda		*				0000 01 101 000 -- ----------
Ukraine			*			0101 00 001 --- -- ----------
United Arab Emirates		*				1000 10 010 110 -- ----------
United Kingdom				*		0100 00 --- --- -- ----------
United Republic of Tanzania		*				0000 10 000 000 -- ----------
United States					*	1010 -- --- --- -- ----------
Uruguay		*				1110 10 010 000 -- ----------
Uzbekistan	*					0101 00 000 111 11 ----------
Vanuatu	*					1100 10 010 000 00 ----------
Venezuela			*			0000 11 011 --- -- ----------
Viet Nam			*			1000 10 001 --- -- ----------
Yemen		*				1000 10 010 000 -- ----------
Yugoslavia			*			0100 11 000 --- -- ----------
Zaire		*				0000 10 001 100 -- ----------
Zambia		*				0000 10 001 010 -- ----------
Zimbabwe	*					0000 00 000 100 00 ----------
ICAO[1]			*			1111 00 000 --- -- ----------

1. ICAO or its designate administers this block for assigning temporary aircraft addresses if and when an immediate action is to be taken to avoid the assignment of an unauthorized 24-bit aircraft address. It is intended that the temporary address is to be relinquished as soon as practicable when the 24-bit aircraft address is assigned by a State of Registry or common mark registering authority in conformance with the provisions in 4, 5 and 6 of this Appendix. The State concerned is then expected to inform ICAO or its designate regarding the release of the temporary address.

APPENDIX D TO PART I.— EMERGENCY LOCATOR TRANSMITTER CODING

(see Chapter 5, 5.3.2)

Note.— A detailed description of beacon coding is contained in Document CCIR Recommendation 633. The following information is specific to emergency locator transmitters used in aviation.

1. General

1.1 The UHF emergency locator transmitter (ELT) operating on 406 MHz has the capacity to transmit a programmed digital message which contains information related to the ELT and/or the aircraft on which it is carried.

1.2 The ELT shall be uniquely coded in accordance with 1.3 below and be registered with the appropriate authority.

Note.— The registration of an ELT will normally be made in a data base of the registering authority of the State on whose register the aircraft equipped with the ELT is entered. Any movement of the ELT through, for example, the sale of the ELT or of the aircraft into which it is installed will normally be reported to the registering authority.

1.3 The ELT digital message shall contain either the transmitter serial number or one of the following information elements:

a) aircraft operating agency designator and a serial number from 0001 to 4096;

b) 24-bit aircraft address;

c) aircraft nationality and registration marks.

1.4 All ELTs shall be designed for co-operation with the COSPAS-SARSAT* system and be type approved.

Note.— Transmission characteristics of the ELT signal can be confirmed by making use of the COSPAS-SARSAT Type Approval Standard (C-S T.007).

2. ELT Coding

2.1 The ELT digital message contains information relating to the message format, coding protocol, country code and identification data consisting of one of the information elements listed in 1.3 above.

2.2 The short message format described in CCIR Recommendation 633 shall be used, making use of bits 1 through 112.

2.3 Protected field

2.3.1 The protected field consisting of bits 25 through 85 is protected by an error correcting code, and is the portion of the message which must be unique in every distress beacon.

2.3.2 A message format flag is indicated by bit 25 and shall be value "0" to indicate the short message format.

2.3.3 A protocol flag is indicated by bit 26 and shall be value "1".

2.3.4 A country code, which indicates the State where additional data are available on the aircraft on which the ELT is carried, is contained in bits 27 through 36 which designate a three-digit decimal country code number expressed in binary notation.

Note.— Country codes are based on the International Telecommunication Union (ITU) country code shown in Table 1 of Appendix 43 of the ITU Radio Regulations.

2.3.5 Bits 37 through 39 designate one of the user protocols where values "001" and "011" are used for aviation as shown in the examples contained in this Appendix.

2.3.6 The ELT digital message shall contain either the transmitter serial number or an identification of the aircraft or operator in bits 40 through 83 as shown in the Attachment. This information shall be encoded in binary notation with the least significant bit on the right, or using the modified Baudot code shown in Table D-1.

2.3.7 In the serialized user protocol (designated by bits 37 through 39 being "011") bits 40 through 42 indicate type of beacon where:

— "000" indicates ELT serial number is encoded in bits 44 through 63;

— "001" indicates aircraft operator and a serial number are encoded in bits 44 through 61 and 62 through 73, respectively;

— "011" indicates the aircraft 24-bit address is encoded in bits 44 through 67 and each additional ELT on the same aircraft is numbered in bits 68 through 73.

Note.— States will ensure that each beacon, coded with the country code of the State, is uniquely coded and registered in

* COSPAS = Space system for search of vessels in distress; SARSAT = Search and rescue satellite-aided tracking.

a data base. Unique coding of serialized coded beacons can be facilitated by including the COSPAS-SARSAT Type Approval Certificate Number which is a unique number assigned by COSPAS-SARSAT for each approved ELT model, as part of the ELT message.

2.3.8 In the aviation user protocol (designated by bits 37 through 39 being "001"), the aircraft nationality and registration marking shall be encoded in bits 40 through 81, using the modified Baudot code shown in Table D-1 to encode seven alpha-numeric characters. This data shall be right justified with the modified Baudot space ("100100") being used where no character exists.

2.3.9 Bits 84 and 85 indicate any homing transmitter that may be integrated in the ELT.

Table D-1. Modified Baudot Code

Letter	*Code* *MSB LSB*	*Figure*	*Code* *MSB LSB*
A	111000	(-)*	011000
B	110011		
C	101110		
D	110010		
E	110000	3	010000
F	110110		
G	101011		
H	100101		
I	101100		
J	111010	8	001100
K	111110		
L	101001		
M	100111		
N	100110		
O	100011	9	000011
P	101101	0	001101
Q	111101	1	011101
R	101010	4	001010
S	110100		
T	100001	5	000001
U	111100	7	011100
V	101111		
W	111001	2	011001
X	110111	/	010111
Y	110101	6	010101
Z	110001		
( )**	100100		

MSB = most significant bit
LSB = least significant bit
* = hyphen
** = space

EXAMPLES OF CODING

ELT serial number

25		27 36	37			40				44 63	64 73	74 83		85
F	1	COUNTRY	0	1	1	T	T	T	C	SERIAL NUMBER DATA (20 BITS)	SEE NOTE 1	SEE NOTE 2	A	A

Aircraft 24-bit address

25		27 36	37			40				44 67	68 73	74 83		85
F	1	COUNTRY	0	1	1	T	T	T	C	24-BIT AIRCRAFT ADDRESS (24 BITS)	SEE NOTE 3	SEE NOTE 2	A	A

Aircraft operator designator and serial number

25		27 36	37			40				44 61	62 73	74 83		85
F	1	COUNTRY	0	1	1	T	T	T	C	OPERATOR 3-LETTER DESIGNATOR	SERIAL NUMBER 0-4096	SEE NOTE 2	A	A

Aircraft registration marking

25		27 36	37			40 81		83		85
F	1	COUNTRY	0	0	1	AIRCRAFT REGISTRATION MARKING (UP TO 7 ALPHANUMERIC CHARACTERS) (42 BITS)	0	0	A	A

T = Beacon type TTT = 000 indicates ELT serial number is encoded;
= 001 indicates operating agency and serial number are encoded;
= 011 indicates 24-bit aircraft address is encoded.

C = Certificate flag bit: 1 — to indicate that COSPAS-SARSAT Type Approval Certificate number is encoded in bits 74 through 83 and
0 — otherwise

F = Format flag: 0 = Short Message
1 = Long Message

A = Auxiliary radio-locating device: 00 = no auxiliary radio-locating device
01 = 121.5 MHz
11 = other auxiliary radio-locating device

Note 1.— 10 bits, all 0s or National use.

Note 2.— COSPAS-SARSAT Type Approval Certificate number in binary notation with the least significant bit on the right, or National use.

Note 3.— Serial number, in binary notation with the least significant bit on the right, of additional ELTs carried in the same aircraft or default to 0s when only one ELT is carried.

PART II — RADIO FREQUENCIES

CHAPTER 1. DEFINITIONS

When the following terms are used in this Part of the Annex, they have the following meanings:

Alternative means of communication. A means of communication provided with equal status, and in addition to the primary means.

Double channel simplex. Simplex using two frequency channels, one in each direction.

Note.— This method was sometimes referred to as crossband.

Duplex. A method in which telecommunication between two stations can take place in both directions simultaneously.

Frequency channel. A continuous portion of the frequency spectrum appropriate for a transmission utilizing a specified class of emission.

Note.— The classification of emissions and information relevant to the portion of the frequency spectrum appropriate for a given type of transmission (bandwidths) are specified in the Radio Regulations, Article 4 RR 264 to RR 273 inclusive.

Offset frequency simplex. A variation of single channel simplex wherein telecommunication between two stations is effected by using in each direction frequencies that are intentionally slightly different but contained within a portion of the spectrum alloted for the operation.

Operational control communications. Communications required for the exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of the safety of the aircraft and the regularity and efficiency of a flight.

Note.— Such communications are normally required for the exchange of messages between aircraft and aircraft operating agencies.

Primary means of communication. The means of communication to be adopted normally by aircraft and ground stations as a first choice where alternative means of communication exist.

Simplex. A method in which telecommunication between two stations takes place in one direction at a time.

Note.— In application to the Aeronautical Mobile Service, this method may be subdivided as follows:

a) single channel simplex;

b) double channel simplex;

c) offset frequency simplex.

Single channel simplex. Simplex using the same frequency channel in each direction.

VHF air-ground data link. Two-way data communication in the 118-137 MHz VHF band between aircraft and aeronautical stations.

CHAPTER 2. DISTRESS FREQUENCIES

Introduction

The Standards and Recommended Practices relating to radio frequencies for distress communications take into account certain procedures that have been adopted by ICAO and also certain provisions made by the ITU in its Radio Regulations.

The ICAO Communication Procedures require that an aircraft in distress when it is airborne should use the frequency in use for normal communications with aeronautical stations at the time. However, it is recognized that, after an aircraft has crashed or ditched, there is a need for designating a particular frequency or frequencies to be used in order that uniformity may be attained on a world-wide basis, and so that a guard may be maintained or set up by as many stations as possible including direction-finding stations, and stations of the Maritime Mobile Service.

The frequency 2 182 kHz also offers possibilities for communication between aircraft and stations of the Maritime Mobile Service. The current Radio Regulations specify (RR 2973) that the frequency 2 182 kHz is the international distress frequency for radiotelephony to be used for that purpose by ship, aircraft and survival craft stations using frequencies in the authorized bands between 1 605 kHz and 4 000 kHz when requesting assistance from the maritime service.

With respect to emergency locator transmitters (ELTs) designed to be detected and located by satellite, the Radio Regulations authorize the use of these devices, which are referenced in ITU as satellite emergency position indicating radio beacons (EPIRBs). Radio Regulation 649 specifies that the band 406-406.1 MHz is used exclusively by satellite emergency position indicating radio beacons in the earth-to-space direction.

The frequency 4 125 kHz is also authorized by the ITU to enable communications between stations in the maritime mobile service and aircraft stations in distress. The current ITU Radio Regulations (RR 2982A/N2981) state that the carrier frequency 4 125 kHz may be used by aircraft stations to communicate with stations of the maritime mobile service for distress and safety purposes.

Similarly, the frequency 500 kHz is the international distress frequency for radiotelegraphy to be used for that purpose by ship, aircraft and survival craft stations using frequencies in the bands between 405 kHz and 535 kHz when requesting assistance from the maritime service (RR 2970).

With respect to survival craft stations, the Radio Regulations provide for the use of the frequency(ies) 500 kHz, 8 364 kHz, 2 182 kHz, 121.5 MHz and 243 MHz, if the survival craft is capable of operating in the bands between 405-535 kHz, 4 000-27 500 kHz, 1 605-2 850 kHz, 117.975-136 MHz and 235-328.6 MHz respectively (RR 3001-3008).

2.1 Frequencies for emergency locator transmitters (ELT) for search and rescue

2.1.1 Emergency locator transmitters carried in compliance with Standards of Annex 6, Parts I, II and III shall operate either on both 406 MHz and 121.5 MHz or on 121.5 MHz.

Note.— ITU Radio Regulations (No. 592) provide for the use of 243 MHz in addition to the above frequencies.

2.2 Search and rescue frequencies

2.2.1 Where there is a requirement for the use of high frequencies for search and rescue scene of action co-ordination purposes, the frequencies 3 023 kHz and 5 680 kHz shall be employed.

2.2.2 **Recommendation.—** *Where specific frequencies are required for communication between rescue co-ordination centres and aircraft engaged in search and rescue operations, they should be selected regionally from the appropriate aeronautical mobile frequency bands in the light of the nature of the provisions made for the establishment of search and rescue aircraft.*

Note.— Where civil commercial aircraft take part in search and rescue operations, they will normally communicate on the appropriate en-route channels with the flight information centre associated with the rescue co-ordination centre concerned.

CHAPTER 3. UTILIZATION OF FREQUENCIES BELOW 30 MHz

Introduction

High frequency bands allocated to the Aeronautical Mobile (R) Service

The frequency bands between 2.8 MHz and 22 MHz allocated to the Aeronautical Mobile (R) Service are given in Article 8 of the Radio Regulations. The utilization of these bands must be in accordance with the relevant provisions of the Radio Regulations. Prior to 1 September 1979, the provisions are contained in the Final Acts of the ITU Extraordinary Administrative Radio Conference (Geneva 1966). On 1 September 1979, revised provisions came into force, details of which are contained in the Final Acts of the World Administrative Radio Conference for the Aeronautical Mobile (R) Service (Geneva 1978) and Appendix 27 Aer2 to the Radio Regulations, except the Frequency Allotment Plan which entered into force at 0001 hours UTC, 1 February 1983. In the utilization of these bands, States' attention is drawn to the possibility of harmful radio interference from non-aeronautical sources of radio frequency energy and the need to take appropriate measures to minimize its effects.

3.1 Method of operations

3.1.1 In the Aeronautical Mobile Service, single channel simplex shall be used in radiotelephone communications utilizing radio frequencies below 30 MHz in the bands allocated exclusively to the Aeronautical Mobile (R) Service.

3.1.2 Assignment of single sideband channels

3.1.2.1 Single sideband channels shall be assigned in accordance with Part I, 4.10.1.3 and 4.10.1.4.

3.1.2.2 Until 1 February 1983 it shall be permissible to use channels in the new Plan provided that no harmful interference occurs to users of channels in the present Plan. For the operational use of the channels concerned administrations shall take into account the provisions of 27/20 of Appendix 27 Aer2 of the Radio Regulations.

3.1.2.3 **Recommendation.—** *The use of aeronautical mobile (R) frequencies below 30 MHz for international operations should be co-ordinated as specified in Appendix 27 Aer2 of the Radio Regulations as follows:*

27/20 The International Civil Aviation Organization (ICAO) co-ordinates radiocommunications of the Aeronautical Mobile (R) Service with international aeronautical operations and this Organization should be consulted in all appropriate cases in the operational use of the frequencies in the Plan.

3.1.2.4 **Recommendation.—** *Where international operating requirements for HF communications cannot be satisfied by the allotments in the table at Nos. 27/195 to 27/207 in Appendix 27 EARC, an appropriate frequency should be assigned as specified in Appendix 27 Aer2 of the Radio Regulations as follows:*

27/21 It is recognized that not all the sharing possibilities have been exhausted in the Allotment Plan contained in this Appendix. Therefore, in order to satisfy particular operational requirements which are not otherwise met by this Allotment Plan, administrations may assign frequencies from the aeronautical mobile (R) bands in areas other than those to which they are alloted in this Plan. However, the use of the frequencies so assigned must not reduce the protection to the same frequencies in the areas where they are allotted by the Plan below that determined by the application of the procedure defined in Part I, Section II B of this Appendix.

Note.— Part I, Section II B of Appendix 27 Aer2 relates to Interference Range Contours, and application of the procedure results in a protection ratio of 15 dB.

27/22 When necessary to satisfy the needs of international air operations administrations may adapt the allotment procedure for the assignment of aeronautical mobile (R) frequencies, which assignments shall then be the subject of prior agreement between administrations affected.

27/23 The co-ordination described in No. 27/20 shall be effected where appropriate and desirable for the efficient utilization of the frequencies in question, and especially when the procedures of No. 27/22 are unsatisfactory.

3.1.2.5 The use of classes of emission J7B and J9B shall be subject to the following provisions of Appendix 27 Aer2:

27/11 For radiotelephone emissions the audio frequencies will be limited to between 300 and 2 700 Hz and the occupied bandwidth of other authorized emissions will not exceed the upper limit of J3E emissions. In specifying these limits, however, no restriction in their extension is implied in so far as emissions other than J3E are concerned, provided that the limits of unwanted emissions are met (see Nos. 27/66B and 27/66C).

27/11B On account of the possibility of interference, a given channel should not be used in the same allotment area for radiotelephony and data transmissions.

27/12 The use of channels derived from the frequencies indicated in 27/16 for the various classes of emissions other than J3E and H2B will be subject to special arrangements by the administrations concerned and affected in order to avoid harmful interference which may result from the simultaneous use of the same channel for several classes of emission.

3.1.3 Assignment of frequencies for aeronautical operational control communications

3.1.3.1 World-wide frequencies for aeronautical operational control communications are required to enable aircraft operating agencies to meet the obligations prescribed in Annex 6, Part I. Assignment of these frequencies shall be in accordance with the following provisions of Appendix 27 Aer2:

27/8A A world-wide allotment area is one in which frequencies are allotted to provide long distance communications between an aeronautical station within that allotment area and aircraft operating anywhere in the world.

27/8A.1 The type of communication referred to in 27/8A may be regulated by Administrations.

27/194A The world-wide frequency allotments appearing in the tables at No. 27/189 and Nos. 27/195 to 27/207, except for carrier (reference) frequencies 3 023 kHz and 5 680 kHz, are reserved for assignment by administrations to stations operating under authority granted by the administration concerned for the purpose of serving one or more aircraft operating agencies. Such assignments are to provide communications between an appropriate aeronautical station and an aircraft station anywhere in the world for exercising control over regularity of flight and for safety of aircraft. World-wide frequencies are not to be assigned by administrations for MWARA, RDARA and VOLMET purposes. Where the operational area of an aircraft lies wholly within a RDARA or sub-RDARA boundary, frequencies allotted to those RDARAs and sub-RDARAs shall be used.

Note 1.— Tables 27/189 and 27/195 to 27/207 appearing in Appendix 27 Aer2 to the Radio Regulations refer to, respectively, the Frequency Allotment Plan, listing frequencies by areas, and the Frequency Allotment Plan, listing frequencies in numerical order.

Note 2.— Guidance material on the assignment of world-wide frequencies is contained in Attachment C to Part II to this Annex.

3.2 NDB frequency management

3.2.1 **Recommendation.—** *NDB frequency management should take into account the following:*

a) the interference protection required at the edge of the rated coverage;

b) the application of the figures shown for typical ADF equipments;

c) the geographical spacings and the respective rated coverages;

d) the possibility of interference from spurious radiations generated by non-aeronautical sources (e.g. electric power services, power line communication systems, industrial radiations, etc.).

Note 1.— Guidance material to assist in determining the application of the foregoing is given in Attachment B to Part II.

Note 2.— Attention is drawn to the fact that some portions of the bands available for aeronautical beacons are shared with other services.

3.2.2 **Recommendation.—** *To alleviate frequency congestion problems, at locations where two separate ILS facilities serve opposite ends of a single runway, the assignment of a common frequency to both of the outer locators should be permitted, and the assignment of a common frequency to both of the inner locators should be permitted, provided that:*

a) the operational circumstances permit;

b) each locator is assigned a different identification signal;

c) arrangements are made whereby locators using the same frequency cannot radiate simultaneously.

Note.— The Standard in Part I, 3.4.4.4, specifies the equipment arrangements to be made.

CHAPTER 4. UTILIZATION OF FREQUENCIES ABOVE 30 MHz

4.1 Utilization in the band 117.975-137 MHz

Introduction

The band 118-132 MHz was allocated in 1947 by the Atlantic City ITU Radio Conference, and again in 1959 by the Geneva Conference, but with extension downwards to 117.975 MHz, for the exclusive use by the Aeronautical Mobile (R) Service. This Chapter of Annex 10 deals with Standards and Recommended Practices relating to this band and includes matters pertaining to the selection of particular frequencies for various aeronautical purposes. These Standards are introduced by the following preface, which sets out the principles upon which the utilization of VHF on a world-wide basis with due regard to economy has been planned.

ITU Radio Conferences subsequent to 1947 also made provisions for the use of the band 132-136 MHz for the Aeronautical Mobile (R) Service under conditions which vary for the different ITU Regions, countries or combination of countries. The utilization of this band has been included in the Allotment Table in this Chapter; however, it should be kept in mind that the use of frequencies of the band 132-136 MHz must take account of the conditions contained in the notes against this band in the ITU Allocation Table. The ITU Radio Conference (1979) made provisions for the use of the band 136-137 MHz by the Aeronautical Mobile (R) Service, subject to conditions of No. 595 of the Radio Regulations. In the utilization of these bands, States' attention is drawn to the possibility of harmful radio interference from non-aeronautical sources of radio frequency energy and the need to take appropriate measures to minimize its effects.

Preface

The utilization of VHF on a world-wide basis with due regard to economy and practicability requires a plan that will take into account:

a) the need for an orderly evolution towards improved operation and the required degree of world-wide standardization;

b) the desirability of providing for an economic transition from present utilization to optimum utilization of the frequencies available, taking into account the maximum possible utilization of existing equipment;

c) the need to provide for co-ordination between international and national utilization so as to ensure mutual protection from interference;

d) the need for providing a framework for the integrated development of Regional Plans;

e) the desirability of incorporating in any group of frequencies to be used those now in use for international air services;

f) the need for keeping the total number of frequencies and their grouping in appropriate relation to the airborne equipment known to be widely used by international air services;

g) a requirement for the provision of a single frequency that may be used for emergency purposes on a world-wide basis and, also, in certain regions, for another frequency that may be used as a common frequency for special purposes;

h) the need for providing sufficient flexibility to allow for the differences in application necessitated by regional conditions.

4.1.1 General allotment of frequency band 117.975-137 MHz

Note.— The plan includes a general Allotment Table that subdivides the complete band 117.975-137 MHz, the chief subdivisions being the bands of frequencies allocated to both national and international services, and the bands allocated to national services. Observance of this general subdivision should keep to a minimum the problem of co-ordinating national and international application.

The block allotment of the frequency band 117.975-137 MHz shall be as shown in Table 4-1.

In the case of the new band 136-137 MHz, international applications have not yet been agreed, and these frequencies should be brought into use on a regional basis where and in the manner required.

4.1.2 Frequency separation and limits of assignable frequencies

4.1.2.1 The minimum separation between assignable frequencies in the Aeronautical Mobile (R) Service shall be 25 kHz.

Note.— It is recognized that, in some regions or areas, 100 kHz or 50 kHz channel spacing may provide an adequate number of frequencies suitably related to international and national air services and that equipment designed specifically for 100 kHz or 50 kHz channel spacing will remain adequate for services operating within such regions or areas.

Table 4-1. Allotment table

Block allotment of frequencies (MHz)	*World-wide utilization*	*Remarks*
a) 118 to 121.4 inclusive	International and National Aeronautical Mobile Services	Specific international allotments will be determined in the light of regional agreement. National assignments are covered by the provisions in 4.1.5.9 below.
b) 121.5	Emergency frequency	In order to provide a guard band for the protection of the aeronautical emergency frequency, the nearest assignable frequencies on either side of 121.5 MHz are 121.4 MHz and 121.6 MHz, except that by regional agreement it may be decided that the nearest assignable frequencies are 121.3 MHz and 121.7 MHz.
c) 121.6 to 121.975 inclusive	International and National aerodrome surface communications	Reserved for ground movement, pre-flight checking, air traffic services clearances, and associated operations.
d) 122 to 123.05 inclusive	National Aeronautical Mobile Services	Reserved for national allotments.
e) 123.1	Auxiliary frequency SAR	See 4.1.4.1 below.
f) 123.15 to 123.675	National Aeronautical Mobile Services	Reserved for national allotments.
g) 123.7 to 129.675 inclusive	International and National Aeronautical Mobile Services	Specific international allotments will be determined in the light of regional agreement. National assignments are covered by the provisions in 4.1.5.9 below.
h) 129.7 to 130.875 inclusive	National Aeronautical Mobile Services	Reserved for national allotments but may be used in whole or in part, subject to regional agreement, to meet the requirements mentioned in 4.1.8.1.3 below.
i) 130.9 to 136.875 inclusive	International and National Aeronautical Mobile Services	Specific international allotments will be determined in the light of regional agreement. National assignments are covered by the provisions in 4.1.5.9 below. (See remark in the Introduction to 4.1 above regarding the band 132-137 MHz.)
j) 136.9 to 136.975 inclusive	International and National Aeronautical Mobile Services	Reserved for VHF air-ground data link communications.

4.1.2.2 Until at least 1 January 1995, equipment specifically designed for 25 kHz channel spacing shall be safeguarded with respect to its suitability for the Aeronautical Mobile (R) Service.

4.1.2.3 In the band 117.975-137 MHz, the lowest assignable frequency shall be 118 MHz and the highest 136.975 MHz.

4.1.3 Frequencies used for particular functions

4.1.3.1 *Emergency channel*

4.1.3.1.1 The emergency channel (121.5 MHz) shall be used only for genuine emergency purposes, as broadly outlined in the following:

a) to provide a clear channel between aircraft in distress or emergency and a ground station when the normal channels are being utilized for other aircraft;

b) to provide a VHF communication channel between aircraft and aerodromes, not normally used by international air services, in case of an emergency condition arising;

c) to provide a common VHF communication channel between aircraft, either civil or military, and between such aircraft, and surface services, involved in common search and rescue operations, prior to changing when necessary to the appropriate frequency;

d) to provide air-ground communication with aircraft when airborne equipment failure prevents the use of the regular channels;

e) to provide a channel for the operation of emergency locator transmitters (ELT), and for communication between survival craft and aircraft engaged in search and rescue operations;

f) to provide a common VHF channel for communication between civil aircraft and intercepting aircraft or intercept control units and between civil or intercepting aircraft and air traffic services units in the event of interception of the civil aircraft.

Note 1.— The use of the frequency 121.5 MHz for the purpose outlined in c) above is to be avoided if it interferes in any way with the efficient handling of distress traffic.

Note 2.— The current Radio Regulations make provisions that the aeronautical emergency frequency 121.5 MHz may also be used by mobile stations of the Maritime Mobile Service, using A3E emission to communicate on this frequency for safety purposes with stations of the Aeronautical Mobile Service (RR 593, 2990 and 2991).

4.1.3.1.2 The frequency of 121.5 MHz shall be provided at:

a) all area control centres and flight information centres;

b) aerodrome control towers and approach control offices serving international aerodromes and international alternate aerodromes; and

c) any additional location designated by the appropriate ATS authority,

where the provision of that frequency is considered necessary to ensure immediate reception of distress calls or to serve the purposes specified in 4.1.3.1.1 above.

Note.— Where two or more of the above facilities are collocated, provision of 121.5 MHz at one would meet the requirement.

4.1.3.1.3 The frequency of 121.5 MHz shall be available to intercept control units where considered necessary for the purpose specified in 4.1.3.1.1 f).

4.1.3.1.4 The emergency channel shall be guarded continuously during the hours of service of the units at which it is installed.

4.1.3.1.5 The emergency channel shall be guarded on a single channel simplex operation basis.

4.1.3.2 *Air-to-air communications channel*

4.1.3.2.1 Subject to regional air navigation agreement, an air-to-air VHF communications channel shall be designated to enable aircraft engaged in flights over remote and oceanic areas out of range of VHF ground stations to exchange necessary operational information and to facilitate the resolution of operational problems.

Note.— The assignment of the frequency to be used for the VHF air-to-air communications channel is intended to be co-ordinated whenever necessary between adjacent regions to ensure the most efficient and safe utilization of VHF frequencies.

4.1.4 Auxiliary frequencies for search and rescue operations

4.1.4.1 Where a requirement is established for the use of a frequency auxiliary to 121.5 MHz, as described in 4.1.3.1.1 c) above, the frequency 123.1 MHz shall be used.

4.1.5 Provisions concerning the deployment of VHF frequencies and the avoidance of harmful interference

4.1.5.1 In the case of those VHF facilities providing service up to the radio horizon, the geographical separation between facilities working on the same frequency shall, except where there is an operational requirement for the use of common frequencies for groups of facilities, be such that points at the protection heights and at the limit of the functional service range of each facility are separated by distances not less than the sum of distances from each of the points to its associated radio horizon.

4.1.5.2 In the case of those VHF facilities providing service beyond the radio horizon, except where there is an operational requirement for the use of common frequencies for groups of facilities, planning for co-channel operations shall be such that points at the protection heights and at the limits of the functional service area of each facility are separated by distances not less than the sum of distances from each point to its associated radio horizon.

Note 1.— The distance to the radio horizon from a station in an aircraft is normally given by the formula:

$$D = K\sqrt{h}$$

where D = *distance in nautical miles;*
h = *height of the aircraft station above earth;*
K = *(corresponding to an effective earth's radius of 4/3 of the actual radius)*
= *2.22 when* h *is expressed in metres; and*
= *1.23 when* h *is expressed in feet.*

Note 2.— In calculating the radio line-of-sight distance between a ground station and an aircraft station, the distance from the radio horizon of the aircraft station computed from Note 1 above must be added to the distance from the radio horizon of the ground station. In calculating the latter the same formula is employed, taking for h *the height of the ground station transmitting antenna.*

Note 3.— The criterion contained in 4.1.5.2 above is applicable in establishing minimum geographical separation between VHF facilities, with the object of avoiding co-channel air-to-air interference. Guidance material relating to the establishment of separation distances between ground stations and between aircraft and ground stations for co-channel operations is contained in Section 3 of Attachment A to Part II. Guidance material relating to adjacent channel frequency deployment is contained in Section 2 of Attachment A to Part II.

Note 4.— Guidance material on the interpretation of 4.1.5.1 and 4.1.5.2 above is contained in Attachment A to Part II.

4.1.5.3 The geographical separation between facilities working on adjacent channels shall be such that points at the protection heights and at the limit of the functional service range of each facility are separated by a distance sufficient to ensure operations free from harmful interference.

Note.— Guidance material covering separation distances and related system characteristics is contained in Attachment A to Part II.

4.1.5.4 The protection height shall be a height above a specified datum associated with a particular facility, such that below it harmful interference is improbable.

4.1.5.5 The protection height to be applied to functions or to specific facilities shall be determined regionally, taking into consideration the following factors:

a) the nature of the service to be provided;

b) the air traffic pattern involved;

c) the distribution of communication traffic;

d) the availability of frequency channels in airborne equipment;

e) probable future developments.

4.1.5.6 **Recommendation.—** *Where the protection heights determined are less than those operationally desirable, separation between facilities operating on the same frequency should not be less than that necessary to ensure that an aircraft at the limit of the functional service range and the operationally desirable protection height of one facility does not come above the radio horizon with respect to adjacent facilities.*

Note.— The effect of this recommendation is to establish a geographical separation distance below which harmful interference is probable.

4.1.5.7 The geographical separation between VHF VOLMET stations shall be determined regionally and, generally, shall be such that operations free from harmful interference are secured at the highest altitude flown by aircraft in the area concerned.

Note.— Guidance material on the interpretation of 4.1.5.7 above is contained in Attachment A to Part II.

4.1.5.8 Frequencies in the aeronautical mobile VHF band used for national services, unless world-wide or regionally allotted to this specific purpose, shall be so deployed that minimum interference is caused to facilities for the international air services in this band.

4.1.5.9 **Recommendation.—** *The problem of inter-State interference on frequencies allotted world-wide or on a regional basis to national services, should be resolved by consultation between the Administrations concerned.*

4.1.5.10 The communication coverage provided by a VHF ground transmitter shall, in order to avoid harmful interference to other stations, be kept to the minimum consistent with the operational requirement for the function.

4.1.5.11 **Recommendation.—** *For ground VHF facilities which provide service beyond the radio horizon, any spurious or harmonic radiation outside the band plus or minus 250 kHz from the assigned carrier frequency should not exceed an effective radiated power of 1 mW in any azimuth.*

4.1.6 Equipment requirements

Note 1.— Frequency tolerances to which stations operating in the aeronautical mobile band (117.975-137 MHz) must conform are contained in Appendix 3 to the Radio Regulations. Tolerances for transmitters used for aeronautical services are not mentioned in this Annex, except in those cases where tighter tolerances than those contained in the Radio Regulations are required (e.g. the equipment specifications in Part I contain several such instances).

Note 2.— The frequency tolerance applicable to individual components of a multi-carrier or similar system will be determined by the characteristics of the specific system.

4.1.6.1 **Recommendation.—** *The antenna gain of an extended range VHF facility should preferably be such as to ensure that, beyond the limits of plus or minus 2 Φ about the centre line of the angular width Φ of the area to be served, it does not exceed 3 dB above that of a dipole. But, in any case, it should be such as to ensure freedom from harmful interference with other radio services.*

Note 1.— The actual azimuth, the angular width of the service area, and the effective radiated power would have to be taken into account in each individual case.

Note 2.— Guidance material on the interpretation of 4.1.6.1 above is contained in Attachment A to Part II.

4.1.7 Method of operation

4.1.7.1 Single channel simplex operation shall be used in the VHF band 117.975 MHz to 136 MHz at all stations providing for aircraft engaged in international air navigation.

4.1.7.2 In addition to the above, the ground-to-air voice channel associated with an ICAO standard radio navigational aid may be used, subject to regional agreement, for broadcast or communication purposes or both.

4.1.8 Plan of assignable VHF radio frequencies for use in the international aeronautical mobile service

Introduction

This plan designates the list of frequencies available for assignment, together with provision for the use by the Aeronautical Mobile (R) Service of all frequencies with a channel *spacing of 25 kHz, with the frequencies in Group A continuing to be used wherever they provide a sufficient number to meet the operational requirements.*

The plan provides that the total number of frequencies required in any region would be determined regionally. The effect of this will be that frequencies assignable in a particular region may be restricted to a limited number of the frequencies in the list, the actual number being selected as outlined herein.

In order that the assignable frequencies may be co-ordinated between regions as far as practicable, the plan requires that, whenever the number of frequencies contained in Group A of 4.1.8.1.2 below is sufficient to meet the requirements in a region, the frequencies of this Group be used in the sequence commencing with 118 MHz. This ensures that all regions will have in common the frequencies used in the region requiring the least number of frequencies and, in respect to any two regions, the region with the greater number will have in use all the frequencies used by the other. Group A provides for frequency planning based on 100 kHz channel spacing.

Group B of the list at 4.1.8.1.2 below contains the frequencies in the band 117.975-132 MHz ending in 50 kHz. Together with the frequencies in Group A, they provide for frequency planning based on 50 kHz channel spacing. In Group C are listed the frequency channels in the band 132-137 MHz based upon 50 kHz channel spacing. Group D contains the frequency channels in the band 132-137 MHz ending in 25 kHz, and Group E similarly lists the frequency channels in the band 117.975-132 MHz. The utilization of the channels in Groups B, C, D and E is explained below.

Whenever the number of frequencies required in a particular region exceeds the number in Group A, frequencies may be selected from the other Groups taking into account the provisions of 4.1.8.1 below with respect to the use of channels based on 25 kHz channel spacing and, with regard to the band 132-137 MHz, the provisions of the Radio Regulations (see Introduction to 4.1 above). Although for Groups B, C, D and E a preferred order of selection is not indicated, regional planning may require a particular selection of frequencies from these Groups in order to cater for specific regional circumstances. This may apply particularly to the utilization of frequencies from the band 132-137 MHz for reasons of available airborne equipment and/or availability of particular frequency channels for the Aeronautical Mobile (R) Service. It may also be found that, in a particular region, it is desirable to select frequencies from Group B first, before selecting frequencies from Groups C, D or E.

In many regions particular frequencies have already been assigned for particular functions as, for instance, aerodrome or approach control. The plan does not make such assignments (except in respect to the emergency channel and ground service frequencies), such action being taken regionally if considered desirable.

4.1.8.1 The frequencies in the band 117.975 MHz to 136 MHz for use in the Aeronautical Mobile (R) Service shall be selected from the list in 4.1.8.1.2 below.

Note.— Frequencies between 136 and 136.975 MHz are not available for international use before 1990.

4.1.8.1.1 When the number of frequencies required in a particular region does not exceed the number of frequencies contained in Group A of 4.1.8.1.2 below, the frequencies to be used shall be selected in sequence, in so far as practicable, from those of Group A of 4.1.8.1.2 below.

4.1.8.1.2 *List of assignable frequencies*

The list of assignable frequencies is shown on the following pages.

4.1.8.1.3 **Recommendation.—** *Frequencies for operational control communications may be required to enable aircraft operating agencies to meet the obligations prescribed in Annex 6, Part I, in which case they should be selected from the bands 128.825-132.025 MHz. These frequencies should be chosen, in so far as practicable, from the upper end of the band and in sequential order.*

Note.— It is recognized that the assignment of such frequencies and the licensing of the operation of the related facilities are matters for national determination. However, in regions where a problem exists with respect to the provision of frequencies for operational control purposes, it may be advantageous if States endeavour to co-ordinate the requirements of aircraft operating agencies for such channels prior to regional meetings.

4.1.8.2 The frequencies that may be allotted for use in the Aeronautical Mobile (R) Service in a particular region shall be limited to the number determined as being necessary for operational needs in the region.

Note.— The number of frequencies required in a particular region is normally determined by the Council on the recommendations of Regional Air Navigation Meetings. The capabilities of VHF airborne equipment known to be widely used in the region will be taken into account in this determination.

4.2 Utilization in the band 108-117.975 MHz

4.2.1 The block allotment of the frequency band 108-117.975 MHz shall be as follows:

— *Band 108-111.975 MHz:*

a) ILS in accordance with 4.2.2 below and Part I, 3.1.5;

b) VOR provided that:

1) no harmful adjacent channel interference is caused to ILS;

2) only frequencies ending in either *even tenths* or *even tenths plus a twentieth* of a megahertz are used.

— *Band 111.975-117.975 MHz:* VOR

Frequency (MHz)	*Annotations*
121.5	Emergency frequency
123.1	Auxiliary frequency SAR
121.60	Reserved for aerodrome surface communications [see Table 4-1, Item c)]
121.65	
121.70	
121.75	
121.80	
121.85	
121.90	
121.95	
121.625	
121.675	
121.725	
121.775	
121.825	
121.875	
121.925	
121.975	

GROUP A

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
118.00	123.80	127.40
118.10	123.90	127.50
118.20	124.00	127.60
118.30	124.10	127.70
118.40	124.20	127.80
118.50	124.30	127.90
118.60	124.40	128.00
118.70	124.50	128.10
118.80	124.60	128.20
118.90	124.70	128.30
119.00	124.80	128.40
119.10	124.90	128.50
119.20	125.00	128.60
119.30	125.10	128.70
119.40	125.20	128.80
119.50	125.30	128.90
119.60	125.40	129.00
119.70	125.50	129.10
119.80	125.60	129.20
119.90	125.70	129.30
120.00	125.80	129.40
120.10	125.90	129.50
120.20	126.00	129.60
120.30	126.10	130.90
120.40	126.20	131.00
120.50	126.30	131.10
120.60	126.40	131.20
120.70	126.50	131.30
120.80	126.60	131.40
120.90	126.70	131.50
121.00	126.80	131.60
121.10	126.90	131.70
121.20	127.00	131.80
121.30	127.10	131.90
121.40	127.20	
123.70	127.30	

GROUP B

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
118.05	123.85	127.35
118.15	123.95	127.45
118.25	124.05	127.55
118.35	124.15	127.65
118.45	124.25	127.75
118.55	124.35	127.85
118.65	124.45	127.95
118.75	124.55	128.05
118.85	124.65	128.15
118.95	124.75	128.25
119.05	124.85	128.35
119.15	124.95	128.45
119.25	125.05	128.55
119.35	125.15	128.65
119.45	125.25	128.75
119.55	125.35	128.85
119.65	125.45	128.95
119.75	125.55	129.05
119.85	125.65	129.15
119.95	125.75	129.25
120.05	125.85	129.35
120.15	125.95	129.45
120.25	126.05	129.55
120.35	126.15	129.65
120.45	126.25	130.95
120.55	126.35	131.05
120.65	126.45	131.15
120.75	126.55	131.25
120.85	126.65	131.35
120.95	126.75	131.45
121.05	126.85	131.55
121.15	126.95	131.65
121.25	127.05	131.75
121.35	127.15	131.85
123.75	127.25	131.95

GROUP C

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
132.00	132.95	133.90
132.05	133.00	133.95
132.10	133.05	134.00
132.15	133.10	134.05
132.20	133.15	134.10
132.25	133.20	134.15
132.30	133.25	134.20
132.35	133.30	134.25
132.40	133.35	134.30
132.45	133.40	134.35
132.50	133.45	134.40
132.55	133.50	134.45
132.60	133.55	134.50
132.65	133.60	134.55
132.70	133.65	134.60
132.75	133.70	134.65
132.80	133.75	134.70
132.85	133.80	134.75
132.90	133.85	134.80

Group C *(cont.)*

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
134.85	135.25	135.65
134.90	135.30	135.70
134.95	135.35	135.75
135.00	135.40	135.80
135.05	135.45	135.85
135.10	135.50	135.90
135.15	135.55	135.95
135.20	135.60	

GROUP D

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
132.025	134.025	136.000
132.075	134.075	136.025
132.125	134.125	136.050
132.175	134.175	136.075
132.225	134.225	136.100
132.275	134.275	136.125
132.325	134.325	136.150
132.375	134.375	136.175
132.425	134.425	136.200
132.475	134.475	136.225
132.525	134.525	136.250
132.575	134.575	136.275
132.625	134.625	136.300
132.675	134.675	136.325
132.725	134.725	136.350
132.775	134.775	136.375
132.825	134.825	136.400
132.875	134.875	136.425
132.925	134.925	136.450
132.975	134.975	136.475
133.025	135.025	136.500
133.075	135.075	136.525
133.125	135.125	136.550
133.175	135.175	136.575
133.225	135.225	136.600
133.275	135.275	136.625
133.325	135.325	136.650
133.375	135.375	136.675
133.425	135.425	136.700
133.475	135.475	136.725
133.525	135.525	136.750
133.575	135.575	136.775
133.625	135.625	136.800
133.675	135.675	136.825
133.725	135.725	136.850
133.775	135.775	136.875
133.825	135.825	136.900
133.875	135.875	136.925
133.925	135.925	136.950
133.975	135.975	136.975

Note.—Frequencies between 136 and 136.975 MHz are not available for international use before 1990.

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GROUP E

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
118.025	119.225	120.425
118.075	119.275	120.475
118.125	119.325	120.525
118.175	119.375	120.575
118.225	119.425	120.625
118.275	119.475	120.675
118.325	119.525	120.725
118.375	119.575	120.775
118.425	119.625	120.825
118.475	119.675	120.875
118.525	119.725	120.925
118.575	119.775	120.975
118.625	119.825	121.025
118.675	119.875	121.075
118.725	119.925	121.125
118.775	119.975	121.175
118.825	120.025	121.225
118.875	120.075	121.275
118.925	120.125	121.325
118.975	120.175	121.375
119.025	120.225	123.725
119.075	120.275	123.775
119.125	120.325	123.825
119.175	120.375	123.875

Group E *(cont.)*

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
123.925	125.075	126.225
123.975	125.125	126.275
124.025	125.175	126.325
124.075	125.225	126.375
124.125	125.275	126.425
124.175	125.325	126.475
124.225	125.375	126.525
124.275	125.425	126.575
124.325	125.475	126.625
124.375	125.525	126.675
124.425	125.575	126.725
124.475	125.625	126.775
124.525	125.675	126.825
124.575	125.725	126.875
124.625	125.775	126.925
124.675	125.825	126.975
124.725	125.875	127.025
124.775	125.925	127.075
124.825	125.975	127.125
124.875	126.025	127.175
124.925	126.075	127.225
124.975	126.125	127.275
125.025	126.175	127.325

Group E *(cont.)*

Frequency (MHz)	*Frequency (MHz)*	*Frequency (MHz)*
127.375	128.525	129.675
127.425	128.575	130.925
127.475	128.625	130.975
127.525	128.675	131.025
127.575	128.725	131.075
127.625	128.775	131.125
127.675	128.825	131.175
127.725	128.875	131.225
127.775	128.925	131.275
127.825	128.975	131.325
127.875	129.025	131.375
127.925	129.075	131.425
127.975	129.125	131.475
128.025	129.175	131.525
128.075	129.225	131.575
128.125	129.275	131.625
128.175	129.325	131.675
128.225	129.375	131.725
128.275	129.425	131.775
128.325	129.475	131.825
128.375	129.525	131.875
128.425	129.575	131.925
128.475	129.625	131.975

Note.— Guidance material relating to the distance separation required to prevent harmful interference between ILS and VOR when using the band 108-111.975 MHz is to be found in Section 3 of Attachment C to Part I.

4.2.2 For regional assignment planning, the frequencies for ILS facilities shall be selected in the following order:

a) localizer channels ending in *odd tenths* of a megahertz and their associated glide path channels;

b) localizer channels ending in *odd tenths plus a twentieth* of a megahertz and their associated glide path channels.

4.2.2.1 ILS channels identified by localizer frequencies ending in an *odd tenth plus one twentieth* of a megahertz in the band 108-111.975 MHz shall be permitted to be utilized on the basis of regional agreement when they become applicable in accordance with the following:

a) for restricted use commencing 1 January 1973;

b) for general use on or after 1 January 1976.

Note.— See Note to 4.2.3.1 below.

4.2.3 For regional assignment planning, the frequencies for VOR facilities shall be selected in the following order:

a) frequencies ending in *odd tenths* of a megahertz in the band 111.975-117.975 MHz;

b) frequencies ending in *even tenths* of a megahertz in the band 111.975-117.975 MHz;

c) frequencies ending in *even tenths* of a megahertz in the band 108-111.975 MHz;

d) frequencies ending in *50 kHz* in the band 111.975-117.975 MHz, except as provided in 4.2.3.1 below;

e) frequencies ending in *even tenths plus a twentieth* of a megahertz in the band 108-111.975 MHz except as provided in 4.2.3.1 below.

4.2.3.1 Frequencies for VOR facilities ending in *even tenths plus a twentieth* of a megahertz in the band 108-111.975 MHz and all frequencies ending in *50 kHz* in the band 111.975-117.975 MHz shall be permitted to be utilized on the basis of a regional agreement when they have become applicable in accordance with the following:

a) in the band 111.975-117.975 MHz for restricted use;

b) for general use in the band 111.975-117.975 MHz at a date fixed by the Council but at least one year after the approval of the regional agreement concerned;

c) for general use in the band 108-111.975 MHz at a date fixed by the Council but giving a period of two years or more after the approval of the regional agreement concerned.

Note.— "Restricted use", where mentioned in 4.2.2.1 a) and 4.2.3.1 a) above, is intended to refer to the limited use of the frequencies by only suitably equipped aircraft and in such a manner that:

a) the performance of ILS or VOR equipment not capable of operating on these frequencies will be protected from harmful interference;

b) a general requirement for the carriage of ILS or VOR airborne equipment capable of operation on these frequencies will not be imposed; and

c) operational service provided to international operators using 100 kHz airborne equipment is not derogated.

4.2.4 To protect the operation of airborne equipment during the initial stages of deploying VORs utilizing 50 kHz channel spacing in an area where the existing facilities may not fully conform with the Standards in Part I, Chapter 3, all existing VORs within interference range of a facility utilizing 50 kHz channel spacing shall be modified to comply with the provisions of Part I, 3.3.5.7.

4.2.5 *Frequency deployment.* The geographical separation between facilities operating on the same and adjacent frequencies shall be determined regionally and shall be based on the following criteria:

a) the required functional service radio of the facilities;

b) the maximum flight altitude of the aircraft using the facilities;

c) the desirability of keeping the minimum IFR altitude as low as the terrain will permit.

Note.— Guidance material on this subject is contained in the Attachments to this Annex.

4.2.6 **Recommendation.—** *To alleviate frequency congestion problems at locations where two separate ILS facilities serve opposite ends of the same runway or different runways at the same airport, the assignment of identical ILS localizer and glide path paired frequencies should be permitted provided that:*

a) the operational circumstances permit;

b) each localizer is assigned a different identification signal;

c) arrangements are made whereby the localizer and glide path not in operational use cannot radiate.

Note.— The Standards in Part I, 3.1.2.7.2 and 3.1.3.9, specify the equipment arrangements to be made.

4.3 Utilization in the band 960-1 215 MHz for DME

Note.— Guidance on the frequency planning of channels for DME systems is given in Attachment C to Part I, 7.3.8.

4.3.1 DME operating channels bearing the suffix "X" or "Y" in Table A of Part I, Chapter 3 shall be chosen on a general basis without restriction.

Note.— The channel pairing plan provides for the use of certain Y channels with either VOR or MLS. The guidance material at 7.3.8 includes specific provisions relating to situations where the same, or adjacent channel, is used in the same area for both systems.

4.3.2 DME channels bearing the suffix "W" or "Z" in Table A of Part I, Chapter 3 shall be chosen, on the basis of regional agreement when they become applicable in accordance with the following:

a) for restricted regional use on or after, whichever is the later, of:

1) 1 January 1989; or

2) a date prescribed by the Council giving a period of two years or more following approval of the regional agreement concerned;

b) for general use on or after, whichever is the later, of:

1) 1 January 1995; or

2) a date prescribed by the Council giving a period of two years or more following approval of the regional agreement concerned.

Note.— "Restricted use" is intended to refer to the limited use of the channel by only suitably equipped aircraft and in such a manner that:

a) the performance of existing DME equipment not capable of operating on these multiplexed channels will be protected from harmful interference;

b) a general requirement for the carriage of DME airborne equipment capable of operating on these multiplexed channels will not be imposed; and

c) operational service provided to international operators using existing DME equipment without the multiplexed channel capability is not derogated.

4.3.3 For regional assignment planning, the channels for DME associated with MLS shall be selected from Table 4-2.

4.3.3.1 *Groups 1-5.* These DME channels shall be permitted to be used generally. In selecting channels for assignment purposes the following rules are applicable:

a) when an MLS/DME is intended to operate on a runway in association with an ILS, the DME channel, if possible, shall be selected from Group 1 or 2 and paired with the ILS frequency as indicated in the DME channelling and pairing table in Table A of Part I, Chapter 3. In cases where the composite frequency protection cannot be satisfied for all three components, the MLS channel may be selected from Group 3, 4 or 5;

Table 4-2

Group	*DME channels*	*Associated paired VHF channels*	*Remarks*	*Assignment procedure*
1	EVEN 18X to 56 X	ILS 100 kHz spacings	Would normally be used if a single DME is paired with ILS and is part of MLS	for general use (see 4.3.1)
2	EVEN 18Y to 56Y	ILS 50 kHz spacings		
3	EVEN 80Y to 118Y	VOR 50 kHz spacings Odd tenths of a MHz		
4	ODD 17Y to 55Y	VOR 50 kHz spacings		
5	ODD 81Y to 119Y	VOR 50 kHz spacings Even tenths of a MHz		
6	EVEN 18W to 56W	No associated paired VHF channel		for later use (see 4.3.2)
7	EVEN 18Z to 56Z	No associated paired VHF channel		
8	EVEN 80Z to 118Z	No associated paired VHF channel		
9	ODD 17Z to 55Z	No associated paired VHF channel		
10	ODD 81Z to 119Z	No associated paired VHF channel		

Note.— DME channels in Groups 1 and 2 may be used in association with ILS and/or MLS. DME channels in Groups 3, 4 and 5 may be used in association with VOR or MLS.

b) when an MLS/DME is intended to operate on a runway without the coexistence of an ILS, the DME channel to be used shall preferably be selected from Group 3, 4 or 5.

4.3.3.2 *Groups 6-10.* These DME channels shall be permitted to be used on the basis of a regional agreement when they have become applicable in accordance with the conditions specified at 4.3.2 above.

4.3.4 **Recommendation.—** *Co-ordination of regional DME channel assignments should be effected through ICAO.*

4.4 Utilization of the frequency band 5 031-5 091 MHz

Note.— Guidance material on the frequency protection planning of MLS facilities is contained in Attachment G to Part I, 9.

4.4.1 The MLS channels shall be selected from the 200 channels as specified at Table A of Part I, Chapter 3.

4.4.2 For regional planning purposes MLS channels shall be selected in accordance with the conditions specified in 4.3.3 above for the associated DME facility.

ATTACHMENTS TO ANNEX 10 — VOLUME I

ATTACHMENT A TO PART I. — RECOMMENDATIONS OF COUNCIL CONCERNING THE UTILIZATION OF FACILITIES, RESEARCH, DEVELOPMENT AND EVALUATION

The Council, at the Sixth meeting of its Seventh Session (30 May 1949), after having adopted Annex 10, resolves that the following special Recommendations be communicated to Contracting States.

1. Utilization of facilities not covered by Annex 10

1.1 Short-distance radio aids to navigation and aids to final approach and landing

The Council recommends that:

a) systems and equipment for short-distance radio aids to navigation or radio aids to final approach and landing, not specified in Annex 10, be retained, or extended as necessary, to meet the immediate requirements of international civil aviation, pending the availability of preferred systems, or when installation of the standard aid is not practicable;

b) non-visual aids to approach and landing that can be used in whole or in part by aircraft and equipment designed for use with the ILS, but which inherently are not capable of meeting in all respects the Standards contained in Part I, Chapter 3, of Annex 10, should be adjusted to approximate as nearly as practicable to these Standards;

c) after the installation of aids at particular locations, in compliance with Annex 10, existing types of aids be retained or installed at such locations and be maintained in use so long as their service to international civil aviation can be justified economically.

1.2 Other aids

The Council recommends that systems and equipment at present in existence to meet requirements other than those for short-distance and long-distance radio aids to navigation and aids to final approach and landing be retained, or extended as necessary, to meet the requirements of international civil aviation pending the development of Standards and Recommended Practices for such aids.

2. Research, development and evaluation of radio aids to air navigation

2.1 General

2.1.1 The Council considers that continued development and operational improvement of the aids to navigation prescribed in the Annex to the Convention are essential to the stability of such Standards. Furthermore, research and development and operational evaluation of further aids to navigation, which may at some time in the future culminate in Standards and Recommended Practices, are essential to progress in aviation.

2.1.2 The Council recommends that the attainment of complete satisfaction of the functional requirements as approved from time to time by the Council be the objective guiding all research and development.

2.2 Aids to final approach and landing

2.2.1 The Council considers that, in the field of non-visual aids to final approach and landing, a promising line of development lies in the field of microwave techniques, and recommends that investigation along this line, and along other promising lines of development in this field, be pursued actively with the aim of producing a complete landing system that will satisfy the functional requirements. The development of ground search primary radar should be continued to produce equipment that will meet the functional requirements of such aids, although standardization may not be necessary.

The following Recommendation was initially made by the Council at the Seventh meeting of its Twenty-eighth Session, 11 May 1956, and was revised by the Council at the Twelfth meeting of its Fifty-ninth Session, 12 December 1966:

2.2.2 The Council recommends that, in respect of the siting of the inner and middle marker beacons contained in Part I, Chapter 3 of Annex 10, Contracting States give attention to the views expressed in the reports of the Second and Fourth Air Navigation Conferences as follows:

2.2.2.1 From the Second Air Navigation Conference:

Experience of operation of ILS has shown that the inner marker does not provide the pilot with any information *essential* to a successful approach (it is not intended to imply that the information it provides is of no service to the pilot in some circumstances).

2.2.2.2 From the Fourth Air Navigation Conference:

Inner and middle markers sited at any particular site may not fully satisfy the operational requirements. In this case, the ideal solution may lie in the availability of continuous information regarding distance from the threshold. The means for providing such an ideal solution to the problem are under study in some States. One State was already making use of this means for Category I operations.

2.3 Short-distance aids to air navigation

The Council recommends that:

a) in the field of short-distance radio aids to air navigation, the development and operational improvement of the CW omni-range and DME be continued with the objective of satisfying completely the functional requirements;

b) if a Contracting State determines that there is a probability that such aids as the VHF multi-track pulse range, the GEE system or other aids can satisfy more fully the functional requirements that the CW omni-range and DME, their development and operational evaluation be continued or undertaken;

c) serious consideration be given to development which will make possible the integration of the short-distance aids and aids to final approach and landing.

2.4 Long-distance aids to air navigation

2.4.1 The Council considers that the following material, developed by the Fourth Air Navigation Conference, should be used as a basis for operational and technical planning and as guidance for related research and development activity in the field of long-distance navigation:

Operational requirements for long-distance navigating capability

1. *Foreword*

1.1 The rapid technological development of self-contained* aids has resulted in significant changes in the possible means of satisfying the requirements for long-distance navigation. There is a growing realization that, for certain operations, navigation may be conducted solely by self-contained aids. On the other hand, station-referenced* aids may continue to play a role, either as a prime navaid or as part of the complete navigation system. The significance of the above is that a complete long-distance navigation system must now be considered to be either a self-contained or a station-referenced aid, or a combination of both. Although certain aircraft may be equipped to use only one of the two types, others will be equipped to use both. The term "system", as used in these operational requirements, is intended to describe the total navigational capability of an aircraft, however derived. The complexity of the system required will be determined by the environment in which it is to be used.

**Note.— "Station-referenced" aids are understood to include "ground-referenced" or "satellite-referenced" aids.*

"Self-contained" aids are understood to include "Doppler radar", "inertial navigation", and "celestial navigation" or combinations thereof.

1.2 The statement of operational requirements recognizes that:

1.2.1 A basic requirement of any national or world-wide system is that it must be suitable for use in all the aircraft types which may require the service.

1.2.2 There are two requirements for navigational capability: one, that of conducting a flight from one place to another safely and economically, and the other, which arises from the needs of ATS, including those associated with SAR, in certain areas. The relative severity of these two requirements will vary with place and time.

1.2.3 The required level of performance of the navigation system for long-distance operation is not constant throughout the world since the required position and tracking accuracy of the system is a function of the density of traffic in each particular ATS environment, which itself is subject to change with time.

1.2.4 No one set of operational requirements, even though it meets the basic requirement of safety, can adequately reflect the many different combinations of operating conditions encountered in various parts of the world, in that the requirements applicable to the most exacting region may be rather extravagant when applied to others.

1.2.5 The system should be capable of integration with the flight control system of the aircraft to provide automatic tracking.

1.2.6 Requirements for flight deck presentation of navigation information should be considered, as well as the more usual features such as position fixing, accuracy, reliability, etc.

1.2.7 The long-distance system should be used primarily along routes where short-distance station-referenced aids do not provide the desired service, although it may also be applicable in certain short-distance environments.

1.3 The following conclusions were reached in developing the operational requirements:

1.3.1 That in the operational requirements as presented, there is no requirement for a world standard station-referenced aid, either for use alone or with self-contained capability at this time.

1.3.2 In the future a need may arise for a world standard station-referenced aid but this is by no means certain. Research and development should, however, continue to carry out feasibility studies to ascertain the possible future need for such an aid and the means of fulfilment.

1.3.3 There appears no need for international standardization of self-contained aids, provided that they meet agreed requirements for accuracy and reliability for aircraft navigation and air traffic separation.

1.3.4 To support separation standards even smaller than those now envisaged for the most critical area, research and development should be encouraged to carry out feasibility studies. An accuracy figure of 9.3 km (5 NM) standard deviation has been suggested as a goal.

1.3.5 The most critical accuracy requirement is considered to be associated with the North Atlantic where need for a lateral separation standard of 111 km (60 NM) has been envisaged, based on current traffic forecasts. In other cases, the most critical requirement arises when the long-distance system is used in transition to critical continental routes. For non-critical areas, the accuracy should not be less than that necessary to permit safe, smooth integration with a short-distance navigation aid.

1.3.6 In assessing collision risk, it is unrealistic to assume that all of the protection should necessarily be provided in one of the dimensions alone. Achievement of safe separation is a three-dimensional consideration. Separation standards in each of the three dimensions provide the required protection, and this fact should be considered in assessing navigation accuracy requirements in the development of separation standards.

1.3.7 Separation standards provide full protection against normal errors in the navigation system but not against all gross errors. Maximum protection against blunders which can often cause gross errors can be achieved by attacking their causes and reducing their occurrence. This can be facilitated by the development and application of appropriate procedures, and by providing cockpit presentation of navigation information that has the continuity and consistency to make blunders unlikely, or at least to ensure early blunder detection.

2. *Statement of operational requirements*

2.1 *Coverage.* The system should be capable of providing service over all the used airspace of the world, regardless of time, weather, altitude, terrain and propagation characteristics.

2.2 *Reliability/Integrity.* The over-all integrity of the system, including the presentation of information in the cockpit, shall be as near 100 per cent as is achievable and, to the extent feasible, should provide flight deck warnings in the event of failure, malfunction or interruption.

Note.— It is recognized that, in the various arrangements which may be employed to meet the total requirement, many different ways of approaching the reliability requirement could be utilized, including the use of such concepts as equipment duplication, monitoring and system combinations.

2.3 *Ambiguity.* The navigational information provided by the system must be free from unresolved ambiguities of operational significance.

2.4 *Capacity.* Any station-referenced component of the total navigational system shall be capable of providing navigational information simultaneously to all aircraft which require access to it.

2.5 *Presentation.* The system must have the capability of providing the pilot with a continuously available indication of present position in an operationally meaningful manner, and with information enabling him to follow the designated track with the accuracy required and to estimate further progress of the flight.

2.6 *Compatibility.* The long-distance navigation system must, from an operational viewpoint, permit smooth integration with navigation requirements applicable in other phases of flight.

2.7 *Accuracy.* The system must provide the navigational capability needed in specific areas and permit the application of the horizontal separation minima necessary so as to accommodate present and forecast traffic over the next decade.

Note 1.— The accuracy most likely to be required in the most critical specific area (North Atlantic) is approximately 18.5 km (10 NM) standard deviation in order to support a 111 km (60 NM) lateral separation standard.

Note 2.— The above values take into account the need to reduce blunders. In the opinion of some States, when considering this aspect, for at least 99.95 per cent of the time, the aircraft should not be farther from the assigned track than a distance equivalent to half the lateral separation standard in use.

2.5 Other aids

The Council considers that extensive development and evaluation are needed in the fields of aids for use in the movement area, aids to traffic control and in aids to collision prevention.

2.6 Exchange of information

2.6.1 The Council considers that the prompt and efficient utilization of improved techniques would be aided by an exchange of current information on new air navigation systems and on the results of researches relating thereto.

2.6.2 The Council recommends that such information should be communicated to the Secretariat of ICAO, for dissemination to Contracting States and interested groups within those States.

21/11/85

ATTACHMENT B TO PART I. — GUIDANCE MATERIAL RELATED TO THE SECONDARY SURVEILLANCE RADAR (SSR) SYSTEM CHARACTERISTICS

Note.— Updated guidance material related to the Secondary Surveillance Radar (SSR) and SSR Mode S systems characteristics will be incorporated into this Attachment in due course.

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ATTACHMENT C TO PART I.— INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE STANDARDS AND RECOMMENDED PRACTICES IN ANNEX 10

1. Introduction

The material in this Attachment is intended for guidance and clarification purposes and is not to be considered as part of the specifications or as part of the Standards and Recommended Practices contained in this Annex.

For the clarity of understanding of the text that follows and to facilitate the ready exchange of thoughts on closely associated concepts, the following definitions are included:

Definitions relating to the Instrument Landing System (ILS)

Note.— The terms given here are in most cases capable of use either without prefix or in association with the prefixes "nominal" and "indicated". Such usages are intended to convey the following meanings:

The prefix "nominal": *the design characteristics of an element or concept.*

No prefix: *the achieved characteristics of an element or concept.*

The prefix "indicated": *the achieved characteristics of an element or concept, as indicated on a receiver (i.e. including the errors of the receiving installation).*

Localizer system	ILS Glide path system

Slant course line. The line formed at the intersection of the course surface and the plane of the nominal ILS glide path.

False ILS glide path. (ILS Glide path system) Those loci of points in the vertical plane containing the runway centre line at which the DDM is zero, other than that locus of points forming the ILS glide path.

Displacement error. The angular or linear displacement of any point of zero DDM with respect to the nominal course line or the nominal ILS glide path respectively.

Linearity sector. A sector containing the course line or ILS glide path, within a course sector or an ILS glide path sector, respectively, in which the increment of DDM per unit of displacement remains substantially constant.

Low DDM zone. A zone outside a course sector or an ILS glide path sector in which the DDM is less than the minimum value specified for the zone.

Note.— The minimum values of DDM related to such zones are specified in Part I, 3.1.3.7 and 3.1.5.6.

Plane of the nominal ILS glide path. A plane perpendicular to the vertical plane of the runway centre line extended and containing the nominal ILS glide path.

Definitions relating to the received radiation pattern

Indicated course line. The locus of points in any horizontal plane at which the receiver indicator deflection is zero.

Indicated ILS glide path. The locus of points in the vertical plane containing the runway centre line at which the receiver indicator deflection is zero.

Indicated slant course line. The line formed at the intersection of the indicated course surface and the plane of the nominal ILS glide path.

Indicated ILS glide path angle. The angle above the horizontal plane of the indicated ILS glide path.

Indicated course sector. A sector in any horizontal plane containing the indicated course line in which the receiver indicator deflection remains within full-scale values.

Indicated ILS glide path sector. The sector containing the indicated ILS glide path in which the receiver indicator deflection remains within full-scale values.

Localizer course bend. A course bend is an aberration of the localizer course line with respect to its nominal position.

ILS glide path bend. An ILS glide path bend is an aberration of the ILS glide path with respect to its nominal position.

Incremental sensitivity. The increment of receiver indicator current per unit change of receiver antenna displacement from the nominal course line or nominal ILS glide path.

Flat zone. A zone within an indicated course sector or an indicated ILS glide path sector in which the slope of the sector characteristic curve is zero.

Reversal zone. A zone within an indicated course sector or an indicated ILS glide path sector in which the slope of the sector characteristic curve is negative.

2. Material concerning ILS installations

2.1 Operational objectives, design and maintenance objectives, and definition of course structure for Facility Performance Categories

2.1.1 The Facility Performance Categories defined in Part I, 3.1.1 have operational objectives as follows:

Category I operation: A precision instrument approach and landing with a decision height not lower than 60 m (200 ft) and with either a visibility not less than 800 m or a runway visual range not less than 550 m.

Category II operation: A precision instrument approach and landing with a decision height lower than 60 m (200 ft) but not lower than 30 m (100 ft), and a runway visual range not less than 350 m.

Category IIIA operation: A precision instrument approach and landing with:

a) a decision height lower than 30 m (100 ft), or no decision height; and

b) a runway visual range not less than 200 m.

Category IIIB operation: A precision instrument approach and landing with:

a) a decision height lower than 15 m (50 ft), or no decision height; and

b) a runway visual range less than 200 m but not less than 50 m.

Category IIIC operation: A precision instrument approach and landing with no decision height and no runway visual range limitations.

2.1.2 Relevant to these objectives will be the type of aircraft using the ILS and the capabilities of the aircraft flight guidance system(s). Modern aircraft fitted with equipment of appropriate design are assumed in these objectives. In practice, however, operational capabilities may extend beyond the specific objectives given at 2.1.1 above.

2.1.2.1 The availability of fail-passive and fail-operational flight guidance systems in conjunction with an ILS ground system which provides adequate guidance with an appropriate level of continuity of service and integrity for the particular case can permit the attainment of operational objectives which do not coincide with those described at 2.1.1 above.

2.1.2.2 For modern aircraft fitted with automatic approach and landing systems the routine use of such systems is being encouraged by aircraft operating agencies in conditions where the progress of the approach can be visually monitored by the flight crew. For example, such operations may be conducted on Facility Performance Category I — ILS where the guidance quality and coverage exceeds basic requirements given at Part I, 3.1.3.4.1 and extends down to the runway.

2.1.2.3 In order to fully exploit the potential benefits of modern aircraft automatic flight control systems there is a related need for a method of describing ground based ILS more completely than can be achieved by reference solely to the Facility Performance Category. This is achieved by the ILS classification system using the three designated characters. It provides a description of those performance aspects which are required to be known from an operations viewpoint in order to decide the operational applications which a specific ILS could support.

2.1.2.4 The ILS classification scheme provides a means to make known the additional capabilities that may be available from a particular ILS ground facility, beyond those associated with the facilities defined in Part I, 3.1.1. These additional capabilities can be exploited in order to permit operational use according to 2.1.2.1 and 2.1.2.2 above to be approved down to and below the values stated in the operational objectives described in 2.1 above.

2.1.2.5 An example of the classification system is presented in 2.14.3 below.

2.1.3 Guidance material relating to airborne equipment tolerances appropriate to the attainment of the objectives of ILS Operational Performance Categories I and II are given in 2.2.4 and 2.2.5 below. In the case of Category II operations utilizing appropriate ILS facilities, it may be feasible to allow operations by aircraft with low approach speeds and adequate demonstrable manoeuvrability fitted with airborne equipment having tolerances less stringent than those specified for Category II.

Note.— The following guidance material is intended to assist States when they are evaluating the acceptability of ILS localizer courses and glide paths having bends. Although, by definition, course bends and glide path bends are related to the nominal positions of the localizer course and glide path respectively, the evaluation of high frequency aberrations is based on the deviations from the mean course or path. The material in 2.1.6 and Figure C-2 regarding the evaluation of bends indicates how the bends relate to the mean position of the course and path. Aircraft recordings will normally be in this form.

2.1.4 *Course bends.* Localizer course bends should be evaluated in terms of the course structure specified in Part I, 3.1.3.4. With regard to landing and rollout in Category III conditions, this course structure is based on the desire to provide adequate guidance for manual and/or automatic operations along the runway in low visibility conditions. With regard to Category I performance in the approach phase, this course structure is based on the desire to restrict aircraft deviations, due to course bends (95 per cent probability basis) at the 30 m (100 ft) height, to lateral displacement of less than 10 m (30 ft). With regard to Categories II and III performance in the approach phase, this course structure is based on the desire to restrict aircraft deviations due to course bends (95 per cent probability basis) in the region between ILS Point B and the ILS reference datum (Category II facilities) or Point D (Category III facilities), to less than 2 degrees of roll and pitch attitude and to lateral displacement of less than 5 m (15 ft).

Note 1.— Course bends are unacceptable when they preclude an aircraft under normal conditions from reaching the decision height in a stable attitude and at a position, within acceptable limits of displacement from the course line, from which a safe landing can be effected. Automatic and semi-automatic coupling is affected to a greater degree than manual coupling by the presence of bends. Excessive control activity after the aircraft has settled on an approach may preclude it from satisfactorily completing an approach or landing. Additionally, when automatic coupling is used, there may be an operational requirement to continue the approach below the decision height. Aircraft guidance can be satisfied if the specification for course structure in Part I, 3.1.3.4 is met.

Note 2.— Bends or other irregularities that are not acceptable will normally be ascertained by flight tests in stable air conditions requiring precision flight check techniques.

2.1.5 *ILS glide path bends.* Bends should be evaluated in terms of the ILS glide path structure specified in Part I, 3.1.4.4. With regard to Category I performance, this glide path structure is based on the desire to restrict aircraft deviations due to glide path bends (95 per cent probability basis) at the 30 m (100 ft) height, to vertical displacements of less than 3 m (10 ft). With regard to Categories II and III performance, this glide path structure is based on the desire to restrict aircraft deviations due to path bends (95 per cent probability basis) at the 15 m (50 ft) height, to less than 2 degrees of roll and pitch attitude and to vertical displacements of less than 1.2 m (4 ft).

Note 1.— Path bends are unacceptable when they preclude an aircraft under normal conditions from reaching the decision height in a stable attitude and at a position within acceptable limits of displacement from the ILS glide path, from which a safe landing can be effected. Automatic and semi-automatic coupling is affected to a greater degree than manual coupling by the presence of bends. Additionally, when automatic coupling is used, there may be an operational requirement to continue the approach below the decision height. Aircraft guidance can be satisfied if the specification for ILS glide path structure in Part I, 3.1.4.4, is met.

Note 2.— Bends or other irregularities that are not acceptable will normally be ascertained by precision flight tests, supplemented as necessary by special ground measurements.

2.1.6 *Application of localizer course/glide path bend amplitude Standard.* In applying the specification for localizer course structure (Part I, 3.1.3.4) and ILS glide path structure (Part I, 3.1.4.4), the following criteria should be employed:

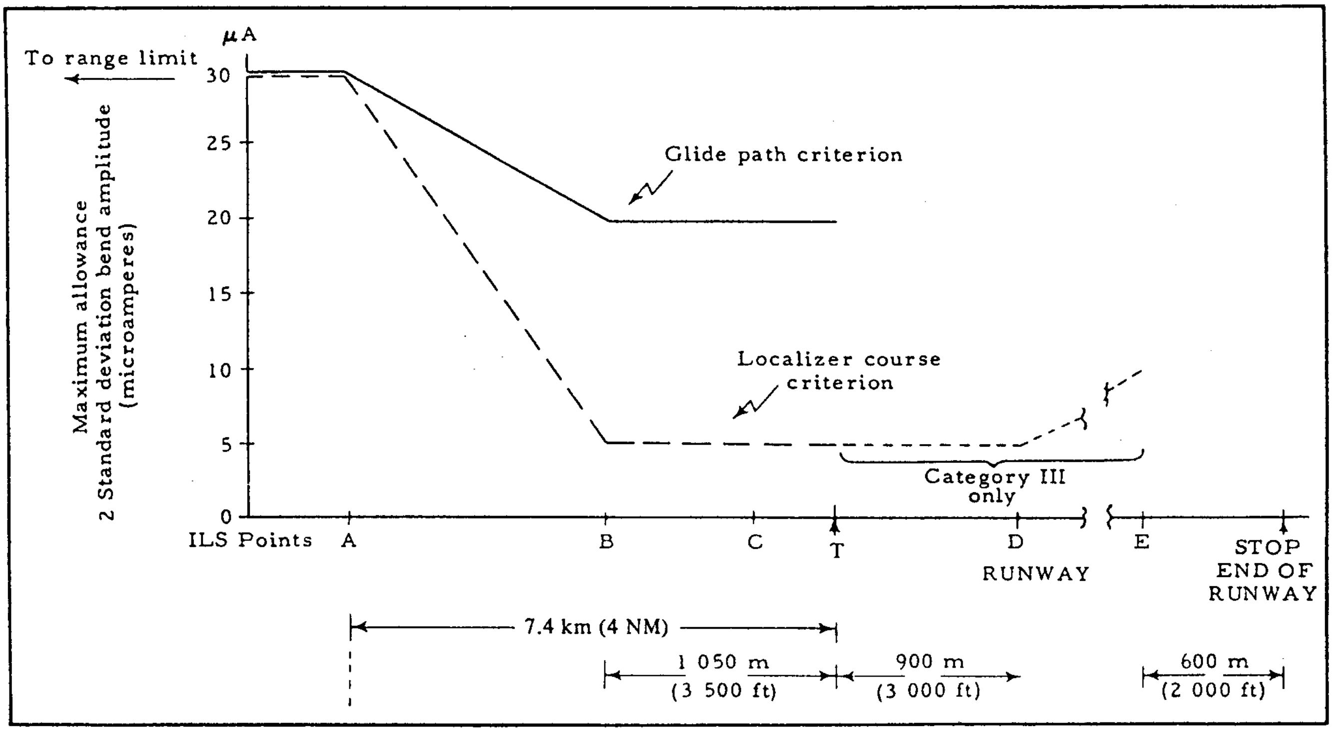


Figure C-1. Categories II and III localizer course and glide path maximum bend amplitude criteria

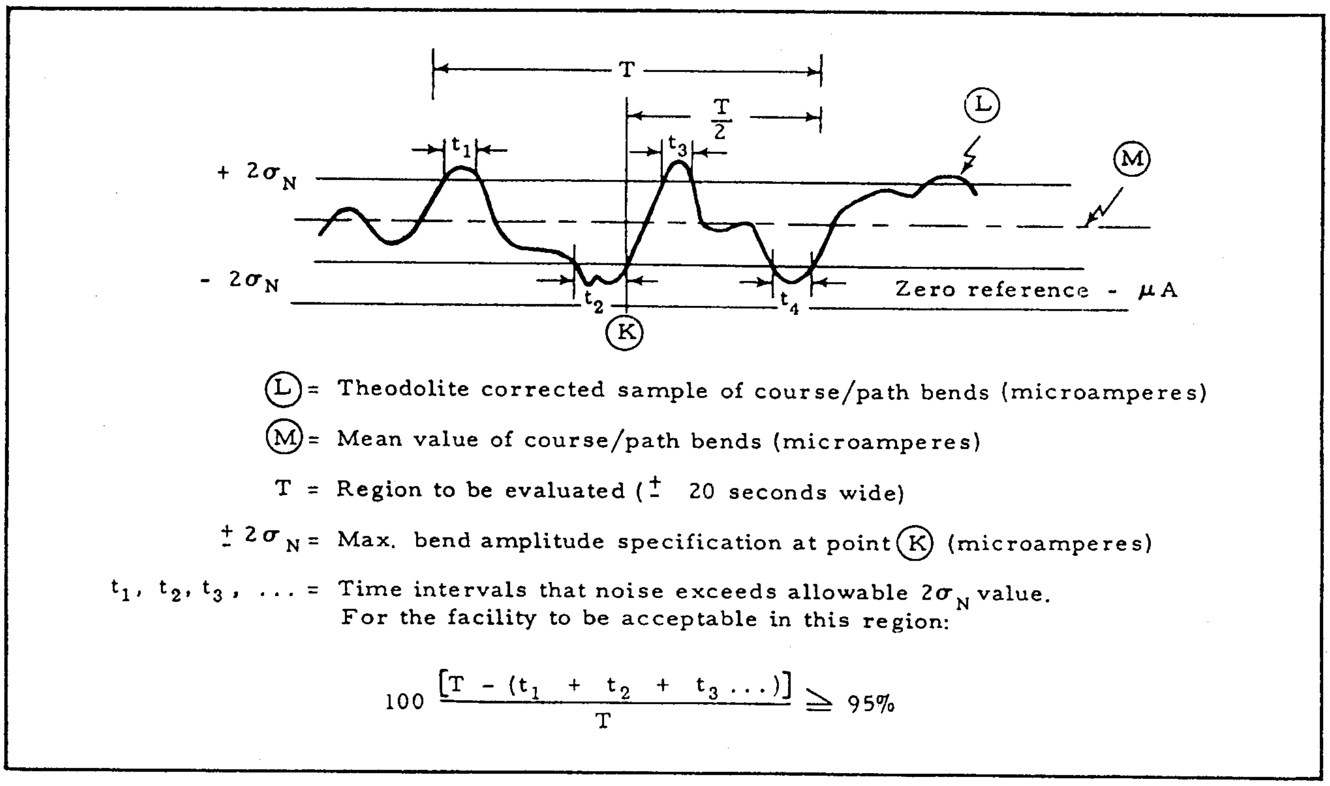


Figure C-2. Evaluation of course/path bend amplitude

— Figure C-1 shows the relationship between the maximum (95 per cent probability) localizer course/glide path bend amplitudes and distances from the runway threshold that have been specified for Categories II and III performance.

— If the bend amplitudes are to be evaluated in any region of the approach, the flight recordings, corrected for aircraft angular position error, should be analysed for a time interval of plus or minus 20 seconds about the midpoint of the region to be evaluated. The foregoing is based on an aircraft ground speed of 195 km/h (105 knots) plus or minus 9 km/h (5 knots).

The 95 per cent maximum amplitude specification is the allowable percentage of total time interval in which the course/path bend amplitude must be less than the amount specified in Figure C-1 for the region being evaluated. Figure C-2 presents a typical example of the method that can be employed to evaluate the course/path bend amplitude at a particular facility. If the sum of the time intervals t_1, t_2, t_3, where the given specification is exceeded, is equal to or less than 5 per cent of the total time T, the region that is being evaluated is acceptable. Therefore,

$$100 \frac{[T - (t_1 + t_2 + \ldots)]}{T} \geq 95\%$$

Analysis of ILS glide path bends should be made using as a datum the mean glide path and not the downward extended straight line. The extent of curvature is governed by the offset displacement of the ground equipment glide path antenna system, the distance of this antenna system from the threshold, and the relative heights of the ground along the final approach route and at the glide path site (see 2.4 below).

2.1.7 Owing to the complex frequency components present in the ILS beam bend structures, measured values of beam bends are dependent on the frequency response of the airborne receiving and recording equipment. It is intended that beam bend measurements be obtained by using a total time constant (in seconds) for the receiver DDM output circuits and associated recording equipment of 92.6/V, where V is the velocity in km/h of the aircraft or ground vehicle as appropriate.

2.1.8 *Monitor systems.* Available evidence indicates that performance stability within the limits defined in Part I, 3.1.3.6, 3.1.3.7 and 3.1.5.6., i.e. well within the monitor limit, can readily be achieved.

The choice of monitor limits is based on judgement, backed by a knowledge of the safety requirements for the category of operation. However, the specifications of such monitoring limits do not indicate the magnitude of the normal day-to-day variations in performance which result from setting-up errors and equipment drift. It is necessary to investigate and take corrective action if the day-to-day performance frequently drifts beyond the limits specified in Part I, 3.1.3.6, 3.1.3.7 and 3.1.5.6. The causes of such drifts should be eliminated:

a) to reduce greatly the possibility of critical signal parameters hovering near the specified monitor limits;

b) to ensure a high continuity of ILS service.

Following are some general guidelines for the design, operation and maintenance of monitor systems to meet the requirements in Part I, 3.1.3.11 and 3.1.5.7.

1) Great care should be exercised to ensure that monitor systems respond to all those variations of the ground facility which adversely affect the operation of the airborne system during ILS approach.

2) Monitor systems should not react to local conditions which do not affect the navigational information as seen by airborne systems.

3) Drifts of the monitor system equipment should not appreciably reduce or increase the monitoring limits specified.

4) Special care must be taken in the design and operation of the monitor system with the aim of ensuring that the navigational components will be removed or radiation cease in the event of a failure of the monitor system itself.

5) Some monitors rely on devices which sample the signal in the vicinity of the transmitter antenna system. Experience has shown that such monitor systems require special attention in the following aspects:

   a) where large-aperture antenna systems are used, it is often not possible to place the monitor sensors in such a position that the phase relationship observed in the far field on the course exists at the sensing point. Nevertheless, the monitor system should also detect antenna and associated feeder system changes which significantly affect the course in the far field;

   b) changes in effective ground level caused by snow, flooding, etc., may affect glide path monitor systems, and the actual course in space differently, particularly when reliance is placed on the ground plane to form the desired glide path pattern;

   c) attention should be paid to other causes which may disturb the monitor sensing of the radiated signal, such as icing, birds, etc;

   d) in a system where monitoring signals are used in a feedback loop to correct variations of the corresponding equipment, special care should be taken that extraneous influence and changes in the monitor system itself do not cause course or ILS glide path variations outside the specified limits without alarming the monitor.

6) One possible form of monitor is an integral monitor in which the contribution of each transmitting antenna element to the far-field course signal is measured at the antenna system. Experience has shown that such monitoring systems, properly designed, can give a close correlation between the monitor indication and the radiated signal in the far field. This type of monitor, in certain circumstances, overcomes the problem outlined in 5), a), b) and c) above.

It will be realized that the DDM measured at any one point in space is a function of displacement sensitivity and the position of the course line or ILS glide path. This should be taken into account in the design and operation of monitor systems.

2.1.9 *Radiation by ILS localizers not in operational use.* Severe interference with operational ILS localizer signals has been experienced in aircraft carrying out approaches to low levels at runways equipped with localizer facilities serving the reciprocal direction to the approach. Interference in aircraft overflying this localizer antenna system is caused by cross modulation due to signals radiated from the reciprocal approach localizer. Such interference, in the case of low level operations, could seriously affect approach or landing, and may prejudice safety. Paragraphs 3.1.2.7, 3.1.2.7.1 and 3.1.2.7.2 of Part I specify the conditions under which radiation by localizers not in operational use may be permitted.

2.1.10 *ILS multipath interference due to large reflecting objects and movements on the ground*

2.1.10.1 The occurrence of interference to ILS signals is dependent on the total environment around the ILS antennas, and the antenna characteristics. Any large reflecting objects, including vehicles or fixed objects such as structures within the radiated signal coverage, will potentially cause multipath interference to the ILS course and path structure. The location and size of the reflecting fixed objects and structures in conjunction with the directional qualities of the antennas will determine the static course or path structure quality whether Category I, II or III. Movable objects can degrade this structure to the extent that it becomes unacceptable. The areas within which this degradable interference is possible need to be defined and recognized. For the purposes of developing protective zoning criteria, these areas can be divided into two types, i.e. critical areas and sensitive areas.

a) The ILS critical area is an area of defined dimensions about the localizer and glide path antennas where vehicles, including aircraft, are excluded during all ILS operations. The critical area is protected because the presence of vehicles and/or aircraft inside its boundaries will cause unacceptable disturbance to the ILS signal-in-space.

b) The ILS sensitive area is an area extending beyond the critical area where the parking and/or movement of vehicles, including aircraft, is controlled to prevent the possibility of unacceptable interference to the ILS signal during ILS operations. The sensitive area is protected against interference caused by large moving objects outside the critical area but still normally within the airfield boundary.

Note.— The objective of defining critical and sensitive areas is to afford adequate protection to the ILS. The manner in which the terminology is applied may vary between States. In some States, the term "critical area" is also used to describe the area that is referred to herein as the sensitive area.

2.1.10.2 Typical examples of critical and sensitive areas that need to be protected are shown in Figures C-3A, C-3B, C-4A and C-4B. To protect the critical area, it is necessary to normally prohibit all entry of vehicles and the taxiing or parking of aircraft within this area during all ILS operations. The critical area determined for each localizer and glide path should be clearly designated. Suitable signal devices may need to be provided at taxiways and roadways which penetrate the critical area to restrict the entry of vehicles and aircraft. With respect to sensitive areas, it may be necessary to exclude some or all moving traffic depending on interference potential and category of operation. It would be advisable to have the aerodrome boundaries include all the sensitive areas so that adequate control can be exercised over all moving traffic to prevent unacceptable interference to the ILS signals. If these areas fall outside the aerodrome boundaries, it is essential that the co-operation of appropriate authorities be obtained to ensure adequate control. Operational procedures need to be developed for the protection of sensitive areas.

2.1.10.3 The size of the sensitive area depends on a number of factors including the type of ILS antenna, the topography, and the size and orientation of man-made objects, including large aircraft and vehicles. Modern designs of localizer and glide path antennas can be very effective in reducing the disturbance possibilities and hence the extent of the sensitive areas. Because of the greater potential of the larger types of aircraft for disturbing ILS signals, the sensitive areas for these aircraft extend a considerable distance beyond the critical areas. The problem is aggravated by increased traffic density on the ground.

2.1.10.3.1 In the case of the localizer, any large objects illuminated by the main directional radiation of the antenna must be considered as possible sources of unacceptable signal interference. This will include aircraft on the runway and on some taxiways. The dimensions of the sensitive areas required to protect Category I, II and III operations will vary, the largest being required for Category III. Only the least disturbance can be tolerated for Category III, but an out-of-tolerance course along the runway surface would have no effect on Category I or II operations. If the course structure is already marginal due to static multipath effects, less additional interference will cause an unacceptable signal. In such cases a larger-size sensitive area may have to be recognized.

2.1.10.3.2 In the case of the glide path, experience has shown that any object penetrating a surface above the reflection plane of the glide path antenna and within azimuth coverage of the antenna must be considered as a source of signal interference. The angle of the surface above the horizontal plane of the antenna is dependent on the type of glide path antenna array in use at the time. Very large aircraft, when parked or taxiing within several thousand feet of the glide path antenna and directly between it and the approach path, will usually cause serious disturbance to the glide path signal. On the other hand, the effect of small aircraft beyond a few hundred feet of the glide path antenna has been shown to be negligible.

2.1.10.3.3 Experience has shown that the major features affecting the reflection and diffraction of the ILS signal to produce multipath interference are the height and orientation of the vertical surfaces of aircraft and vehicles. The maximum height of vertical surface likely to be encountered must be established, together with the "worst case" orientation. This is because certain orientations can cause out-of-tolerance localizer or glide path deviations at greater distances than parallel or perpendicular orientations.

2.1.10.4 Computer or model techniques can be employed to calculate the probable location, magnitude and duration of ILS disturbances caused by objects, whether by structures or by aircraft of various sizes and orientation at different locations. ILS performance information relative to this subject should normally be made available by the ILS equipment manufacturer. Taking into account the maximum allowable multipath degradation of the signal due to aircraft on the ground, the corresponding minimum sensitive area limits can be determined. Such an approach has been used to determine the sensitive areas in Figures C-3A, C-3B, C-4A and C-4B after validation of computer models which included spot check comparison of computed results with actual field demonstration data on parked aircraft interference to the ILS signal.

2.1.10.5 Control of critical areas and the designation of sensitive areas on the airport proper may still not be sufficient to protect an ILS from multipath effects caused by large, fixed ground structures. This is particularly significant when considering the size of new buildings being erected for larger new aircraft and other purposes. Structures outside the boundaries of the airport may also cause difficulty to the ILS course quality, even though they meet AGA restrictions with regard to obstruction heights.

2.1.10.5.1 Should the environment of an airport in terms of large fixed objects such as tall buildings cause the structure of the localizer and/or glide path to be near the tolerance limits for the category of operation, much larger sensitive areas may need to be established. This is because the effect of moving objects, which the sensitive areas are designed to protect the ILS against, has to be *added* to the *static* beam bends caused by fixed objects. However, direct addition of the maximum bend amplitudes is not considered appropriate and a root sum square combination is felt to be more realistic. Examples are as follows:

a) localizer course bends due to static objects = plus or minus 1½μA. Limit plus or minus 5μA. Therefore allowance for moving objects to define *localizer sensitive area* is $\sqrt{5^2 - 1.5^2} = 4.77\mu A$.

b) localizer course bends due to static objects = plus or minus 4μA. Limit plus or minus 5μA. Therefore allowance for moving objects to define *localizer sensitive area* is $\sqrt{5^2 - 4^2} = 3\mu A$.

In case b) the sensitive area would be larger, thus keeping interfering objects further away from the runway so that they produce 3μA or less distortion of the localizer beam. The same principle is applied to the glide path sensitive area.

2.1.10.6 Directional localizer and glide path antennas are effective not only in keeping sensitive areas to a minimum but also in reducing the probability of multipath degradation to the ILS by large structures on or surrounding an airport. They should therefore be considered at all locations where other antennas cannot meet the requirement. Where an ILS has been installed and found satisfactory, computers and simulation techniques can be employed to calculate the probable extent of ILS disturbance which may arise as a result of proposed new construction. Wherever possible, the results of such computer-aided simulation should be validated by practical tests utilizing representative aircraft.

Note.— The following are factors which affect the size and shape of the critical and sensitive areas:

— *aircraft types likely to cause interference*
— *antenna aperture*
— *antenna type (log periodic dipole/dipole, etc.)*
— *type of clearance (single/dual frequency)*
— *category of operations proposed*
— *runway length*
— *static bends*

These factors should be borne in mind when interpreting Figures C-3A, C-3B, C-4A and C-4B.

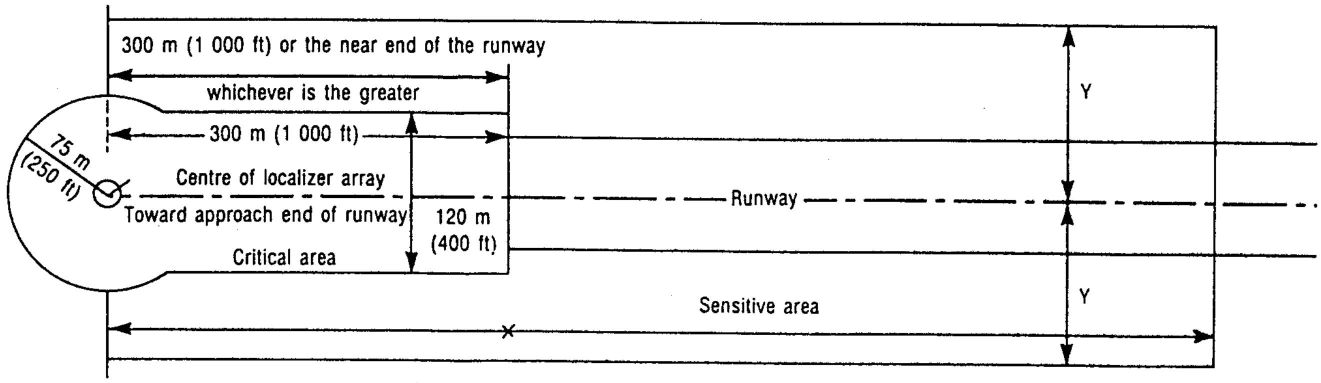
2.1.11 *Guidance on operational aspects of improving the performance of the ILS localizer in respect to bends*

2.1.11.1 *Introduction.* Owing to site effects at certain locations, it is not always possible to produce with simple standard ILS installations localizer courses that are sufficiently free from troublesome bends or irregularities. At such installations, it will often be possible to reduce bends and irregularities in the localizer course to a satisfactory extent by various methods, most of which require acceptance of some deviation from the specification for ILS set forth in this Annex, together with possible penalties from an operational aspect.

2.1.11.2 *Methods of effecting improvement.* In general, improvements in localizer courses from the aspect of bends or irregularities may be effected by restriction of radiation in particular directions so as to avoid or minimize reflection from objects that give rise to the bends. In the majority of instances where special treatment is required, this may be achieved by screens placed and designed to reduce the radiation in the direction of the object. Where reflecting objects are numerous or of large dimensions, however, it may be necessary to restrict almost all the radiation from the localizer to a narrow sector centred on the course line. Each method introduces certain disadvantages which should be weighed for the individual installation in the light of the specific operational application to be made of the installation and the following considerations.

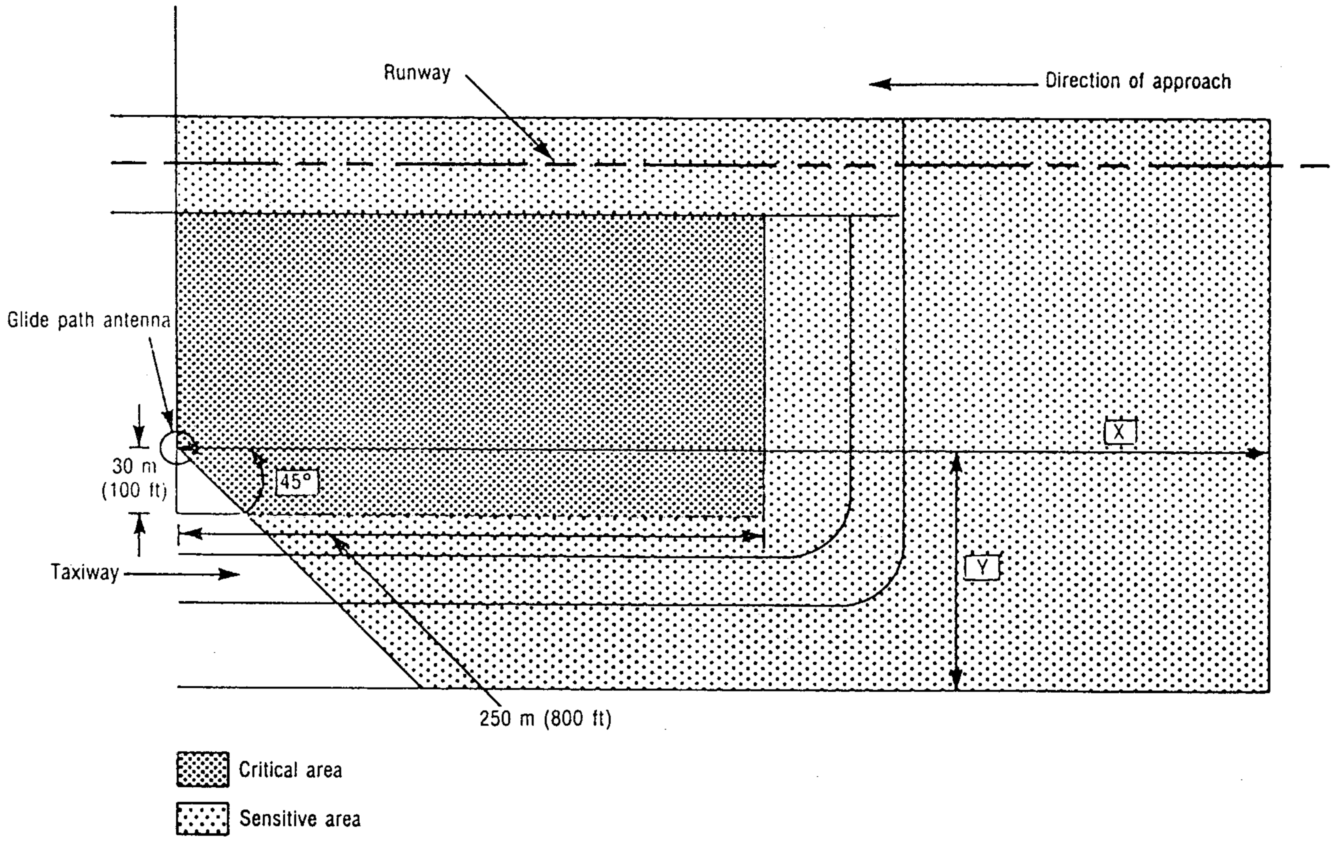
2.1.11.3 *Disadvantages of methods of effecting improvements mentioned above*

2.1.11.3.1 The use of screens limiting radiation in selected directions will, in general, give rise to a reduction of the clearance between the two modulation signals of the ILS in some other direction, with the consequence that the ILS indicator needle may move towards the centre when the aircraft is passing through areas in that direction. It is considered however that, in general, such deviations are not operationally significant or may be overcome by suitable



		Example 1	*Example 2*	*Example 3*
Aircraft type		B-747	B-747	B-727
Localizer antenna aperture		Typically 27 m (90 ft) (Directional dual freq., 14 elements)	Typically 16 m (50 ft) (Semidirectional, 8 elements)	Typically 16 m (50 ft) (Semidirectional, 8 elements)
Sensitive area (X, Y)				
Category I	X	600 m (2 000 ft)	600 m (2 000 ft)	300 m (1 000 ft)
	Y	60 m (200 ft)	110 m (350 ft)	60 m (200 ft)
Category II	X	1 220 m (4 000 ft)	2 750 m (9 000 ft)	300 m (1 000 ft)
	Y	90 m (300 ft)	210 m (700 ft)	60 m (200 ft)
Category III	X	2 750 m (9 000 ft)	2 750 m (9 000 ft)	300 m (1 000 ft)
	Y	90 m (300 ft)	210 m (700 ft)	60 m (200 ft)

Figure C-3A. Typical localizer critical and sensitive areas dimension variations for a 3 000 m (10 000 ft) runway



		Example 1	Example 2	Example 3
Aircraft type		B-747	B-727	small & medium*
Category I	X	915 m (3 000 ft)	730 m (2 400 ft)	250 m (800 ft)
	Y	60 m (200 ft)	30 m (100 ft)	30 m (100 ft)
Category II/III	X	975 m (3 200 ft)	825 m (2 700 ft)	250 m (800 ft)
	Y	90 m (300 ft)	60 m (200 ft)	30 m (100 ft)

* Small and medium aircraft here are considered as those having both a length less than 18 m (60 ft) and a height less than 6 m (20 ft).

Note.— In some cases the sensitive areas may be extended beyond the opposite side of the runway.

Figure C-3B. Typical glide path critical and sensitive areas dimension variations

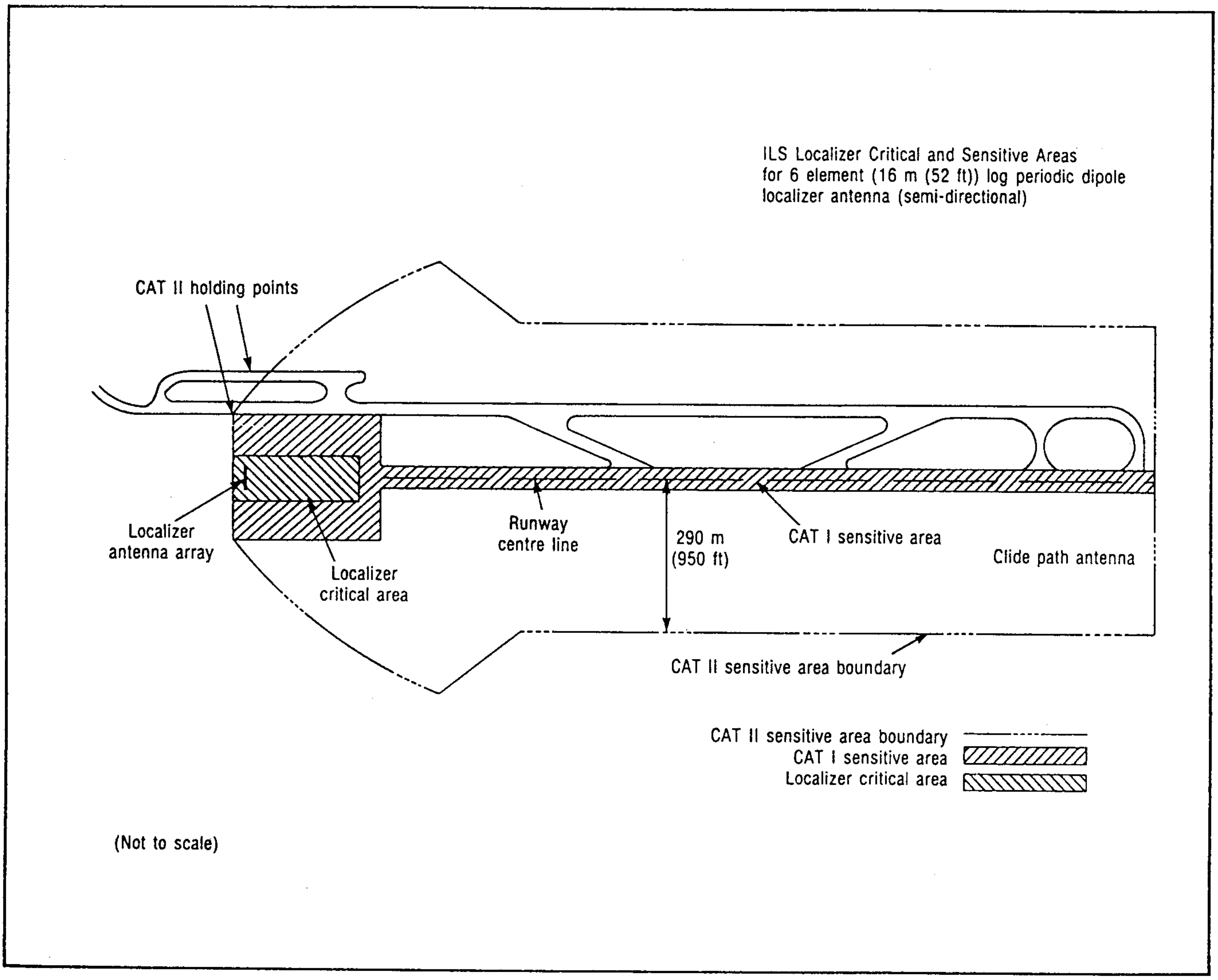


Figure C-4A. Example of critical and sensitive area application at specific sites with 747 aircraft interference

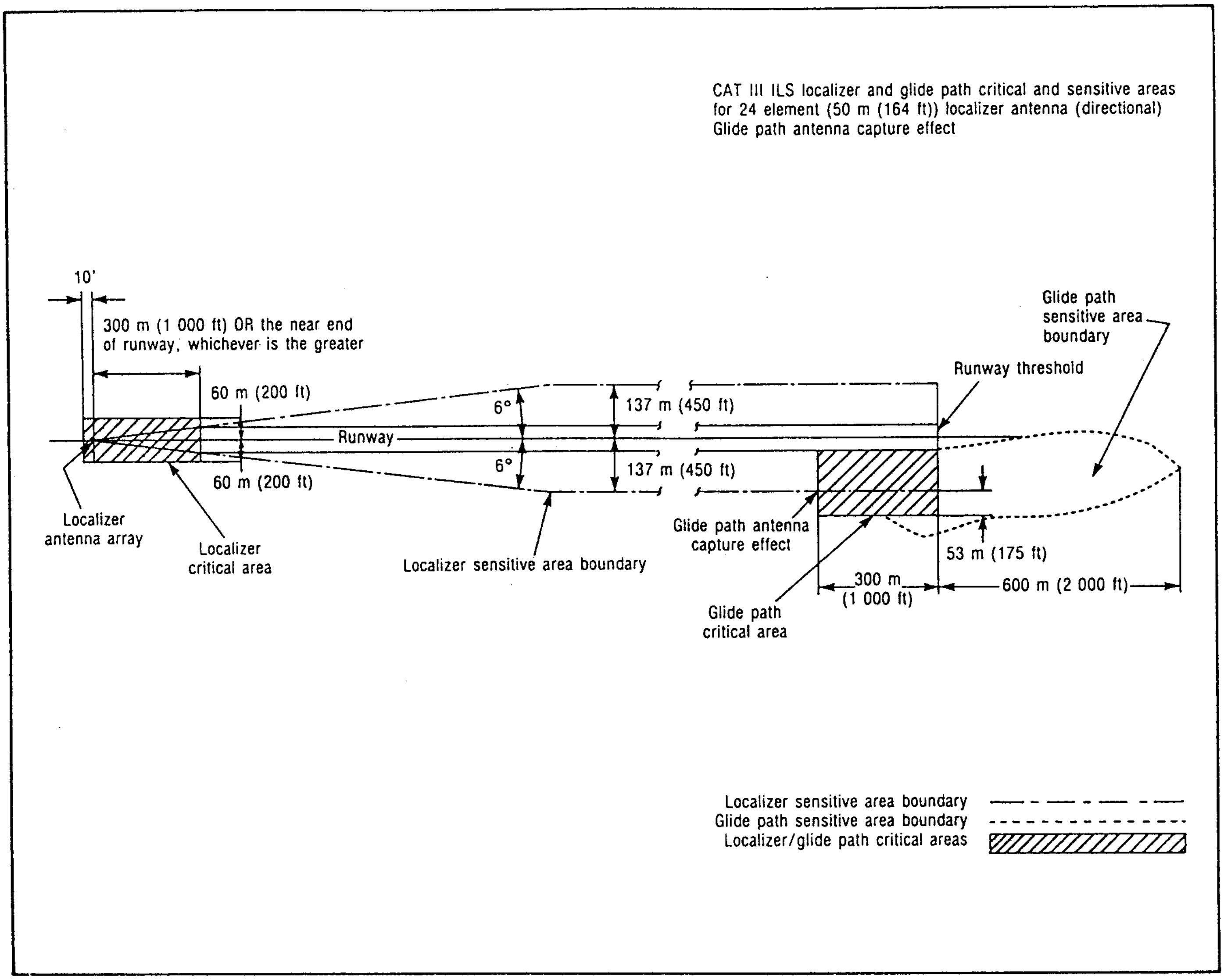


Figure C-4B. Example of critical and sensitive area application at specific sites with 747 aircraft interference

procedures. In certain applications including the use of screens or reflectors to reinforce signals in the course sector, the use of screens or reflectors will modify the range and characteristics of the back course of the localizer. Here again, it is considered that the effects are unlikely to be operationally significant unless operational use is being made of the back course. In this latter case, it may be necessary to provide an additional facility to supplement or replace the back course.

2.1.11.3.2 Where it is necessary to limit radiation from the localizer over a wide sector and confine most of it to a sector centred on the front course of the localizer in order to reduce bends sufficiently, the disadvantages will, in general, be as follows:

1) Orientation information from the localizer in the sector in which radiation is limited will no longer be available or will be unreliable.

2) It will not be practicable to carry out a preliminary check of the performance of the aircraft receiver through the flag system until the aircraft is within the sector centred on the course line.

3) In the area outside the sector centred on the course line, sufficient radiation may occur in particular directions to operate the ILS indicator in the aircraft in an erratic manner, giving rise to false indications.

4) The loss of the back course.

2.1.11.3.3 In respect to 1), it is considered that orientation information is necessary but that practice has shown that such information is preferably obtained in any event from an auxiliary aid such as a locator. Such an auxiliary aid would be necessary if radiation from the localizer is confined to a narrow sector centred on the course line. In respect to 2), it is considered that the loss of a receiver check prior to entry into the sector centred on the course line could be operationally accepted.

2.1.11.3.4 The disadvantage indicated in 3) may, in some instances, be a serious drawback. In general, it is considered that acceptance of this disadvantage will depend on the extent to which false indications will occur at a particular site and on the procedures established or specified for the use of the ILS installation. In practice, it is possible to establish procedures so that no use is made of the localizer signals until the aircraft is able to check that it is in the usable sector. Experience has shown at one installation in operational use that, procedurally, no difficulty has arisen through the existence of erratic indications in the off-course sector. It is considered that the question of whether or not the off-course signal characteristics due to reduction of radiation in a narrow sector may be accepted operationally is a matter for individual assessment at each location concerned.

2.1.11.3.5 The loss of the back course indicated in 4) may have several disadvantages. At some locations, the back course serves a useful function through intersection with other aids for facilitating procedures in the area concerned. Also, the back course often provides a useful aid in missed approach procedures and can often be used to simplify approach for landing when conditions require that the landing direction be opposite to the direction for which the ILS is primarily installed. Loss of the back course will, in general, require the provision of a substitute aid or aids, and the principal disadvantage in suppressing the back course may be considered in terms of the additional expense of a substitute aid or aids.

2.1.11.4 *Extent to which sector centred on course line may be narrowed.* It is considered that a radiation sector 10 degrees each side of the localizer course line would be the minimum sector that could be accepted operationally. It is desirable that the characteristics of the signal from the localizer should be identical with those specified in this Annex within the region in the immediate vicinity (region from DDMs 0.155 to zero) of the course line and approximate closely to them out to 10 degrees, so that the indications of the ILS indicator and the signals fed to a coupling device, if used, will correspond to the standard ILS throughout any manoeuvres necessary in the transition from the approach to the localizer to establishment on course line.

It should be realized, however, that for an increased runway length, the localizer course sector wherein proportional guidance is provided will be narrower as a result of adjusting the localizer to the sensitivity specified in Part I, 3.1.3.7.1. Although a proportional guidance signal is provided on each side of the course line up to a level of 0.180 DDM, the level above 0.150 DDM may not be usable by the automatic airborne system during the intercept manoeuvre unless that system is armed within the sector in which a minimum of 0.180 DDM is provided (e.g. plus or minus 10 degrees). It is advantageous to permit the localizer capture mode of the automatic airborne system to be armed at off-course angles greater than 10 degrees; consequently it is desirable to maintain a minimum DDM of 0.180 through a wider sector than plus or minus 10 degrees wherever practical.

2.1.11.5 *Further possibilities.* If the disadvantages arising from the use of the restricted coverage and modified signal characteristics discussed in 2.1.11.3 above are unacceptable, possibilities exist through the addition of equipment to provide the coverage and signal characteristics that would maintain the essential information provided by a standard ILS in the suppressed sector while, at the same time, maintaining in the regions about the course sector the objective of the restricted coverage system. It may be necessary to employ this more elaborate system at aerodromes of high traffic density.

2.2 ILS airborne receiving equipment

Note.— The specified tolerances are those considered necessary to achieve the operational objective and include allowances, where appropriate, for:

a) variation of relevant ground system parameters within the limits defined in Part I, 3.1;

b) variation of aircraft environment;

c) measurement error; and

d) deterioration in service between maintenance periods.

The words "receiving equipment" as used in this section, include the receiver itself, the antenna(s) and the necessary inter-connexions in the aircraft.

2.2.1 *General*

2.2.1.1 In order to ensure consistent and reliable operation, the output characteristics of the receiver in respect of course line (centring) and course width (deflection) should be maintained to a degree of accuracy appropriate to the operational objective. Attention is directed towards the need to take into account the variable conditions that may affect such accuracy.

2.2.1.2 Furthermore, in order to ensure that a constant course width is realized by all users of the ILS system, it is necessary to standardize the over-all gain of the localizer receiver. Similar considerations apply in the case of the glide path receiver.

2.2.2 *Localizer receiver audio gain adjustment*

2.2.2.1 The audio gain of the receiver should be such that, with a radio frequency input of 1 000 microvolts modulated 20 per cent by a 90 Hz tone and 20 per cent by a 150 Hz tone, a zero indication is achieved and that, upon a simultaneous increase in one component of 4.65 per cent (i.e. to 24.65 per cent) and a decrease in the other component of 4.65 per cent (i.e. to 15.35 per cent), there is a proportional deflection of 3/5 of the full course width indication but not less than 9.5 mm along its scale. This gain adjustment is to be made with the normal power supply voltage encountered under airborne operating conditions.

2.2.3 *Localizer receiving equipment centring tolerance*

2.2.3.1 To obtain the operational objectives associated with ILS Performance Categories I, II and III and to assure the safe operation of aircraft within the obstacle clearance surfaces, the centring error of the receiving equipment, operating within all the likely aircraft environmental conditions and receiving a zero signal (DDM) within the limits of the ground equipment radio frequency modulation characteristics and identification tolerances, as specified in Part I, 3.1.3 and with an RF field strength of 90 microvolts per metre (minus 107 dBW/m²), should not exceed the following limits with a 68 per cent probability:

Category I: 4.66 per cent of the full course width indication (0.0072 DDM)

Category II: 2.33 per cent of the full course width indication (0.0036 DDM)

Category III: 1.66 per cent of the full course width indication (0.00258 DDM)

Note.— These requirements should also be met at larger field strengths up to the maximum field strength likely to be encountered in operational service.

2.2.4 *Localizer course displacement sensitivity (deflection) tolerance*

2.2.4.1 When the receiver audio gain has been adjusted in accordance with 2.2.2 above, and with an increase in one modulation tone of the audio frequency input signal of 4.65 per cent with respect to the nominal value (i.e. 24.65 per cent) and a simultaneous decrease of the other component by 4.65 per cent with respect to the nominal value (i.e. 15.35 per cent), the indicated deflection signal should not vary more than plus or minus 0.019 DDM from the nominal value at a signal strength of 90 microvolts per metre (minus 107 dBW/m²) up to the maximum field strength likely to be encountered in operational service.

Note.— See 2.2.5 below in respect to signal levels.

2.2.5 *Localizer receiving system minimum signal level sensitivity*

2.2.5.1 The sensitivity of the localizer receiving equipment should be such that in a high percentage of cases, the receiver should indicate a usable signal and a substantially steady indication in the presence of the minimum field strength specified in Part I, 3.1.3.3.2 (40 microvolts per metre or minus 114 dBW/m²).

Note 1.— The maximum signal level likely to be encountered under 2.2.3 and 2.2.4 above is 500 microvolts. Signal levels on the order of 5 000 microvolts may be encountered in the near vicinity of the transmitter (e.g. when flying over the localizer during a missed approach, or when the localizer is used for rollout or take-off guidance).

Note 2.— The two levels of sensitivity addressed in 2.2.4 and 2.2.5 above ensure:

a) a high quality output such as is necessary for approach purposes; and

b) an output of lesser quality adequate for operational usage of the facility in other parts of the coverage volume.

Note 3.— The proper operation of the localizer receiving system in the presence of the specified minimum field strength should occur independent of the orientation of the aircraft longitudinal axis in the horizontal plane when the aircraft is exposed to roll angles of 20 degrees and pitch angles of 10 degrees.

2.2.6 *Localizer course displacement linearity*

2.2.6.1 The receiver output course displacement signal should be a substantially linear function of the DDM of the receiver input signal. For any input over the range of plus or minus 0.155 DDM, and for any RF signal level likely to be encountered in operational service, the displacement sensitivity should not depart from the nominal DDM/deflection ratio defined in 2.2.2 above by more than plus or minus 20 per cent. Also for an input signal of plus or minus 0.165 DDM or greater, the output must be greater than full course displacement.

Note.— See 2.2.5 above in respect to signal levels.

2.2.7 *Localizer receiver bandwidth*

2.2.7.1 The receiver bandwidth should be such as to provide for the reception of channels having the characteristics defined in Part I, 3.1.3.2.1 after taking suitable account of appropriate receiver tolerances.

2.2.8 *Setting of localizer receiver capture level for automatic flight control*

2.2.8.1 With reference to Notes 1 and 2 of Part I, 3.1.3.7.4, it is desirable to set the localizer capture level of automatic flight control systems not above 0.175 DDM. This would allow high speed aircraft to execute large angle intercepts at operationally desirable distances without experiencing nuisance switching effects, provided the criteria for the ground installation in the above-mentioned paragraph are met.

2.2.9 *Localizer receiver susceptibility to VOR and localizer signals*

2.2.9.1 The receiver design should provide correct operation in the following environment:

a) the desired signal exceeds an undesired co-channel by 20 dB or more;

b) an undesired signal, 50 kHz removed from the desired signal, exceeds the desired signal by up to 34 dB. (During bench testing of the receiver, in this first adjacent channel case, the undesired signal is varied over the frequency range of the combined ground station (plus or minus 9 kHz) and receiver frequency tolerance);

c) an undesired signal, 100 kHz removed from the desired signal, exceeds the desired signal by up to 46 dB;

d) an undesired signal, 150 kHz or further removed from the desired signal, exceeds the desired signal by up to 50 dB.

Note 1.— It is recognized that not all receivers currently meet requirement b); however, all future equipments should be designed to meet this requirement.

Note 2.— In some States, a smaller ground station tolerance is used.

2.2.10 *Immunity performance of ILS receiving systems to interference from VHF FM broadcast signals*

2.2.10.1 With reference to the Note of 3.1.4 of Part I, the immunity performance defined there must be measured against an agreed measure of derogation of the receiving system's normal performance, and in the presence of, and under standard conditions for the input wanted signal. This is necessary to ensure that the checking of receiving station equipment on bench test can be performed to a repeatable set of conditions and results and to facilitate their subsequent approval. Tests have shown that FM interference signals may affect both course guidance and flag current, and their effects vary depending on the DDM of the wanted signal which is applied. An adequate measure of immunity performance may be obtained by the use of a wanted signal level of minus 86 dBm with the DDM adjusted to give standard deflections between 5 and 180 microamps. With these conditions the change in course deflection current due to the interfering signal should not exceed 10 per cent of the standard deflection when the levels quoted in 3.1.4.1 and 3.1.4.2 of Part I are applied. The broadcast signals should be selected from frequencies in the range between 87.5 and 107.9 MHz and should be modulated with the representative broadcast type signal.

Note 1.— The signal level of minus 86 dBm assumes a combined antenna and feeder gain of 0 dB.

Note 2.— The change of 10 per cent quoted above is for the purpose of standardization when checking that receiving station equipment on bench measurements meet the required immunity. In the planning of frequencies, and in the assessment of protection from FM broadcast interference, a value not exceeding this, but in many cases lower, depending on the operational circumstances in individual cases, should be chosen as the basis of the interference assessment.

2.2.11 *Glide path receiver audio gain adjustment*

2.2.11.1 The audio gain of the receiver should be such that, with a radio frequency input of 600 microvolts modulated 40 per cent by a 90 Hz tone and 40 per cent by a 150 Hz tone, a zero indication is achieved and that, upon a simultaneous increase in one component of 5.25 per cent (i.e. to 45.25 per cent) and a decrease in the other component of 5.25 per cent (i.e. to 34.75 per cent), there is a proportional deflection of 3/5 of full course width indication but not less than 9.5 mm along its scale. This gain adjustment is to be made with the normal power supply voltage encountered under airborne operational conditions.

2.2.12 *Glide path receiving equipment centring tolerance*

2.2.12.1 To obtain the operational objectives associated with ILS Performance Categories I, II and III and to ensure the safe operation of aircraft within the obstacle clearance surfaces, the centring error of the receiving equipment, operating within all likely aircraft environmental conditions and receiving a zero signal (DDM) within the limits of the ground equipment radio frequency, and modulation characteristics tolerances as specified in Part I, 3.1.5, and with an RF field strength of 400 microvolts per metre (minus 95 dBW/m²), should not exceed the following limits with a 68 per cent probability:

Category I: 5.33 per cent of the full course width indication (0.0093 DDM)

Category II: 3.33 per cent of the full course width indication (0.0058 DDM)

Category III: 3.33 per cent of the full course width indication (0.0058 DDM)

Note.— These operational requirements should also be met at larger field strengths up to the maximum field strength likely to be encountered in operational services.

2.2.13 *Glide path course displacement sensitivity (deflection) tolerance*

2.2.13.1 When the receiver audio gain has been adjusted in accordance with 2.2.10 above and with an increase in one modulation tone of the radio frequency input signal of 5.25 per cent (i.e. to 45.25 per cent) and a simultaneous decrease of the other component of 5.25 per cent (i.e. to 34.75 per cent), the displacement signal should not vary more than plus or minus 0.016 DDM from the nominal value at a signal strength of 400 microvolts per metre (minus 95 dBW/m²) up to the maximum field strength likely to be encountered in operational service.

Note.— See 2.2.14 below in respect to signal levels.

2.2.14 *Glide path receiving system minimum signal level sensitivity*

2.2.14.1 The sensitivity of the glide path receiving system should be such that in a high percentage of cases, the receiver should indicate a usable signal and a substantially steady indication in the presence of the minimum field strength specified in Part I, 3.1.5.3.2 (400 microvolts per metre or minus 95 dBW/m²).

Note 1.— The maximum level of signal likely to be encountered under 2.2.12 and 2.2.13 above is 2 500 microvolts. This signal level occurs when the aircraft is at the runway threshold.

Note 2.— The two levels of sensitivity addressed in 2.2.13 and 2.2.14 ensure:

a) a high quality output such as is necessary for approach purposes; and

b) an output of lesser quality adequate for operational usage of the facility in other parts of the coverage volume.

Note 3.— The proper operation of the glide path receiving system in the presence of the specified minimum field strength should occur also if the aircraft longitudinal axis is varied plus or minus 10 degrees in the horizontal plane together with 20 degrees roll about the localizer course line and also plus or minus 10 degrees pitch in the vertical plane about the horizontal plane.

2.2.15 *Glide path displacement linearity*

2.2.15.1 The receiver output glide path displacement signal should be a substantially linear function of the DDM of the receiver input signal. For any input over the range plus or minus 0.175 DDM, and for any RF signal strength likely to be encountered in operational service, the displacement sensitivity should not depart from the nominal DDM/deflection ratio defined in 2.2.11 above by more than plus or minus 20 per cent. For an input signal of 0.185 DDM or greater, the output must be greater than full course displacement.

Note.— See 2.2.14 above with respect to signal levels.

2.2.16 *Glide path receiver bandwidth*

2.2.16.1 The receiver bandwidth should be such as to provide for the reception of channels having the characteristics defined in Part I, 3.1.5.2.1 after taking suitable account of appropriate receiver tolerances.

2.2.17 *Glide path receiver susceptibility to glide path signal*

2.2.17.1 The receiver design should provide correct operation in the following environment:

a) the desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired glide path signal, 150 kHz removed from the desired signal, exceeds the desired signal by up to 20 dB. (During bench testing of the receiver, in this first adjacent channel case, the undesired signal is varied over the frequency range of the combined ground station (plus or minus 17 kHz) and receiver frequency tolerance);

c) an undesired glide path signal, 300 kHz or further removed from the desired signal, exceeds the desired signal by up to 40 dB.

Note 1.— It is recognized that not all receivers currently meet requirement b); however, all future equipments should be designed to meet this requirement.

Note 2.— In some States, a smaller ground station tolerance is used.

2.2.18 *Localizer and glide path receiver effect from vertical polarization*

2.2.18.1 Over the localizer and glide path frequency bands, respectively, the reception of vertically polarized signals from the forward direction with respect to the localizer and glide path antenna should be at least 10 dB below the reception of horizontally polarized signals from the same direction.

2.2.19 *Localizer and glide path receiver spurious response*

2.2.19.1 The response (indicator deflection) of the localizer receiver to a 150 Hz 30 per cent modulated RF signal at 110 MHz should be greater than the response to a similarly modulated but 60 dB greater amplitude RF signal varied over 90 kHz to 107.8 MHz and 112.2 MHz to 1 500 MHz. The response of the glide path receiver to a 150 Hz 30 per cent modulated RF signal at 332.0 MHz should be greater than the response to a similarly modulated but 60 dB greater amplitude RF signal varied over 90 kHz to 329.0 MHz and 335.3 MHz to 1 500 MHz.

2.3 Malfunctioning alarm in ILS airborne equipment

2.3.1 Ideally, a receiver alarm system such as a visual mechanical flag should warn a pilot of any unacceptable malfunctioning conditions which might arise within either the ground or airborne equipments. The extent to which such an ideal may be satisfied is specified below.

2.3.2 The alarm system is actuated by the sum of two modulation depths and, therefore, the removal of the ILS course modulation components from the radiated carrier should result in the actuation of the alarm.

2.3.3 The alarm system should indicate to the pilot and to any other airborne system which may be utilizing the localizer and glide path data, the existence of any of the following conditions:

a) The absence of any RF signal as well as the absence of simultaneous 90 Hz and 150 Hz modulation.

b) The percentage modulation of either the 90 Hz or 150 Hz signal reduction to zero with the other maintained at its normal 20 per cent and 40 per cent modulation respectively for the localizer and glide path.

Note.— It is recommended that the localizer alarm occur when either the 90 Hz or 150 Hz modulation is reduced to 10 per cent with the other maintained at its normal 20 per cent. It is recommended that the glide path alarm occur when either the 90 Hz or 150 Hz modulation is reduced to 20 per cent with the other maintained at its normal 40 per cent.

c) The receiver off-course indication 50 per cent or less of that specified when setting the receiver audio gain adjustment (see 2.2.2 and 2.2.11 above).

2.3.3.1 The alarm indication should be easily discernible and visible under all normal flight deck conditions. If a flag is used, it should be as large as practicable commensurate with the display.

2.4 Guidance for the siting, elevation, adjustment and coverage of glide path equipment

2.4.1 The ILS reference datum and the ILS glide path angle setting are the primary factors influencing the longitudinal location of the ILS glide path equipment with respect to the threshold.

2.4.2 The lateral placement of the glide path antenna system with respect to the runway centre line should not be less than 120 m (400 ft). In deciding the lateral placement of the glide path antenna, account should be taken of the appropriate provisions of Annex 14 with regard to obstacle clearance surfaces and objects on strips for runways.

2.4.3 In selecting the ILS glide path antenna location and glide path angle, the aim should be to place the ILS reference datum as close as possible to the appropriate nominal value. The actual selection of the ILS glide path antenna location and glide path angle are governed by a number of factors, including:

a) acceptable rates of descent and/or approach speeds for the type of operations envisaged at the particular aerodrome;

b) the position of obstacles in the final approach area, the aerodrome sector and the missed approach area, and the resulting obstacle clearance limits;

c) technical siting problems.

2.4.4 The selection of the antenna location and the angle, and the resulting ILS reference datum height, will also be affected by:

a) the runway length available;

b) the operating limits envisaged.

Where the application of the foregoing criteria permits, the preferred angle of the ILS glide path would be 3 degrees.

2.4.5 An ILS reference datum and glide path should then be selected, having regard to the foregoing criteria, and the ability of the site to provide the clearance required by the *Procedures for Air Navigation Services — Airc... Operations* (PANS-OPS, Doc 8168) should be determinea .y calculation and confirmed, where possible, by flight test.

2.4.6 Where the selected ILS reference datum, the ILS glide path angle and the other relevant equipment characteristics do not provide the required clearances, the following alternative course of action should be investigated:

1) removal of the offending obstacle;

2) selection of an alternative height for the ILS reference datum, taking into account the criteria indicated in 2.4.3 and 2.4.5 above;

3) selection of an alternative acceptable ILS glide path angle;

4) variation of the obstacle clearance limit to cater for the offending obstacle.

2.4.7 To enable more effective use of land adjacent to Category III — ILS glide path sites and to reduce siting requirements at these sites, it is desirable that the signals forming the horizontal radiation pattern from the Category III — ILS glide path antenna system be reduced to as low a value as practicable outside the azimuth coverage limits specified in Part I, 3.1.5.3.

2.4.8 *ILS glide path curvature.* In many cases the ILS glide path is formed as a conic surface originating at the glide path aerial system. Owing to the lateral placement of the origin of this conic surface from the runway centre line, the locus of the glide path in the vertical plane along the runway centre line is a hyperbola. Curvature of the glide path occurs in the threshold region and progressively increases until touchdown.

2.4.9 *Relationship between siting of glide path antenna and glide path threshold crossing height.* The longitudinal position of the glide path antenna should be selected so as to meet the recommendation made in Part I, 3.1.5.1.4, in respect to the height of the ILS reference datum above the runway threshold. The height of the ILS reference datum above the runway threshold is then a function of the longitudinal position of the glide path antenna, of the longitudinal slope of the glide path reflection plane and of the position of the runway threshold in respect to the glide path reflection plane. This situation is described pictorially in Figure C-5. The longitudinal position of the glide path antenna is then calculated as follows:

$$D = \frac{H + Y}{\tan(\theta + \alpha)}$$

where

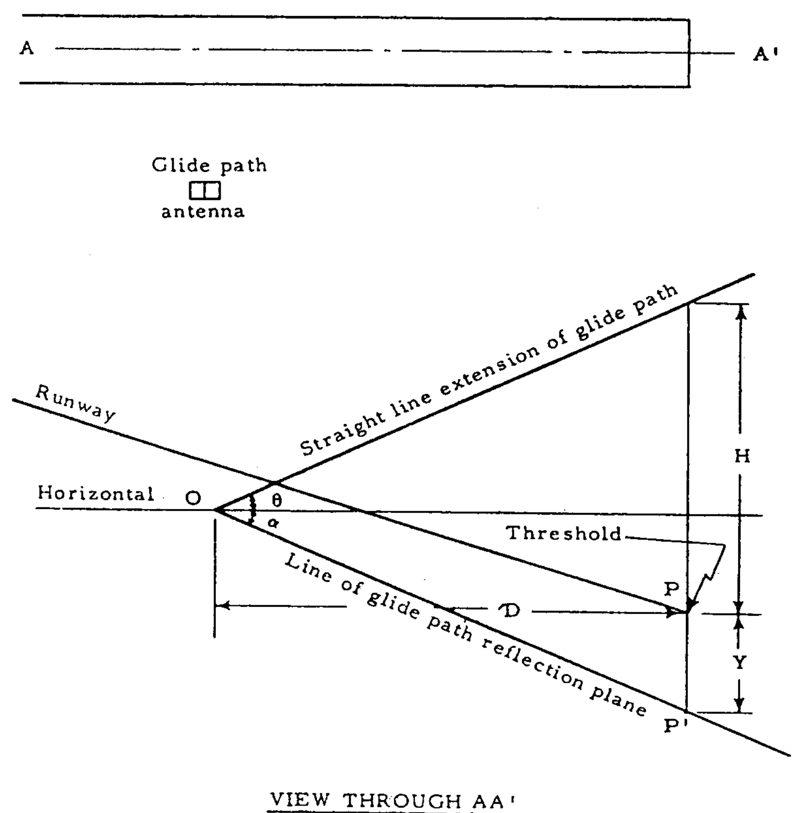
D = the horizontal distance between O and P;

H = the nominal threshold crossing height;

Y = the vertical height of the runway threshold above P′;

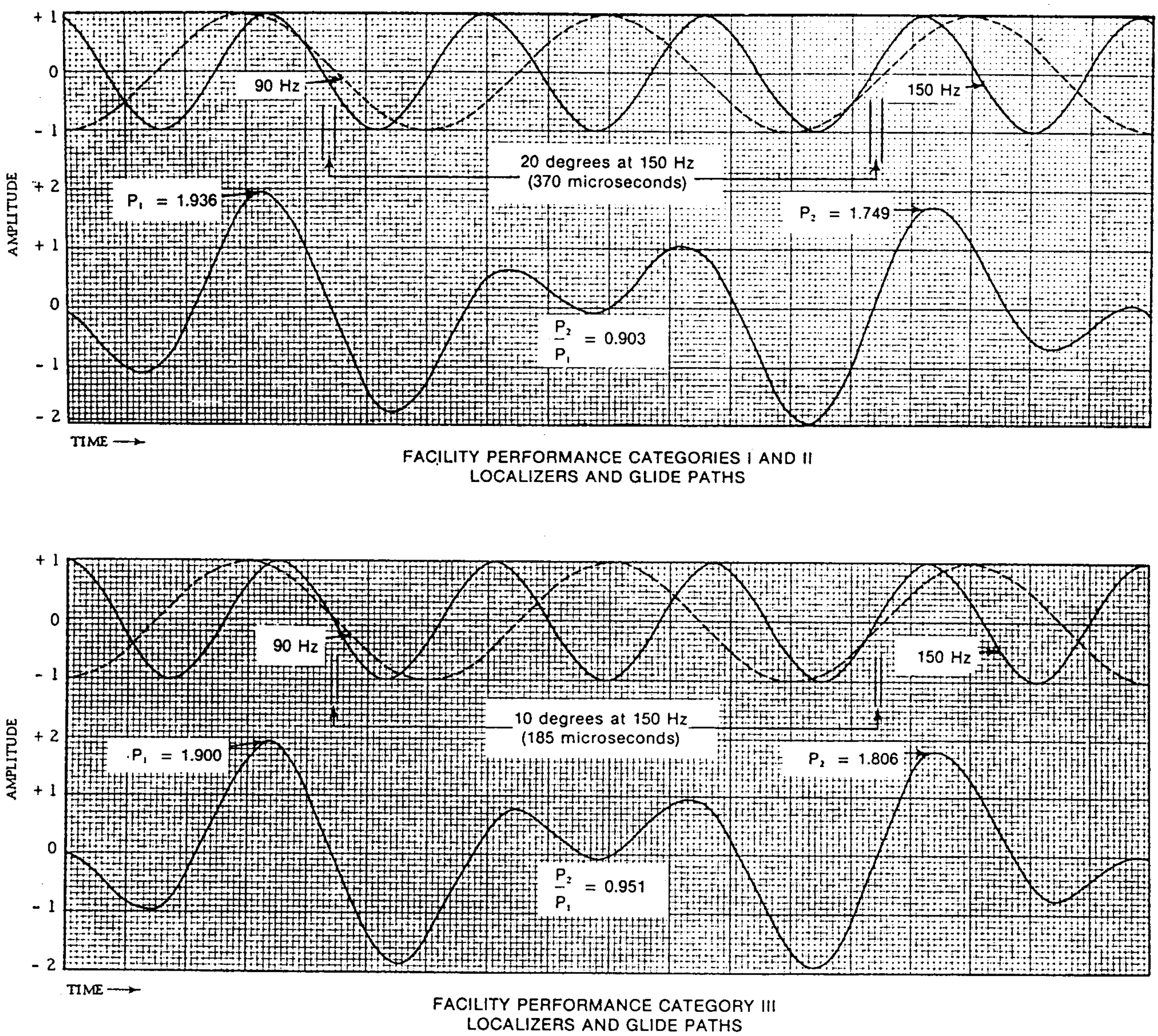
θ = the nominal ILS glide path angle;

α = the longitudinal downslope of the glide path reflection plane.



Note.—The line OP′ represents the intersection of the glide path reflection plane and the vertical plane through AA′.

Figure C-5. Glide path siting for sloping runway



The accompanying graphs illustrate a method that can be used to measure the relative phase relationship between the 90 Hz and 150 Hz tones. The upper portion of each graph shows the individual waveforms and their relationship at the limit of phase differences allowed by Part I, 3.1.3.5.3.3 and 3.1.5.5.3. The lower portion shows the combined waveforms as would be seen on an oscilloscope. By taking the ratio of P_1 and P_2, which gives a value equal to or less than unity, it is possible to determine if the phasing is within tolerance. For Categories I and II ILS the ratio should be greater than 0.903 and for Category III the ratio should be greater than 0.951.

Figure C-6. ILS wave forms illustrating relative audio phasing of the 90 Hz and 150 Hz tones

Note.— In the above formula α is to be taken as positive in the case of a downslope from the antenna towards the threshold. Y *is taken as positive if the threshold is above the reflection plane intersection line.*

2.4.10 The foregoing guidance material in respect of the longitudinal placement to the glide path antenna in relation to the runway threshold, which takes into account the fact that the runway may not be in the glide path reflection plane, and that the glide path reflection plane may be sloped, is based on geometrical abstractions. The material implicity assumes that the glide path locus in the vertical plane, containing the runway centre line, is a perfect hyperbola; consequently, the glide path extension is implicitly assumed as the asymptote to this hyperbola.

2.4.11 In fact, however, the glide path is often quite irregular. The mean ILS glide path angle can be ascertained only by flight tests; the mean observed position of that part of the glide path between ILS Points A and B being represented as a straight line, and the ILS glide path angle being the angle measured between that straight line and its vertical projection on the horizontal plane.

2.4.12 It is important to recognize that the effect of glide path irregularities if averaged within the region between the middle marker and the threshold will likely tend to project a reference datum which is actually different from the ILS reference datum. This reference datum, defined here as the achieved ILS reference datum, is considered to be of important operational significance and should be recognized. The achieved ILS reference datum can only be ascertained by flight check, i.e. the mean observed position of that portion of the glide path typically between points 1 830 m (6 000 ft) and 300 m (1 000 ft) from the threshold being represented as a straight line and extended to touchdown. The point at which this extended straight line meets the line drawn vertically through the threshold at the runway centre line is the achieved ILS reference datum.

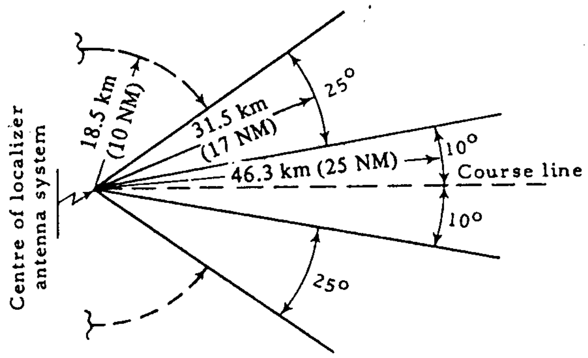
Note.— Further guidance on the measurement of the glide path angle and the achieved ILS reference datum is given in Doc 8071, Volume II.

2.4.13 Part I, 3.1.5.3.1 indicates the glide path coverage to be provided to allow satisfactory operation of a typical aircraft installation. The operational procedures promulgated for a facility must be compatible with the lower limit of this coverage. It is usual for descents to be made to the intercept altitude and for the approach to continue at this altitude until a fly-down signal is received. In certain circumstances a cross-check of position may not be available at this point. Automatic flight control systems will normally start the descent whenever a fly-up signal has decreased to less than about 10 microamperes.

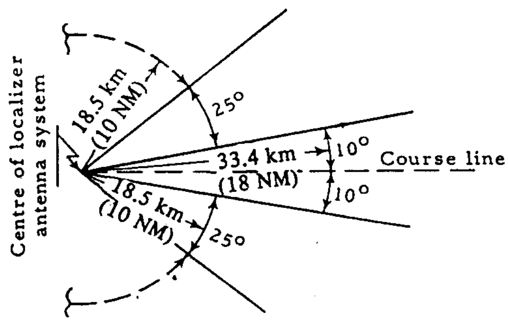
2.4.14 The objective is, therefore, to provide a fly-up signal prior to intercepting the glide path. Although under normal conditions, approach procedures will be accomplished in such a way that glide path signals will not be used below 0.45 θ, or beyond 18.5 km (10 NM) from the runway, it is desirable that misleading guidance information should not be radiated in this area. Where procedures are such that the glide path guidance may be used below 0.45 θ, adequate precautions must be taken to guard against the radiation of misleading guidance information below 0.45 θ, under both normal conditions and during a malfunction, thus preventing the final descent being initiated at an incorrect point on the approach. Some precautions which can be employed to guard against the radiation of misleading guidance include the radiation of a supplementary clearance signal such as provided for in Part I, 3.1.5.2.1, the provision of a separate clearance monitor and appropriate ground inspection and setting-up procedures.

2.4.15 To achieve satisfactory monitor protection against below-path out-of-tolerance DDM, depending on the antenna system used, the displacement sensitivity monitor as required in Part I, 3.1.5.7.1 e) may not be adequate to serve also as a clearance monitor. In some systems, e.g. those using multi-element arrays without supplementary clearance, a slight deterioration of certain antenna signals can cause serious degradation of the clearance with no change or only insignificant changes within the glide path sector as seen by the deviation sensitivity monitor. It is important to ensure that monitor alarm is achieved for any or all possible deteriorated antenna and radiated signal conditions, which may lead to a reduction of clearance to 0.175 DDM or less in the below-path clearance coverage.

2.5 Diagrams (Figure C-7 to Figure C-12) illustrating certain of the standards contained in Part I, Chapter 3 of this Annex

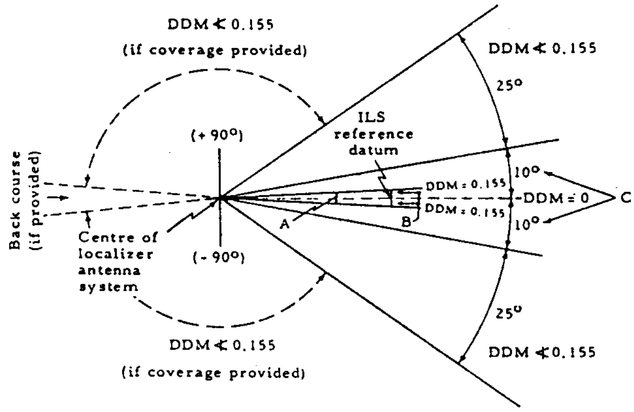


When topographical features dictate or operational requirements and alternative navigation facilities permit, the following coverage may be provided:



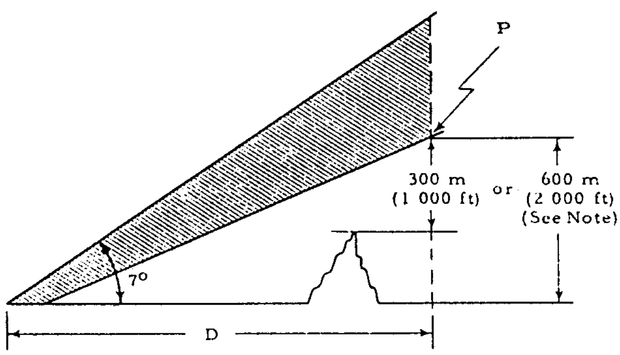
Note.– If coverage as prescribed in Part I, 3.1.3.3.1 is required outside the plus or minus 35-degree sector, this shall be provided to 18.5 km (10 NM), as indicated by the broken arc above.

Figure C-7. Localizer coverage in respect to azimuth



A - Course sector ≯ 6 degrees
B - Displacement sensitivity = 0.00145 DDM/metre (0.00044 DDM/foot) at the ILS reference datum
C - DDM increases linearly from zero to value of 0.180, and then ≮ 0.180

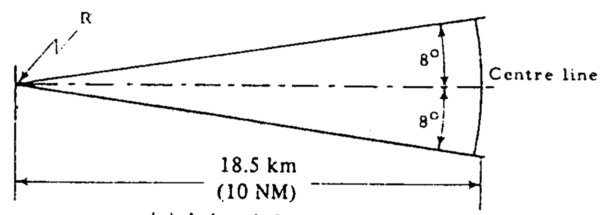
Figure C-9. Difference in depth of modulation and displacement sensitivity



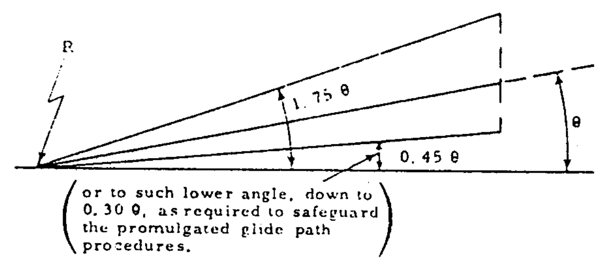
D = Distances and azimuths specified in 3.1.3.3.1

Note.—The point P is either 600 metres (2 000 feet) above the elevation of the threshold, or 300 metres (1 000 feet) above the elevation of the highest point within the intermediate and final approach areas, whichever is the higher.

Figure C-8. Localizer coverage with respect to elevation



(a) Azimuthal cover

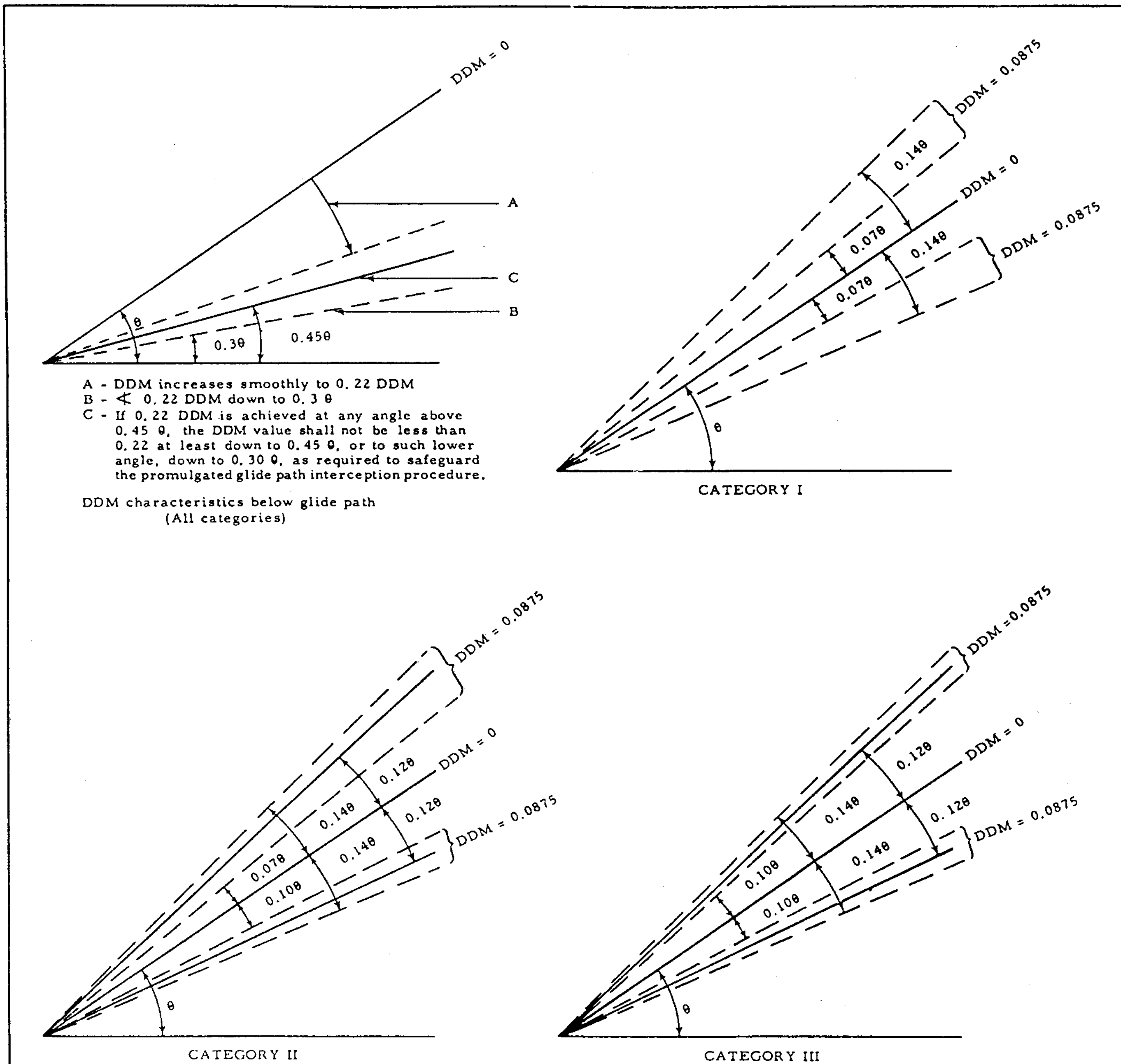


(b) Elevation cover

R = Point at which the downward-extended straight portion of the ILS glide path intersects the runway centre line.

θ = (ILS) glide path angle adjustable between 2° and 4°

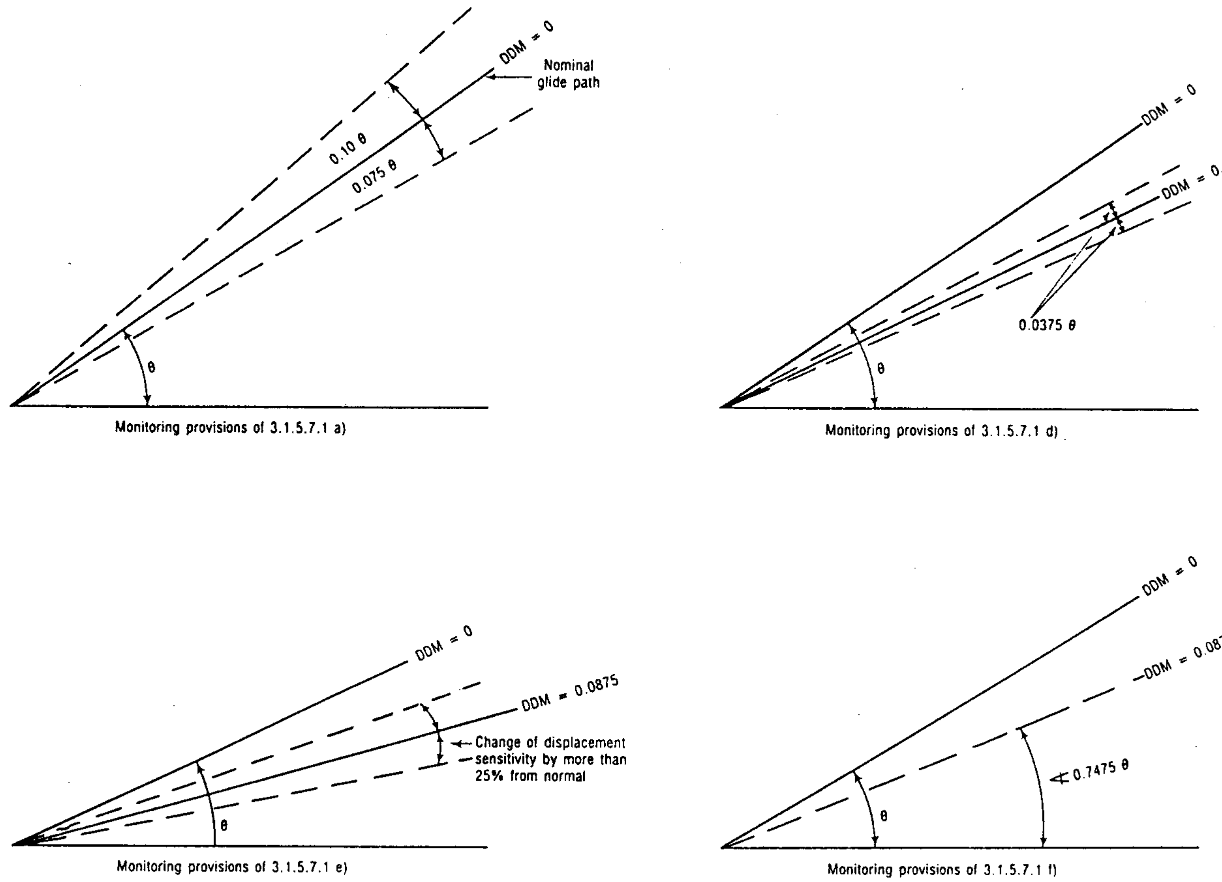
Figure C-10. Glide path coverage



θ = Nominal glide path elevation angle - adjustable between 2° and 4°.
(Broken lines show limits between which the DDM of 0.0875 is to be realized for Categories I, II and III.)

Note.– Figure C-11 depicts the tolerances for the radiated space pattern specified in Part I, 3.1.5.6; however, this space pattern should not be interpreted as being representative of any one particular ground equipment. In this connexion, it should be noted that there are several known types of ILS glide path ground equipment having different characteristics but which can satisfy the requirements of Part I, 3.1.5.6. Therefore, wherever there is a requirement to know the tolerances applicable to a specific equipment, reference should be made to the manufacturer's technical data rather than the ICAO systems specification.

Figure C-11. Glide path — Difference in depth of modulation



Note.—The broken lines represent the permissible limits of deviation before monitoring action is required.

Figure C-12. Glide path monitoring provisions

2.6 Deployment of ILS frequencies

2.6.1 In using the figures listed in Table C-1, it must be noted that these are related to ensuring freedom from interference to a point at the protection height and at the limit of service distance of the ILS in the direction of the front beam. Should there be an operational requirement for back beam use, the criteria would also be applied to a similar point in the back beam direction. Frequency planning will therefore need to take into account the localizer azimuthal alignment. It is to be noted that the criteria must be applied in respect of each localizer installation, in the sense that while of two localizers, the first may not cause interference to the use of the second, nevertheless the second may cause interference to the use of the first.

2.6.2 The figures listed in Table C-1 are based on providing an environment within which the airborne receivers can operate correctly.

2.6.2.1 *ILS localizer receivers*

2.6.2.1.1 In order to protect receivers designed for 50 kHz channel spacing, minimum separations are chosen in order to provide the following minimum signal ratios within the service volume:

a) the desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired signal, 50 kHz removed from the desired signal, exceeds the desired signal by up to 34 dB;

c) an undesired signal, 100 kHz removed from the desired signal, exceeds the desired signal by up to 46 dB;

d) an undesired signal, 150 kHz or further removed from the desired signal, exceeds the desired signal by up to 50 dB.

Table C-1. Required distance separations

	Frequency separation	*Minimum separation between second facility and the protection point of the first facility km (NM)*		
		List A	*List B*	*List C*
Localizer	Co-Channel	148 (80)	148 (80)	148 (80)
	50 kHz	–	37 (20)	9 (5)
	100 kHz	65 (35)	9 (5)	0
	150 kHz	–	0	0
	200 kHz	11 (6)	0	0
Glide Path	Co-channel	93 (50)	93 (50)	93 (50)
	150 kHz	–	20 (11)	2 (1)
	300 kHz	46 (25)	2 (1)	0
	450 kHz	–	0	0
	600 kHz	9 (5)	0	0

List A refers to the use of localizer receivers designed for 200 kHz channel spacing coupled with glide path receivers designed for 600 kHz channel spacing and applicable only in regions where the density of facilities is low.

List B refers to the use of localizer receivers designed for 100 kHz channel spacing coupled with glide path receivers designed for 300 kHz channel spacing.

List C refers to the use of localizer receivers designed for 50 kHz channel spacing coupled with glide path receivers designed for 150 kHz channel spacing.

Note 1.–The above figures are based on the assumption of protection points for the localizer at 46 km (25 NM) distance and 1 900 m (6 250 ft) height and for the ILS glide path at 18.5 km (10 NM) distance and 760 m (2 500 ft) height.

Note 2.–States, in applying the separations shown in the Table, should recognize the necessity to site the ILS and VOR facilities in a manner which will preclude the possibility of airborne receiver error due to overloading by high unwanted signal levels when the aircraft is in the initial and final approach phases.

Note 3.–States in applying the separations shown in the Table should recognize the necessity to site ILS glide path facilities in a manner which will preclude the possibility of erroneous glide path indications due to reception of adjacent channel signals when the desired signal ceases to radiate for any reason while the aircraft is in the final approach phase.

2.6.2.1.2 In order to protect receivers designed for 100 kHz channel spacing, minimum separations are chosen in order to provide the following minimum signal ratios within the service volume:

a) the desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired signal, 50 kHz removed from the desired signal, exceeds the desired signal by up to 7 dB;

c) an undesired signal, 100 kHz removed from the desired signal, exceeds the desired signal by up to 46 dB;

d) an undesired signal, 150 kHz or further removed from the desired signal, exceeds the desired signal by up to 50 dB.

2.6.2.2 *ILS glide path receivers*

2.6.2.2.1 In order to protect receivers designed for 150 kHz spacing, minimum separations are chosen in order to provide the following minimum signal ratios within the service volume:

a) a desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired glide path signal, 150 kHz removed from the desired signal, exceeds the desired signal by up to 20 dB;

c) an undesired glide path signal, 300 kHz or further removed from the desired signal, exceeds the desired signal by up to 40 dB.

2.6.2.2.2 In order to protect receivers designed for 300 kHz spacing, minimum separations are chosen in order to provide the following minimum signal ratios within the service volume:

a) a desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired glide path signal, 150 kHz removed from the desired signal, does not exceed the desired signal (0 dB signal ratio);

c) an undesired glide path signal, 300 kHz removed from the desired signal, exceeds the desired signal by up to 20 dB;

d) an undesired glide path signal, 450 kHz or further removed from the desired signal, exceeds the desired signal by up to 40 dB.

2.6.3 The calculations are based on the assumption that the protection afforded to the wanted signal against interference from the unwanted signal is 20 dB. This corresponds to a disturbance of not more than 15 microamperes at the limit of the service distance of ILS.

2.6.4 In so far as the wanted and unwanted carriers may produce a heterodyne note, the protection ratio ensures that the instrumentation is not affected. However, in cases where a voice facility is used, the heterodyne note may interfere with this facility.

2.6.5 In general, when international use of ILS systems is confined to the pairings listed in Part I, 3.1.6.1.1, the criteria are such that, provided they are met for the localizer element, the glide path element is automatically covered. At certain congested locations, where it is necessary to make assignments in both the first ten and the second ten sequence pairings, it may be necessary to select certain pairings out of sequence in order to meet the minimum geographical separation in 2.6.6 below.

Example: Referring to Part I, 3.1.6.1.1, it will be noted that ILS Sequence Number 2 pairs the localizer frequency of 109.9 MHz with glide path frequency 333.8 MHz. Sequence Numbers 12 and 19, however, although providing wide frequency separation from Sequence Number 2 in the case of the localizers, assign frequencies of 334.1 MHz and 333.5 MHz, respectively, for the glide paths, both being first adjacent channels (300 kHz spacing) to the Sequence Number 2 glide path channel. If selection of ILS channels is confined to either the first ten or the second ten pairings, then the minimum glide path frequency separation will be 600 kHz.

2.6.6 *Table of required distance separations.*
[See Table C-1.]

2.6.7 The application of the figures given in Table C-1 will only be correct within the limitations set by the assumptions which include that facilities are essentially non-directional in character, that they have similar radiated powers, that the field strength is approximately proportional to the angle of elevation for angles up to 10 degrees, and that the aircraft antenna is essentially omnidirectional in character. If more precise determination of separation distances is required in areas of frequency congestion, this may be determined for each facility from appropriate propagation curves, taking into account the particular directivity factors, radiated power characteristics and the operational requirements as to coverage. Where reduced separation distances are determined by taking into account directivity, etc., flight measurements at the ILS protection point and at all points on the approach path should be made wherever possible to ensure that a protection ratio of at least 20 dB is achieved in practice.

2.7 Localizers and glide paths achieving coverage with two radio frequency carriers

2.7.1 Localizer coverage may be achieved by using two composite radiation field patterns on different carrier frequencies spaced within the localizer frequency channel. One field pattern gives accurate course and displacement indications within the front course sector; the other field pattern provides ILS indications outside the front course sector to meet the coverage requirements in Part I, 3.1.3.3 and 3.1.3.7. Discrimination between signals is obtained in airborne receivers by the stronger signal capturing the receiver. Effectiveness of capture depends on the type of detector used but, in general, if the ratio of the two signals is of the order of 10 dB or more, the smaller signal does not cause significantly large errors in demodulated output. For optimum performance within the front course sector, the following guidance material should be applied in the operation of two carrier frequency localizer systems.

2.7.2 The localizer should be designed and maintained so that the ratio of the two radiated signals-in-space within the front course sector and to the coverage limits specified in Part I does not fall below 10 dB. Particular attention should be directed to the vertical lobe structure produced by the two antenna systems which may be different in height and separated in distance, thus resulting in changes in ratio of signal strengths during approach.

2.7.3 To minimize further the risk of errors if the ratio of the two radiated signals falls below 10 dB, the difference in alignment of the nominal course lines from the two signals should be not more than 0.2 degree.

2.7.4 Glide paths which employ two carriers are used to form a composite radiation field pattern on the same radio frequency channel. Special configurations of antennas and the distribution of antenna currents and phasing may permit siting of glide path facilities at locations with particular terrain conditions which may otherwise cause difficulty to a single-frequency system. At such sites, an improvement is obtained by reducing the low angle radiation. The second carrier is employed to provide coverage in the region below the glide path.

2.8 Integrity and continuity of service — ILS ground equipment

2.8.1 *Introduction*

2.8.1.1 This material is intended to provide clarification of the integrity and continuity of service objectives of ILS localizer and glide path ground equipment and to provide guidance on engineering design and system characteristics of this equipment. The integrity and continuity of service must of necessity be known from an operational viewpoint in order to decide the operational application which an ILS could support.

2.8.1.2 It is generally accepted, irrespective of the operational objective, that the average rate of a fatal accident during landing, due to failures or shortcomings in the whole system, comprising the ground equipment, the aircraft and the pilot, should not exceed 1×10^{-7}. This criterion is frequently referred to as the global risk factor.

2.8.1.3 In the case of Category I operations, responsibility for assuring that the above objective is not exceeded is vested more or less completely in the pilot. In Category III operations, the same objective is required but must now be inherent in the whole system. In this context it is of the utmost importance to endeavour to achieve the highest level of integrity and continuity of service of the ground equipment. Integrity is needed to ensure that an aircraft on approach will have a low probability of receiving false guidance; continuity of service is needed to ensure that an aircraft in the final stages of approach will have a low probability of being deprived of a guidance signal.

2.8.1.4 It is seen that various operational requirements correspond to varied objectives of integrity and continuity of service. Paragraph 2.14 below identifies and describes four levels of integrity and continuity of service.

2.8.2 *Guidance material concerning the achievement and retention of integrity and continuity of service levels*

2.8.2.1 An integrity failure can occur if radiation of a signal which is outside specified tolerances is either unrecognized by the monitoring equipment or the control circuits fail to remove the faulty signal. Such a failure might constitute a hazard if it results in a gross error.

2.8.2.2 Clearly not all integrity failures are hazardous in all phases of the approach. For example, during the critical stages of the approach, undetected failures producing gross errors in course width or course line shifts are of special significance whereas an undetected change of modulation depth, or loss of localizer and glide slope clearance and localizer identification would not necessarily produce a hazardous situation. The criterion in assessing which failure modes are relevant must however include all those deleterious fault conditions which are not unquestionably obvious to the automatic flight system or pilot.

2.8.2.3 It is especially important that monitors be designed to provide fail-safe operation through compliance with the Standards of Part I, 3.1.3.11.4 and 3.1.5.7.4. This often requires a rigorous design analysis. Monitor failures otherwise may permit the radiation of erroneous signals. Some of the possible conditions which might constitute a hazard in Operational Performance Categories II and III are:

a) an undetected shift of course line significantly outside the monitor limits for localizer and glide path;

b) an undetected fault that significantly changes the course width and glide path sensitivity;

c) an undetected fault causing slow cyclic movements of the course, producing apparent course bends as seen by the approaching aircraft significantly exceeding in amplitude the figures specified in Part I, 3.1.3.4.2 for the localizer and Part I, 3.1.5.4.2 for the glide path between ILS points "B" and "T".

2.8.2.4 The highest order of protection is required against the risk of undetected failures in the monitoring and associated control system. This would be achieved by careful design to reduce the probability of such occurrences to a low level and by carrying out maintenance checks on the monitor system performance at intervals which are determined by the design analysis. Such an analysis can be used to calculate the level of integrity of the system in any one landing. The following formula applies to certain types of ILS and provides an example of the determination of system integrity, I, from a calculation of the probability of transmission of undetected erroneous radiation, P.

(1) $I = 1 - P$

$$P = \frac{T_1 T_2}{\alpha_1 \alpha_2 M_1 M_2} \quad \text{when } T_1 < T_2$$

where

I = integrity

P = the probability of a concurrent failure in transmitter and monitor systems resulting in erroneous undetected radiation

M_1 = transmitter MTBF

M_2 = MTBF of the monitoring and associated control system

$\frac{1}{\alpha_1}$ = ratio of the rate of failure in the transmitter resulting in the radiation of an erroneous signal to the rate of all transmitter failures

$\frac{1}{\alpha_2}$ = ratio of the rate of failure in the monitoring and associated control system resulting in inability to detect an erroneous signal to the rate of all monitoring and associated control system failures

T_1 = period of time (in hours) between transmitter checks

T_2 = period of time (in hours) between checks on the monitoring and associated control system

When $T_1 \geq T_2$ the monitor system check may also be considered a transmitter check. In this case, therefore $T_1 = T_2$ and the formula would be:

$$(2) \quad P = \frac{T_2^2}{\alpha_1 \alpha_2 M_1 M_2}$$

2.8.2.5 With regard to integrity, since the probability of occurrence of an unsafe failure within the monitoring or control equipment is extremely remote, to establish the required integrity level with a high degree of confidence would necessitate an evaluation period many times that needed to establish the equipment MTBF. Such a protracted period is unacceptable and therefore the required integrity level can only be predicted by rigorous design analysis of the equipment.

2.8.2.6 The MTBF of equipment is governed by basic construction and operating environment. Equipment design should employ the most suitable engineering techniques, materials and components, and rigorous inspection should be applied during manufacture. It is essential to ensure that equipment is operated within the environmental conditions specified by the manufacturer. The manufacturer should be requested to provide the details of the design to enable the MTBF and continuity of service to be calculated. It is recommended that the equipment MTBF should be confirmed by evaluation in an operational environment to take account of the impact of operational factors, i.e. airport environment, inclement weather conditions, power availability, quality and frequency of maintenance, etc. For integrity and continuity of service levels 2, 3 or 4 the evaluation period should be sufficient to determine achievement of the required level with a high degree of confidence.

2.8.2.7 Continuity of service performance may also be demonstrated by means of MTBO (mean time between outages) where an outage is defined as any unanticipated cessation of signal-in-space. It is calculated by dividing the total facility up-time by the number of operational failures. MTBF and MTBO are not always equivalent, as not all equipment failures will necessarily result in an outage, e.g. an event such as a failure of a transmitter resulting in the immediate transfer to a standby transmitter. The minimum MTBO values expected for the continuity of service in 2.14 below have been derived from several years of operational experience of many systems. To determine whether the performance record of an individual ILS system justifies its assignment to levels 2, 3 or 4 requires a judicious consideration of such factors as:

1) the performance record and experience of system use established over a suitable period of time;

2) the average achieved MTBO established for this type of ILS; and

3) the trend of the failure rates.

An assigned designation should not be subject to frequent change.

2.8.2.8 During the equipment evaluation, and subsequent to its introduction into operational service, records should be maintained of all equipment failures or outages to confirm retention of the desired continuity of service.

2.8.2.9 The following configuration is an example of a redundant equipment arrangement that is likely to meet the objectives for integrity and continuity of service levels 3 or 4. The localizer facility consists of two continuously operating transmitters, one connected to the antenna and the standby connected to a dummy load. With these transmitters is associated a monitor system performing the following functions:

a) monitoring of operation within the specified limits of the main transmitter and antenna system by means of majority voting among redundant monitors;

b) monitoring the standby equipment.

2.8.2.9.1 Whenever the monitor system rejects one of the equipments the facility continuity of service level will be reduced because the probability of cessation of signal consequent on failure of other equipment will be increased. This change of performance must be automatically indicated at remote locations.

2.8.2.9.2 An identical monitoring arrangement to the localizer is used for the glide path facility.

2.8.2.9.3 To reduce mutual interference between the main and standby transmitters any stray radiation from the latter is at least 50 dB below the carrier level of the main transmitter measured at the antenna system.

2.8.2.9.4 In the above example the equipment would include provision to facilitate monitoring system checks at intervals specified by the manufacturer, consequent to his design analysis, to ensure attainment of the required integrity level. Such checks, which can be manual or automatic, provide the means to verify correct operation of the monitoring system including the control circuitry and changeover switching system. The advantage of adopting an automatic monitor integrity test is that no interruption to the operational service provided by the localizer or glide path is necessary. It is important when using this technique to ensure that the total duration of the check cycle is short enough not to exceed the total period specified in Part I, 3.1.3.11.3 or 3.1.5.7.3.

2.8.2.9.5 Interruption of facility operation due to primary power failures is avoided by the provision of suitable standby supplies, such as batteries or "no-break" generators. Under these conditions, the facility should be capable of continuing in operation over the period when an aircraft may be in the critical stages of the approach. Therefore the standby supply should have adequate capacity to sustain service for at least two minutes.

2.8.2.9.6 Warnings of failures of critical parts of the system, such as the failure of the primary power supply, must be given at the designated control points if the failure affects operational use.

2.8.2.10 In order to reduce failure of equipment that may be operating near its monitor tolerance limits, it is useful for the monitor system to include provision to generate a pre-alarm warning signal to the designated control point when the monitored parameters reach a limit equal to a value in the order of 75 per cent of the monitor alarm limit.

2.8.2.11 Protection of the integrity of the signal-in-space against degradation which can arise from extraneous radio interference falling within the ILS frequency band or from re-radiation of ILS signals must also be considered. Measures to prevent the latter by critical and sensitive area protection are given in general terms at 2.1.10 above. With regard to radio interference it may be necessary to confirm periodically that the level of interference does not constitute a hazard.

2.8.2.12 A far field monitor can provide additional protection by providing a warning against the extremely remote probability of the radiation of false information from a localizer facility, as indicated in 2.8.5 below.

2.8.2.13 In general, monitoring equipment design is based on the principle of continuously monitoring the radiated signals-in-space at specific points within the coverage volume to ensure their compliance with the Standards specified at Part I, 3.1.3.11 and 3.1.5.7. Although such monitoring provides to some extent an indication that the signal-in-space at all other points in the coverage volume is similarly within tolerance, this is largely inferred. It is essential therefore to carry out rigorous flight and ground inspections at periodic intervals to ensure the integrity of the signal-in-space throughout the coverage volume.

2.8.2.14 An equipment arrangement similar to that at 2.8.2.9 above, but with no transmitter redundancy, and the application of the provisions outlined in 2.8.2.11, 2.8.2.12 and 2.8.2.13 above, would normally be expected to achieve the objectives for integrity and continuity of service level 2.

2.8.2.15 An analysis of the factors involved in different types of operation allows the determination of desired values for the integrity, expressed in terms of the probability in any one landing, to be determined from the allowable global risk factor criterion. See 2.14.2 c) below.

2.8.3 The stringent requirement for integrity and high continuity of service essential for Category III operations requires the use of ILS Facility Performance Category III equipment having adequate assurance against failures. A failure is taken to be performance outside the monitor system tolerances specified in Part I at 3.1.3.11 for Category III localizers and 3.1.5.7 for Category III glide paths. Reliability of ground equipment operation must be very high, so as to ensure that safety during the critical phase of approach and landing is not impaired by a ground equipment failure when the aircraft is at such a height or attitude that it is unable to take safe corrective action. A high probability of performance within the specified limits has to be ensured. Facility reliability in terms of mean time between failure (MTBF) clearly has to be related on a system basis to the probability of failure which may affect any characteristic of the total signal-in-space. One analysis has shown that the continuity of service of an ILS installation used for Category IIIA operations should be such that the localizer facility and the glidepath facility each have an MTBF of 4 000 hours or more. The system must ensure the highest degree of protection against failure of the monitors to detect a failure in performance of the ground equipment. It is suggested that States endeavour to achieve reliability with as large a margin as is technically and economically reasonable.

2.8.3.1 The following configuration is an example of a redundant arrangement suitable for Category III operations. The localizer facility consists of two continuously operating transmitters, one connected to an antenna load. With these transmitters is associated a monitor system performing the following functions:

a) monitoring of operation within the specified limits of the main transmitter and antenna system by means of a majority voting among redundant monitors;

b) monitoring the standby equipment.

2.8.3.1.1 Whenever the monitor system rejects one of the equipments the facility will no longer have Category III status because the probability of cessation of signal consequent on failure of other equipment will be too high. This reversion to a lower category is automatically indicated at remote locations.

2.8.3.1.2 An identical monitoring arrangement is used for the glide path facility.

2.8.3.1.3 To reduce mutual interference between the main and standby transmitters, any stray radiation from the latter should be at least 50 dB below the carrier level of the main transmitter measured at the antenna system.

2.8.3.2 The highest order of protection is required against the consequence of undetected monitor system failures. This should be achieved by careful design to reduce the probability of such occurrences to a low level and by carrying out maintenance checks on the monitor system performance at intervals which are determined by the design analysis.

2.8.4 Additional guidance material applicable to Categories II and III — ILS localizer and glide path ground equipments is given below.

2.8.4.1 Reliability of equipment is governed by basic construction and operating environment. Equipment design should employ the most suitable engineering techniques, materials and components, and rigorous inspection should be applied in manufacture. Equipment should be operated in environmental conditions appropriate to the manufacturers' design criteria. It is recommended that the equipment reliability should be established by evaluation before introduction into Categories II and III service. Design analysis should verify the predicted performance of the equipment.

2.8.4.2 Interruption of facility operation due to primary power failures should be avoided by the provision of suitable standby supplies, such as batteries or "no-break" generators. Under these conditions, the facility should be capable of continuing in operation over the period when an aircraft may be in the final phases of an approach. Therefore, the standby supply should have adequate capacity to sustain service for at least 2 minutes.

2.8.4.3 Warnings of failures of critical parts of the system, such as the failure of the primary power supply, must be given at the designated control points.

2.8.5 Guidance relating to localizer far field monitors is given below.

2.8.5.1 Far field monitors are provided to monitor course alignment but may also be used to monitor course sensitivity. A far field monitor operates independently from integral and near field monitors. Its primary purpose is to protect against the risk of erroneous setting-up of the localizer, or faults in the near field or integral monitors. In addition, the far field monitor system will enhance the ability of the combined monitor system to respond to the effects of physical modification of the radiating elements or variations in the ground reflection characteristics. Moreover, multipath effects and runway area disturbances not seen by near field and integral monitors, may be substantially monitored by using a far field monitoring system built around a suitable receiver(s), installed under the approach path. It may be used as a passive monitor or as an executive monitor.

2.8.5.2 To meet the very stringent ILS reliability objectives for low minima operations, described in this section, a far field monitor is generally considered essential for Category III operations, while for Category II it is generally considered to be desirable. Also for Category I installations, a far field monitor has proved to be a valuable tool to supplement the conventional monitor system.

2.8.5.3 The signal received by the far field monitor will suffer short-term interference effects caused by aircraft movements on or in the vicinity of the runway. Therefore, if the far field monitor is to be used as an executive monitor, means must be adopted to prevent such temporary interference effects from interrupting localizer service; methods of achieving this are covered in 2.8.5.4 below. The response of the far field monitor to interference effects offers the possibility of indicating to the air traffic control point when temporary disturbance of the localizer signal is present. However, experience has shown that disturbances due to aircraft movements may be present along the runway, including the touchdown zone, and not always be observed at the far field monitor. It must not be assumed, therefore, that a far field monitor can provide comprehensive surveillance of aircraft movements on the runway and its environs.

2.8.5.3.1 Additional possible applications of the far field monitor are as follows:

a) it can be a useful maintenance aid to verify course and/or course deviation sensitivity in lieu of a portable far field monitor;

b) it may be used to provide a continuous recording of far field signal performance showing the quality of the far field signal and the extent of signal disturbance.

2.8.5.4 Possible methods of preventing undesired interruption of localizer service when the far field monitor is used to provide an executive alarm are as follows:

a) incorporation of a time delay within the system adjustable from 30 to 120 seconds;

b) the use of a validation technique to ensure that only indications not affected by transitory disturbances are transmitted to the control system;

c) use of low pass filtering.

2.8.5.5 A typical far field monitor consists of an antenna, VHF receiver and associated monitoring units which provide indications of DDM, modulation sum, and RF signal level. The receiving antenna is usually of a directional type to minimize unwanted interference and should be at the greatest height compatible with obstacle clearance limits. For course line monitoring, the antenna is usually positioned along the extended runway centre line. Where it is desired to also monitor deviation sensitivity, an additional receiver and monitor are installed with antenna suitably positioned to one side of the extended runway centre line. Some systems utilize a number of spatially separated antennas. When used for Category III operations, the far field monitor system design should be consistent with the over-all requirements for integrity that are necessary for Category III — ILS.

2.9 Localizer and glide path displacement sensitivities

2.9.1 Although certain localizer and glide path alignment and displacement sensitivities are specified in relation to the ILS reference datum, it is not intended to imply that measurement of these parameters must be made at this datum.

2.9.2 Localizer monitor system limits and adjustment and maintenance limits given in Part I, 3.1.3.7 and 3.1.3.11 are stated as percentage changes of displacement sensitivity. This concept, which replaces specifications of angular width in earlier editions, has been introduced because the response of aircraft guidance systems is directly related to displacement sensitivity. It will be noted that angular width is inversely proportional to displacement sensitivity.

2.10 Siting of ILS markers

2.10.1 Considerations of interference between inner and middle markers, and the minimum operationally acceptable time interval between inner and middle marker light indications, will limit the maximum height marked by the inner marker to a height on the ILS glide path of the order of 37 m (120 ft) above threshold for markers sited within present tolerances in Annex 10. A study of the individual site will determine the maximum height which can be marked, noting that with a typical airborne marker receiver a separation period of the order of 3 seconds at an aircraft speed of 140 kt between middle and inner marker light indications is the minimum operationally acceptable time interval.

2.10.2 In the case of ILS installations serving closely spaced parallel runways, e.g. 500 m (1 650 ft) apart, special measures are needed to ensure satisfactory operation of the marker beacons. Some States have found it practical to employ a common outer marker for both ILS installations.

However, special provisions, e.g. modified field patterns, are needed in the case of the middle markers if mutual interference is to be avoided, and especially in cases where the thresholds are displaced longitudinally from one another.

2.11 Use of DME as an alternative to ILS marker beacons

2.11.1 When DME is used as an alternative to ILS marker beacons, the DME should be located on the airport so that the zero range indication will be a point near the runway.

2.11.2 In order to reduce the triangulation error, the DME should be sited to ensure a small angle (e.g. less than 20 degrees) between the approach path and the direction to the DME at the points where the distance information is required.

2.11.3 The use of DME as an alternative to the middle marker beacon assumes a DME system accuracy of 0.37 km (0.2 NM) or better and a resolution of the airborne indication such as to allow this accuracy to be attained.

2.11.4 While it is not specifically required that DME be frequency paired with the localizer when it is used as an alternative for the outer marker, frequency pairing is preferred wherever DME is used with ILS to simplify pilot operation and to enable aircraft with two ILS receivers to use both receivers on the ILS channel.

2.11.5 When the DME is frequency paired with the localizer, the DME transponder identification should be obtained by the "associated" signal from the frequency-paired localizer.

2.12 The use of supplementary sources of orientation guidance in association with ILS

2.12.1 Aircraft beginning an ILS approach may be assisted by guidance information provided by other ground referenced facilities such as VORs, surveillance radar or, where these facilities cannot be provided, by a locator beacon.

2.12.2 When not provided by existing terminal or en-route facilities, a VOR, suitably sited, will provide efficient transition to the ILS. To achieve this purpose the VOR may be sited on the localizer course or at a position some distance from the localizer course provided that a radial will intersect the localizer course at an angle which will allow smooth transitions in the case of auto coupling. The distance between the VOR site and the desired point of interception must be recognized when determining the accuracy of the interception and the airspace available to provide for tracking errors.

2.12.3 Where it is impracticable to provide a suitably sited VOR, a compass locator or an NDB can assist transition to the ILS. The facility should be sited on the localizer course at a suitable distance from the threshold to provide for optimum transition.

2.13 The use of Facility Performance Category I — ILS for automatic approaches and landings in visibility conditions permitting visual monitoring of the operation by the pilot

2.13.1 Facility Performance Category I — ILS installations of suitable quality can be used, in combination with aircraft flight control systems of types not relying solely on the guidance information derived from the ILS sensors, for automatic approaches and automatic landings in visibility conditions permitting visual monitoring of the operation by the pilot.

2.13.2 To assist aircraft operating agencies with the initial appraisal of the suitability of individual ILS installations for such operations, provider States are encouraged to promulgate:

a) the differences in any respect from Part I, 3.1;

b) the extent of compliance with the provisions in Part I, 3.1.3.4 and 3.1.5.4, regarding localizer and glide path beam structure; and

c) the height of the ILS reference datum above the threshold.

2.13.3 To avoid interference which might prevent the completion of an automatic approach and landing, it is necessary that local arrangements be made to protect, to the extent practicable, the ILS critical and sensitive areas.

2.13.4 Where two separate ILS facilities serve opposite ends of a single runway, an interlock should ensure that only the localizer serving the approach direction in use should radiate.

2.14 ILS classification — supplementary ILS description method with objective to facilitate operational utilization

2.14.1 The classification system given below, in conjunction with the current facility performance categories, is intended to provide a more comprehensive method of describing an ILS.

2.14.2 The ILS classification is defined by using three characters as follows:

a) I, II or III: this character indicates conformance to Facility Performance Category in Part I, 3.1.3 and 3.1.4;

b) A, B, C, T, D or E: this character defines the ILS points to which the localizer structure conforms to the course structure given at Part I, 3.1.3.4.2, except the letter T, which designates the runway threshold. The points are defined in Part I, 3.1.1; and

c) 1, 2, 3 or 4: this number indicates the level of integrity and continuity of service given in Table C-2.

Table C-2. Integrity and continuity of service objectives

Level	Localizer or glide path		
	Integrity	*Continuity of service*	*MTBO (hours)*
1	Not demonstrated, or less than required for level 2		
2	$1 - 10^{-7}$ in any one landing	$1 - 4 \times 10^{-6}$ in any period of 15 seconds	1 000
3	$1 - 0.5 \times 10^{-9}$ in any one landing	$1 - 2 \times 10^{-6}$ in any period of 15 seconds	2 000
4	$1 - 0.5 \times 10^{-9}$ in any one landing	$1 - 2 \times 10^{-6}$ in any period of 30 seconds (localizer) 15 seconds (glide path)	4 000 (localizer) 2 000 (glide path)

Note.— For currently installed systems, in the event that the Level 2 integrity value is not available or cannot be readily calculated, it is necessary to at least perform a detailed analysis of the integrity to assure proper monitor fail-safe operation.

Note.— In relation to specific ILS operations it is intended that the level of integrity and continuity of service would typically be associated as follows:

1) Level 2 is the performance objective for ILS equipment used to support low visibility operations when ILS guidance for position information in the landing phase is supplemented by visual cues. This level basically relates to the needs of Category II operations and is a desirable objective for equipment supporting Category I operations;

2) Level 3 is the performance objective for ILS equipment used to support operations which place a high degree of reliance on ILS guidance for positioning through touchdown. This level basically relates to the needs of Category IIIA operations or Category III operations with a decision height and is a desirable objective for equipment supporting Category II operations; and

3) Level 4 is the performance objective for ILS equipment used to support operations which place a high degree of reliance on ILS guidance throughout touchdown and rollout. This level basically relates to the needs of the full range of Category III operations.

2.14.3 As an example, a Facility Performance Category II — ILS which meets the localizer course structure criteria appropriate to a Facility Performance Category III — ILS down to ILS point "D" and conforms to the integrity and continuity of service objectives of Level 3 would be described as class II/D/3.

2.14.4 ILS classes are appropriate only to the ground ILS element. Consideration of operational categories must also include additional factors such as operator capability, critical and sensitive area protection, procedural criteria and ancillary aids such as transmissometers, lights, etc.

3. Material concerning VOR

3.1 Guidance relating to VOR effective radiated power (ERP) and coverage

3.1.1 The field strength specified at Part I, 3.3.4.2, is based on the following consideration:

Airborne receiver sensitivity	−117 dBW
Transmission line loss, mismatch loss, antenna polar pattern variation with respect to an isotropic antenna	+7 dB
Power required at antenna	−110 dBW

The power required of minus 100 dBW is obtained at 118 MHz with a power density of minus 107 dBW/m²; minus 107 dBW/m² is equivalent to 90 microvolts per metre, i.e. plus 39 dB referenced to 1 microvolt per metre.

Note.— The power density for the case of an isotropic antenna may be computed in the following manner:

$$P_d = P_a - 10 \log \frac{\lambda^2}{4\pi}$$

where P_d = *power density in dBW/m²;*

P_a = *power at receiving point in dBW;*

λ = *wavelength in metres.*

3.1.2 Nominal values of the necessary ERP to achieve a field strength of 90 microvolts per metre (minus 107 dBW/m²) are given at Figure C-13. For coverage under difficult terrain and siting conditions, it may be necessary to make appropriate increases in the effective radiated power. Conversely, practical experience has shown that under favourable siting conditions, and under the less pessimistic conditions often found in actual service, satisfactory system operation is achieved with a lower ERP.

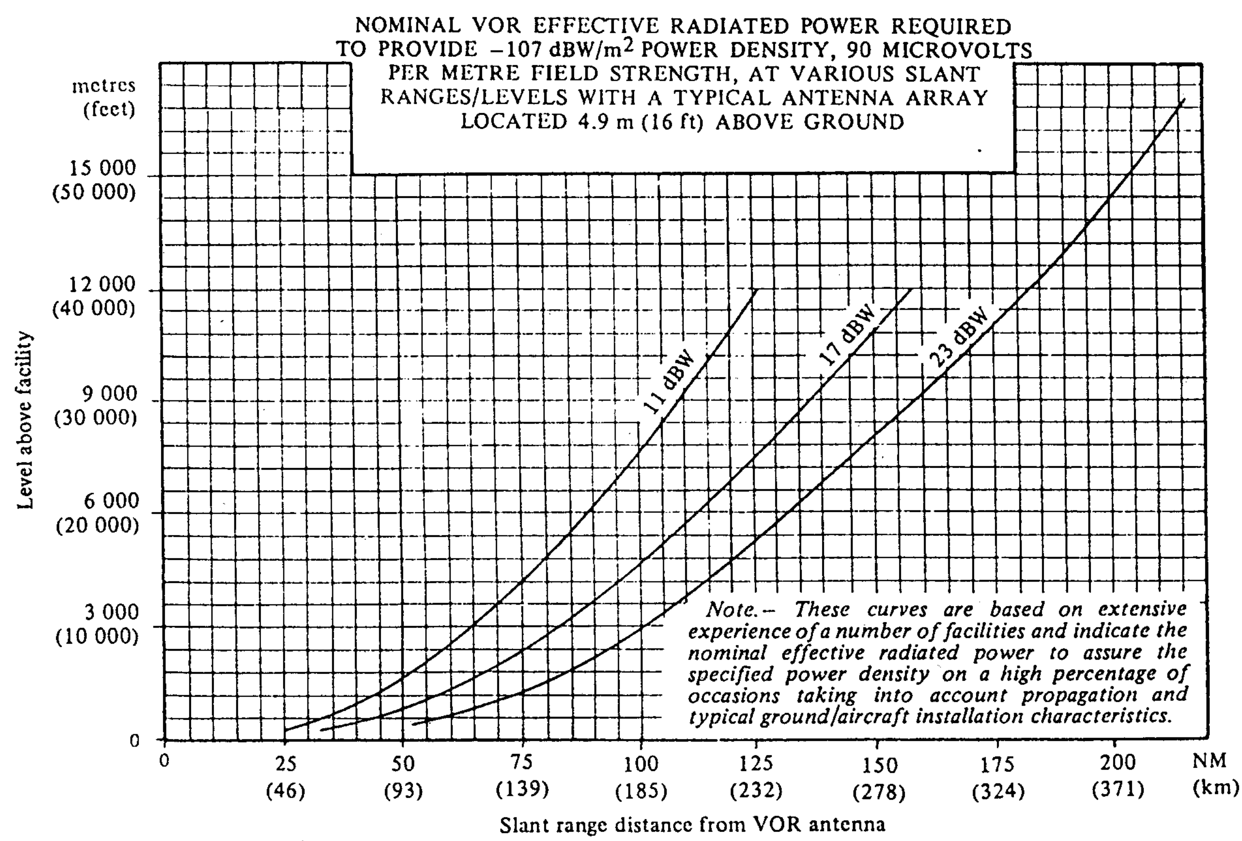
Note.— The nominal effective radiated powers, expressed as a function of level and range, are based upon consideration of basic theoretical data from various sources (such as CCIR, NBS, etc.) modified empirically to reflect typical operational experience.

3.1.3 The use of Figure C-13 is illustrated by the following examples. In order to achieve the necessary field strength at 342 km (185 NM)/12 000 m (40 000 ft), 300 km (162 NM)/12 000 m (40 000 ft), and 166.5 km (90 NM)/6 000 m (20 000 ft), nominal effective radiated powers of plus 23 dBW, plus 17 dBW and plus 11 dBW respectively are required.

3.1.4 In order to facilitate frequency and equipment planning, wherever practicable, ERP categories corresponding to plus 23 dBW, plus 17 dBW and plus 11 dBW should be employed. These ERP values should be indicated during Regional Planning Activities.

3.1.5 A VOR having an ERP of plus 23 dBW approximates to a VOR previously referred to in Annex 10 as Category A (transmitter power 200 W). Possible relationships between ERP and transmitter output powers are illustrated by the following examples:

	Example I	*Example II*
Transmitter power	+23 dBW	+18 dBW
Ground transmission line loss	−2 dB	−1 dB
Antenna gain relative to an isotropic antenna	+2 dB	+6 dB
ERP	+23 dBW	+23 dBW



Note.— These curves display coverage versus power only. For frequency planning guidance, refer to 3.4 of Attachment C to Part I.

Figure C-13

Similarly, a VOR having an ERP of plus 17 dBW approximates to a VOR previously referred to in Annex 10 as Category B (transmitter power 50 W). Possible relationships between ERP and transmitter output powers are illustrated by the following examples:

	Example I	*Example II*
Transmitter power	+ 17 dBW	+ 10 dBW
Ground transmission line loss	− 2 dB	− 1 dB
Antenna gain relative to an isotropic antenna	+ 2 dB	+ 8 dB
ERP	+ 17 dBW	+ 17 dBW

3.1.6 It is recognized that the above ERP categories may achieve a greater coverage than is necessary for some operational requirements. A suitable lesser coverage might be achieved by a VOR facility having an ERP of approximately plus 11 dBW as follows:

	Example I	*Example II*
Transmitter power	+ 11 dBW	+ 7 dBW
Ground transmission line loss	− 2 dB	− 1 dB
Antenna gain relative to an isotropic antenna	+ 2 dB	+ 5 dB
ERP	+ 11 dBW	+ 11 dBW

3.2 Guidance in respect of siting of VOR

3.2.1 The site should be on the highest ground in the vicinity to obtain the greatest line-of-sight coverage and should be level or should slope away from the station (at a downgrade not exceeding 4 per cent) to a distance of at least 300 m (1 000 ft) and preferably to 600 m (2 000 ft) from the station. The site contours should be circular with respect to the antenna array to a radius of at least 300 m (1 000 ft). The site should be as far removed from wire lines and fences as possible. The height of wire lines and fences should not subtend a vertical angle of more than 1.5 degrees or extend more than 0.5 degree above the horizontal as measured from the antenna array. These limits may be increased by 50 per cent for fences or lines which are essentially radial to the antenna array or which subtend a horizontal angle of no more than 10 degrees. Single trees of moderate size, up to 9 m (30 ft) in height, may be tolerated beyond 150 m (500 ft). No groups of trees should subtend a vertical angle greater than 2 degrees or should be within 300 m (1 000 ft) of the station. Provisions should be made for clearing trees to 600 m (2 000 ft) if it should prove necessary. No structures should subtend a vertical angle greater than 1.2 degrees or should be within 150 m (500 ft) of the station. Wooden structures with negligible metallic content and with little prospect of future metallic additions may subtend vertical angles up to 2.5 degrees.

3.2.2 In mountainous terrain, a mountain-top site will often be preferable. The site should be on the highest accessible hilltop or mountain, the top of which should be graded flat to a radius of at least 45 m (150 ft). On such sites, the antenna system should be installed approximately a half wavelength above ground level in the centre of the graded area and the transmitter building should be beyond the graded area, far enough down the slope to be below optical line of sight from the antenna array. No ground, trees, power lines, buildings, etc. between 45 m (150 ft) and 360 m (1 200 ft) should be within optical line of sight of the antenna array.

3.3 Determination of the effect of "polarization error" on VOR accuracy

3.3.1 As it is not possible to specify as yet the maximum permissible value of the vertically polarized component of the radiation from the VOR, certain flight tests are necessary to determine the effect on the bearing indication accuracy due to the presence of the "polarization errors".

3.3.2 Three methods are available to determine the effects of "polarization errors":

1) 30-degree wing rock;

2) flying 8 tracks over a ground check-point;

3) flying a circle at 30-degree bank.

The first of these methods is designed to measure the polarization errors which occur when an aircraft rolls while flying a given VOR radial. The second method measures the polarization error for eight different aircraft headings when the aircraft is not banked. The third method measures the polarization errors, for all aircraft headings, with the aircraft banked at 30 degrees. The flight tests are as follows:

3.3.3 *30-degree wing rock.* The aircraft is flown on a constant heading towards the VOR station and is banked slowly from plus 30 degrees to minus 30 degrees. The course deviation indicator current is recorded and converted into degrees of course displacement.

3.3.4 *Eight tracks over a ground check-point.* The aircraft is flown over a specific ground check-point on eight different headings displaced by 45 degrees. The course deviation indicator current is recorded and the recording is marked when the aircraft is over the check-point . The indicated bearing on each heading is compared with the indicated bearing when the aircraft is heading towards the VOR station and is over the check-point.

3.3.5 *Circular flight with 30-degree bank.* The aircraft is first headed towards the VOR station over a ground check-point. From this point, it is flown in a circle at constant 30-degree bank. The course deviation indicator current is recorded while the aircraft is flying this circle and converted into degrees of error from the bearing indicated at the beginning of the procedure when the aircraft is over the check-point. The change of bearing of the aircraft with respect to the VOR station must be subtracted from the course deviation error. The resultant, after receiver error has been eliminated, is assumed to be polarization error.

3.3.6 The polarization tests may conveniently be conducted at an altitude of 300 m (1 000 ft). Flight tests in 3.3.4 and 3.3.5 above may be employed with respect to a check-point which is approximately 33.4 km (18 NM) from the VOR.

3.4 Criteria for geographical separation of VOR type facilities

3.4.1 In using the figures listed in Table C-3, it must be noted that these are derived from the agreed formulae in respect of specific altitudes. In application of the figures, regional meetings would only afford protection to the extent of the operationally required altitude and distance and, by use of the formulae, criteria can be calculated for any distance or altitude.

3.4.2 The figures listed are calculated on the assumption that the effective adjacent channel rejection of the airborne receiver is better than 60 dB down at the next assignable channel.

3.4.3 The calculations are based on the assumption that the protection against interference afforded to the wanted signal from the unwanted signal is 20 dB, corresponding to a bearing error of less than 1 degree due to the unwanted signal.

3.4.4 It is recognized that, in the case of adjacent channel operation, there is a small region in the vicinity of a VOR facility, in which interference may be caused to an aircraft using another VOR facility. However, the width of this region is so small that the duration of the interference would be negligible and, in any case, it is probable that the aircraft would change its usage from one facility to the other.

3.4.5 The agreed formulae for calculating the geographical separations are as follows (nautical miles may be substituted for kilometres):

A — *minimum geographical separation (co-channel):*

either $2\,D_1 + \frac{20 - K}{S}$ km

where $D_1 > D_2 + \frac{K}{S}$

or $2\,D_2 + \frac{20 + K}{S}$ km

where $D_1 < D_2 + \frac{K}{S}$

Table C-3. Values of geographical separation distances for co-channel operation

Altitude	S	*VOR facilities of equal effective radiated power* — *Minimum geographical separation between facilities is* $2D_1 + \frac{20}{S}$ *if* $D_1 > D_2$ *or* $2D_2 + \frac{20}{S}$ *if* $D_2 > D_1$		*VOR facilities which differ in effective radiated power by 6 dB* — *Minimum geographical separation between facilities is* $2D_1 + \frac{20-K}{S}$ *if* $D_1 > D_2 + \frac{K}{S}$ *or* $2D_2 + \frac{20+K}{S}$ *if* $D_1 < D_2 + \frac{K}{S}$				*VOR facilities which differ in effective radiated power by 12 dB* — *Minimum geographical separation between facilities is* $2D_1 + \frac{20-K}{S}$ *if* $D_1 > D_2 + \frac{K}{S}$ *or* $2D_2 + \frac{20+K}{S}$ *if* $D_1 < D_2 + \frac{K}{S}$			
m (ft)	dB/km (dB/NM)	K (*dB*)	$\frac{20}{S}$ km (NM)	K (*dB*)	$\frac{K}{S}$ km (NM)	$\frac{20-K}{S}$ km (NM)	$\frac{20+K}{S}$ km (NM)	K (*dB*)	$\frac{K}{S}$ km (NM)	$\frac{20-K}{S}$ km (NM)	$\frac{20+K}{S}$ km (NM)
1	2	3	4	5	6	7	8	9	10	11	12
1 200 (4 000)	0.32 (0.60)	0	61 (33)	6	19 (10)	43 (23)	80 (43)	12	37 (20)	24 (13)	98 (53)
3 000 (10 000)	0.23 (0.43)	0	87 (47)	6	26 (14)	61 (33)	113 (61)	12	52 (28)	35 (19)	137 (74)
4 500 (15 000)	0.18 (0.34)	0	109 (59)	6	33 (18)	76 (41)	143 (77)	12	67 (36)	44 (24)	174 (94)
6 000 (20 000)	0.15 (0.29)	0	128 (69)	6	39 (21)	89 (48)	167 (90)	12	78 (42)	52 (28)	206 (110)
7 500 (25 000)	0.13 (0.25)	0	148 (80)	6	44 (24)	104 (56)	193 (104)	12	89 (48)	59 (32)	237 (128)
9 000 (30 000)	0.12 (0.23)	0	161 (87)	6	48 (26)	113 (61)	209 (113)	12	96 (52)	65 (35)	258 (139)
12 000 (40 000)	0.10 (0.19)	0	195 (105)	6	59 (32)	135 (73)	254 (137)	12	119 (64)	78 (42)	311 (168)
18 000 (60 000)	0.09 (0.17)	0	219 (118)	6	65 (35)	154 (83)	284 (153)	12	130 (70)	87 (47)	348 (188)

Note. — S, K and the sign of K are defined in 3.4.5.

B — *geographical separation (adjacent channel):*

collocation case

$$< \frac{40 - K}{S}$$

non-collocated case

$$> 2 D_1 - \frac{40 + K}{S} \text{ km}$$

$$\text{where } D_1 > D_2 + \frac{K}{S}$$

$$or > 2 D_2 - \frac{40 - K}{S} \text{ km}$$

$$\text{where } D_1 < D_2 + \frac{K}{S}$$

C — *geographical separation (adjacent channel) (receivers designed for 100 kHz channel spacing in a 50 kHz channel spacing environment)*

If receivers having an effective adjacent channel rejection of no better than 26 dB are used (e.g. a 100 kHz receiver used in a 50 kHz environment), a figure of 6 should be substituted for the figure of 40 in the above adjacent channel formulae. In this instance, the geographical collocation formula should not be used as the protection afforded may be marginal.

This leads to the following formula:

$$> 2 D_1 - \frac{6 + K}{S} \text{ km}$$

$$\text{where } D_1 > D_2 + \frac{K}{S}$$

$$or > 2 D_2 - \frac{6 - K}{S} \text{ km}$$

$$\text{where } D_1 < D_2 + \frac{K}{S}$$

In the above formulae:

D_1, D_2 = service distances required of the two facilities (km).

K = the ratio (dB) by which the effective radiated power of the facility providing D_1 coverage exceeds that of the facility providing D_2 coverage.

Note.— If the facility providing D_2 is of higher effective radiated power, then "K" will have a negative value.

S = slope of the curve showing field strength against distance for constant altitude (dB/km).

3.4.6 The figures listed in Table C-3 are based on providing an environment within which the airborne receivers can operate correctly.

3.4.6.1 In order to protect VOR receivers designed for 50 kHz channel spacing, minimum separations are chosen in order to provide the following minimum signal ratios within the service volume:

a) the desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired signal, 50 kHz removed from the desired signal, exceeds the desired signal by up to 34 dB;

c) an undesired signal, 100 kHz removed from the desired signal, exceeds the desired signal by up to 46 dB;

d) an undesired signal, 150 kHz or further removed from the desired signal, exceeds the desired signal by up to 50 dB.

3.4.6.2 In order to protect VOR receivers designed for 100 kHz channel spacing, minimum separations are chosen in order to provide the following minimum signal ratios within the service volume:

a) the desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired signal, 50 kHz removed from the desired signal, exceeds the desired signal by up to 7 dB;

c) an undesired signal, 100 kHz removed from the desired signal, exceeds the desired signal by up to 46 dB;

d) an undesired signal, 150 kHz or further removed from the desired signal, exceeds the desired signal by up to 50 dB.

3.4.7 Use of the figures given in 3.4.6 above or other figures appropriate to other service distances and altitudes implies recognition of the basic assumptions made in this substitution of an approximate method of calculating separation, and the application of the figures will only be correct within the limitations set by those assumptions. The assumptions include that the change of field strength with distance (Factor "S") at various altitudes of reception is only valid for angles of elevation at the VOR of up to about 5 degrees, but above the radio line of sight. If more precise determination of separation distances is required in areas of frequency congestion, this may be determined for each facility from appropriate propagation curves.

3.4.8 The deployment of 50 kHz channel spacing requires conformity with 3.3.2.2 and 3.3.5.7 of Part I and 4.2.4 of Part II. Where, due to special circumstances it is essential during the initial conversion period from 100 kHz channel spacing to 50 kHz channel spacing to take account of nearby VOR facilities that do not conform with 3.3.2.2 and 3.3.5.7 of Part I and 4.2.4 of Part II, greater geographical separation between these and the new facilities utilizing 50 kHz channel spacing will be required to ensure a bearing error of less than one degree due to the unwanted signal. On the assumption that the sideband levels of the 9 960 Hz harmonic of the radiated signal of such facilities do not exceed the following levels:

9 960 Hz	0 dB reference
2nd harmonic	-20 dB
3rd harmonic	-30 dB
4th harmonic and above	-40 dB

the separation formulae at 3.4.5 above should be applied as follows:

a) where only receivers designed for 50 kHz channel spacing need to be protected, the value of 40 should be replaced by 20 in the formula at B — non-collocated case;

b) where it is necessary to protect receivers designed for 100 kHz channel spacing, the co-channel formula at A — co-channel case, should be applied for the range of altitudes for which protection is required.

3.4.9 When DME/N facilities and VOR facilities are intended to operate in association with each other, as outlined in Part I, 3.5.3.3.5, and have a common service volume, both the co-channel and adjacent channel geographical separation distances required by the DME are satisfied by the separation distances of the VOR as computed in this section, provided the distance between VOR and DME does not exceed 600 m (2 000 ft). However, if DME/W facilities are employed, the first adjacent channel minimum separation for the DME/W facilities should be equal to the co-channel separation specified for the VOR. The second adjacent channel minimum separation for DME/W facilities should equal the first adjacent channel separation specified for VOR. A potential interference situation may also occur with the implementation of DME "Y" channels since interference between two DME ground stations spaced 63 MHz apart could occur when transmitting and receiving on the same frequency (e.g. transmissions from channel 17 Y could interfere with reception on channels 80 X and 80 Y). To obviate any ground receiver desensitization due to this interference, a minimum ground separation distance of 18.5 km (10 NM) between facilities is necessary.

3.5 Criteria for geographical separation of VOR/ILS facilities

3.5.1 In using the figures of 3.5.3.1 and 3.5.3.2 below, it is to be borne in mind that the following assumptions have been made:

a) that the localizer receiver characteristic is as shown in 2.6.2 above, and the VOR receiver characteristic as shown in 3.4.2 above;

b) that the protection ratio for the ILS system and the VOR system is 20 dB as in 2.6.3 above and 3.4.3 above, respectively;

c) that the protection point for ILS is at a service distance of 46.25 km (25 NM) measured along the line of use, and at an altitude of 1 900 m (6 250 ft).

Note.— With the advent of highly directional ILS localizer antenna arrays, the most critical protection point will not be along the extended runway centre line. Directive antennas result in critical protection points at maximum distance, either plus or minus 10 degrees or plus or minus 35 degrees off the runway centre line. Protection of these points should be examined during the frequency assignment process.

3.5.2 Although international VOR and ILS facilities will not appear on the same frequency, it may occur that an international VOR facility may share temporarily the same frequency as, and on a comparable basis with, a national ILS facility. For this reason, guidance is given as to the geographical separation required not only for a VOR and an ILS facility separated by 50 kHz or 100 kHz, but also for co-channel usage.

3.5.3 Because of the differing characteristics of use of the two equipments, the criteria for minimum geographical separation of VOR/ILS to avoid harmful interference are stated separately for each facility where relevant.

3.5.3.1 *Co-channel case.*

1) Protection of the ILS system requires that a VOR having an ERP of 17 dBW (50 W) be at least 148 km (80 NM) from the ILS protection point.

2) On the assumption that a VOR having an ERP of 17 dBW (50 W) is to be protected to a service distance of 46.25 km (25 NM) and an altitude of 3 000 m (10 000 ft), protection of the VOR system requires that the ILS be at least 148 km (80 NM) from the VOR.

3) If protection of the VOR is required to, say, 92.5 km (50 NM) and 6 000 m (20 000 ft), the ILS is to be at least 250 km (135 NM) from the VOR.

3.5.3.2 *Adjacent channel case.* Protection of the VOR system is effectively obtained without geographical separation of the facilities. However, in the case of:

a) a localizer receiver designed for 100 kHz channel spacing and used in an area where navaid assignments are spaced at 100 kHz, the protection of the ILS system requires that a VOR having an ERP of 17 dBW (50 W) be at least 9.3 km (5 NM) from the ILS protection point;

b) a localizer receiver designed for 100 kHz channel spacing and used in an area where assignments are spaced at 50 kHz, the protection of the ILS system requires that a VOR having an ERP of 17 dBW (50 W) be at least 79.6 km (43 NM) from the ILS protection point.

3.5.4 Use of the figures given in 3.5.3 above or other figures appropriate to other service distances and altitudes implies recognition of the basic assumptions made in this substitution of an approximate method of calculating separation, and the application of the figures will only be correct within the limitations set by those assumptions. If more precise determination of separation distances is required in areas of frequency congestion, this may be determined for each facility from appropriate propagation curves.

3.5.5 Protection of the ILS system from VOR interference is necessary where a VOR facility is located near an ILS approach path. In such circumstances, to avoid disturbance of the ILS receiver output due to possible cross modulation effects, suitable frequency separation between the ILS and VOR channel frequencies should be used. The frequency separation will be dependent upon the ratio of the VOR and ILS field densities, and the characteristics of the airborne installation.

3.6 Receiving function

3.6.1 *Sensitivity.* After due allowance has been made for aircraft feeder mismatch, attenuation loss and antenna polar diagram variation, the sensitivity of the receiving function should be such as to provide on a high percentage of occasions the accuracy of output specified in 3.6.2 below, with a signal having a field strength of 90 microvolts per metre or minus 107 dBW/m^2.

3.6.2 *Accuracy.* The error contribution of the airborne installation should not exceed plus or minus 3 degrees with a 95 per cent probability.

Note 1.— The assessment of the error contribution of the receiver will need to take account of:

1) the tolerance of the modulation components of the ground VOR facility as defined in Part I, 3.3.5;

2) variation in signal level and carrier frequency of the ground VOR facility;

3) the effects of unwanted VOR and ILS signals.

Note 2.— The airborne VOR installation is not considered to include any special elements which may be provided for the processing of VOR information in the aircraft and which may introduce errors of their own (e.g. radio magnetic indicator (RMI), etc.).

3.6.3 *Flag alarm operation.* Ideally, the flag alarm should warn a pilot of any unacceptable malfunctioning conditions which might arise within either the ground or airborne equipments. The extent to which such an ideal might be satisfied is specified below.

3.6.3.1 The flag alarm movement is actuated by the sum of two currents which are derived from the 30 Hz and 9 960 Hz elements of the VOR bearing component signal and, therefore, the removal of these elements from the radiated carrier results in the appearance of the flags. Since the VOR ground monitor interrupts the bearing components when any unacceptable condition prevails on the ground, there will be an immediate indication within an aircraft when the system is unusable.

3.6.3.2 The flag alarm movement current is also dependent upon the AGC characteristics of the airborne equipment and any subsequent gain following the receiver's second detector. Thus, if with a correctly adjusted airborne receiver the flag is just out of view when receiving a VOR signal conforming to the modulation characteristics specified in Part I, 3.3.5, the flags will again become visible in the event of a decrease in the receiver's over-all gain characteristics.

Note.— Certain types of receivers employ warning indications other than mechanical flags to perform the functions described here.

3.6.4 *VOR receiver susceptibility to VOR and localizer signals*

3.6.4.1 The receiver design should provide correct operation in the following environment:

a) the desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired signal, 50 kHz removed from the desired signal, exceeds the desired signal by up to 34 dB. (During bench testing of the receiver, in this first adjacent channel case, the undesired signal is varied over the frequency range of the combined ground station (plus or minus 9 kHz) and receiver frequency tolerance);

c) an undesired signal, 100 kHz removed from the desired signal, exceeds the desired signal by up to 46 dB;

d) an undesired signal, 150 kHz or further removed from the desired signal, exceeds the desired signal by up to 50 dB.

Note 1.— It is recognized that not all receivers currently meet requirement b); however, all future equipments should be designed to meet this requirement.

Note 2.— In some States, a smaller ground station tolerance is used.

3.6.5 *Immunity performance of VOR receiving systems to interference from VHF FM broadcast signals*

3.6.5.1 With reference to the Note of 3.3.8 of Part I, the immunity performance defined there must be measured against an agreed measure of derogation of the receiving system's normal performance, and in the presence of, and under standard conditions for the input wanted signal. This is necessary to ensure that the checking of receiving station equipment on bench test can be performed to a repeatable set of conditions and results and to facilitate their subsequent approval. Tests have shown that FM interference signals may affect both bearing accuracy and flag current. An adequate measure of immunity performance may be obtained by the use of a wanted signal level of minus 79 dBm and a standard VOR modulation. With these conditions the change in bearing indication should not exceed 0.5 degree, corresponding to a change in deflection current of 7.5 microamps when interfering FM broadcast signals with the levels quoted in 3.3.8.1 and 3.3.8.2 of Part I are applied. The broadcast signals should be selected from frequencies in the range between 87.5 and 107.9 MHz and should be modulated with a representative broadcast type signal.

Note 1.— The signal level of minus 79 dBm assumes a combined antenna and feeder gain of 0 dB.

Note 2.— The change of 7.5 microamps quoted above is for the purpose of standardization when checking that receiving station equipment on bench measurements meet the required immunity. In the planning of frequencies and in the assessment of protection from FM broadcast interference, a value not exceeding this, but in many cases lower, depending on the operational circumstances in individual cases, should be chosen as the basis of the interference assessment.

3.7 VOR system accuracy

Note.— Guidance material on the determination of VOR system performance values is also contained in Annex 11, Attachment E.

3.7.1 *Purpose.* The following guidance material is intended to assist in the use of VOR systems. It is not intended to represent lateral separation standards or minimum obstacle clearances, although it may of course provide a starting point in their determination. The setting of separation standards or minimum obstacle clearances will necessarily take account of many factors not covered by the following material.

3.7.1.1 There is, however, a need to indicate a system use accuracy figure for the guidance of States planning VOR systems.

3.7.2 *Explanation of terms.* The following terms are used with the meanings indicated:

a) *VOR radial signal error.* The difference between the nominal magnetic bearing to a point of measurement from the VOR ground station and the bearing indicated by the VOR signal at that same point. The VOR radial signal error is made up of certain stable elements, such as course displacement error and most site and terrain effect errors, and certain random variable errors. The VOR radial signal error is associated with the ground station only and excludes other error factors, such as airborne equipment errors and pilotage element.

b) *VOR radial variability error.* That part of the VOR radial signal error which can be expected to vary about the essentially constant remainder. The radial variability error is the sum of the variable errors.

c) *VOR radial displacement error.* That part of the VOR radial signal error which is stable and may be considered as fixed for long periods of time.

d) *VOR airborne equipment error.* That error attributable to the inability of the equipment in the aircraft to translate correctly the bearing information contained in the radial signal. This error includes the contributions of the airborne receiver and the instrumentation used to present the information to the pilot.

e) *VOR aggregate error.* The difference between the magnetic bearing to a point of measurement from the VOR ground station and the bearing indicated by airborne VOR equipment of stated accuracy. More simply put, this is the error in the information presented to the pilot, taking into account not only the ground station and propagation path errors, but also the error contributed by the airborne VOR receiver and its instrumentation. The entire VOR radial signal error, both fixed and variable, is used.

f) *VOR pilotage element.* The error in the use of VOR navigation attributable to the fact that the pilot cannot or does not keep the aircraft precisely at the centre of the VOR radial or bearing indicated to him.

g) *VOR system use error.* The square root of the sum of the squares (RSS) of VOR aggregate error and the pilotage element. This combination may be used to determine the probability of an aircraft remaining within specified limits when using VOR.

3.7.3 *Calculation of VOR system use accuracy*

3.7.3.1 The VOR system use accuracy is derived by considering the following error elements:

a) *VOR radial signal error* (Eg). This element consists of the radial displacement error and the radial variability error. It is determined by considering such factors as fixed radial displacement, monitoring, polarization effects, terrain effects and environment changes.

b) *VOR airborne equipment error* (Ea). This element embraces all factors in the airborne VOR system which introduce errors (errors resulting from the use of compass information in some VOR displays are not included).

c) *VOR pilotage element* (Ep). The value taken for this element is that used in PANS-OPS (Doc 8168) for pilot tolerance.

Note.— A measurement error also exists, but in a generalized discussion of errors may be considered to be absorbed in the other error values.

3.7.3.2 Since the errors in a), b), and c), when considered on a system basis (not any one radial) are independent variables, they may be combined on a root-sum-square method (RSS) when the same probability level is given to each element. For the purpose of this material, each element is considered to have a 95 per cent probability.

Therefore, the following formulae are derived:

$$\text{VOR aggregate error} = \sqrt{Eg^2 + Ea^2}$$

$$\text{VOR system use error} = \sqrt{Eg^2 + Ea^2 + Ep^2}$$

3.7.3.3 The following examples will derive only the VOR system use error but calculations can also be made to determine VOR aggregate error, if desired. By use of these formulae, the impact on the system of improvement or degradation of one of more error elements can be assessed.

Note.— All figures for VOR radial signal error are related to radials for which no restrictions are published.

3.7.3.4 Subject to the qualifications indicated in 3.7.1 above, it is considered that a VOR system use accuracy of plus or minus 5 degrees on a 95 per cent probability basis is a suitable figure for use by States planning the application of the VOR system (see, however, 3.7.3.5 below). This figure corresponds to the following component errors:

VOR radial signal error:

plus or minus 3° (95 per cent probability), a value readily achieved in practice.

VOR airborne equipment error:

plus or minus 3° (95 per cent probability), system characteristics value (see 3.6.2 above).

VOR pilotage element:

plus or minus 2.5° (95 per cent probability), in accordance with PANS-OPS (see also 3.7.3.8 below).

3.7.3.5 While the figure of plus or minus 5 degrees on a 95 per cent probability basis is a useful figure based on broad practical experience and used by many States, it must be noted that this figure may be achieved only if the error elements which make it up remain within certain tolerances. It is clear that, if the errors attributable to the VOR system elements are larger than the amounts noted, the resulting VOR system use error will also be larger. Conversely, where any or all of the VOR system error elements are smaller than those used in the above computation, the resulting VOR system use error will also be smaller.

3.7.3.6 The following examples, also derived from practical experience, provide additional planning guidance for States:

A. *VOR radial signal error:*

plus or minus 3.5° (95 per cent probability), used by some States as the total ground system error.

VOR airborne equipment error:

plus or minus 4.2° (95 per cent probability), recognized in some States as the minimum performance figure for some classes of operations.

VOR pilotage element:

plus or minus 2.5° (95 per cent probability), in accordance with PANS-OPS (see also 3.7.3.8 below).

Calculated VOR system use accuracy:

plus or minus 6° (95 per cent probability).

B. *VOR radial signal error:*

plus or minus 1.7° (95 per cent probability), based on extensive flight measurements conducted in one State on a large number of VORs.

VOR airborne equipment error:

plus or minus 2.7° (95 per cent probability), achieved in many airline operations.

VOR pilotage element:

plus or minus 2.5° (95 per cent probability), in accordance with PANS-OPS (see also 3.7.3.8 below).

Calculated VOR system use accuracy:

plus or minus 4° (95 per cent probability).

3.7.3.7 More realistic application of the VOR system may be achieved by assessing the errors as they actually exist in particular circumstances, rather than by using all-embracing generalizations which may give unduly optimistic or pessimistic results. In individual applications, it may be possible to utilize a system use accuracy value less than plus or minus 5 degrees if one or more of the error elements are smaller than the values used to compute the plus or minus 5 degrees. Conversely, a system use accuracy value greater than plus or minus 5 degrees will be necessary where it is known that radials are of poor quality or significant site errors exist, or for other reasons. However, in addition to this advice a warning is also essential regarding the use of lower values of individual elements in the system (for example, the radial signal error) on the assumption that an over-all improvement in system accuracy will occur. There is considerable evidence that this may not be the case in some circumstances and that lower system accuracy values should not be applied without other confirmation (e.g. by radar observation) that an actual improvement in over-all performance is being achieved.

3.7.3.8 It is to be noted that in angular systems such as the VOR, the pilotage element error, expressed in angular terms, will be greater as the aircraft nears the point source. Thus, whilst ground system and airborne error contributions, expressed in angular terms, are for all practical purposes constant at all ranges, it is necessary when considering the over-all system use accuracy figures to take into account the larger pilotage element error occurring when the aircraft is near the VOR. However, these larger pilotage element errors do not result in large lateral deviations from course when near the facility.

3.8 Change-over points for VORs

3.8.1 Guidance on the establishment of change-over points on ATS routes defined by VORs is contained in Annex 11, Attachment E.

4. Precision approach radar system

Figures C-14 to C-18 illustrate certain of the Standards contained in Part I, 3.2 of this Annex.

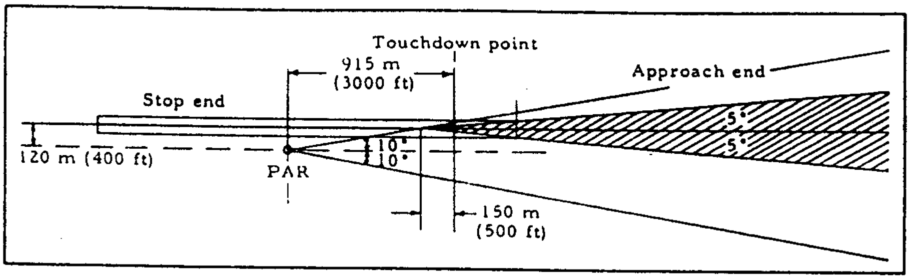


Figure C-14. Minimum set-back of PAR with respect to touchdown for offset of 120 m (400 ft) when aligned to scan plus or minus 10 degrees on QDR of runway

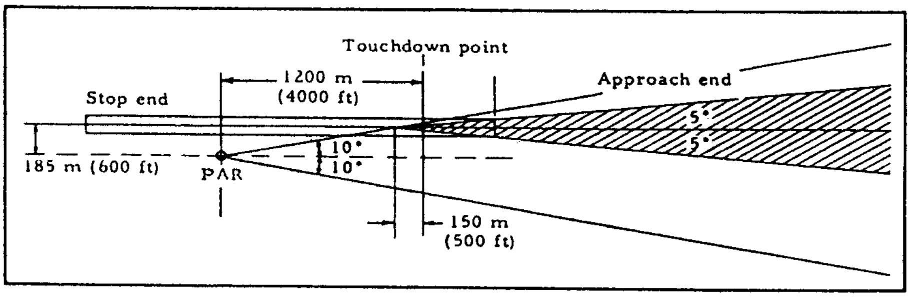


Figure C-15. Minimum set-back of PAR with respect to touchdown for offset of 185 m (600 ft) when aligned to scan plus or minus 10 degrees on QDR of runway

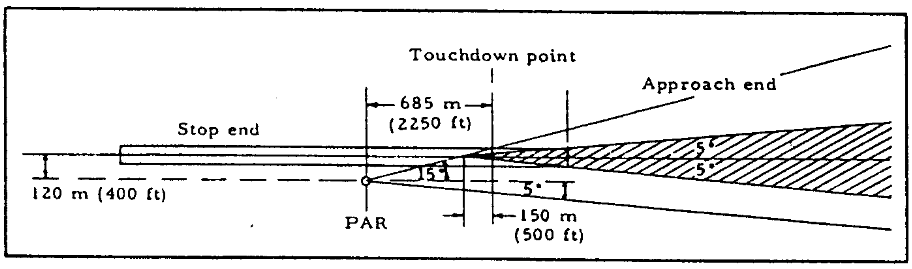


Figure C-16. Minimum set-back of PAR with respect to touchdown for offset of 120 m (400 ft) when aligned to scan 5 degrees and 15 degrees with respect to QDR of runway

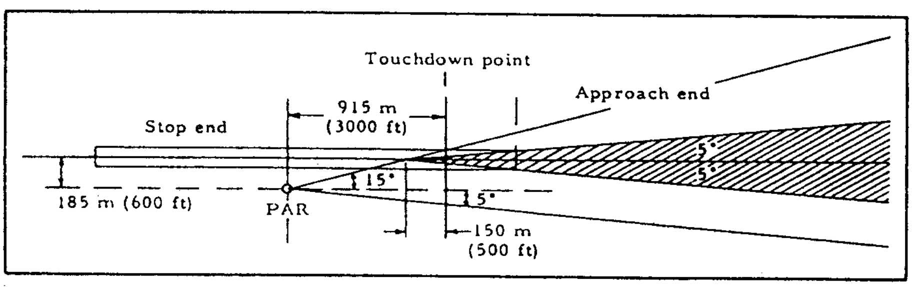


Figure C-17. Minimum set-back of PAR with respect to touchdown for offset of 185 m (600 ft) when aligned to scan 5 degrees and 15 degrees with respect to QDR of runway

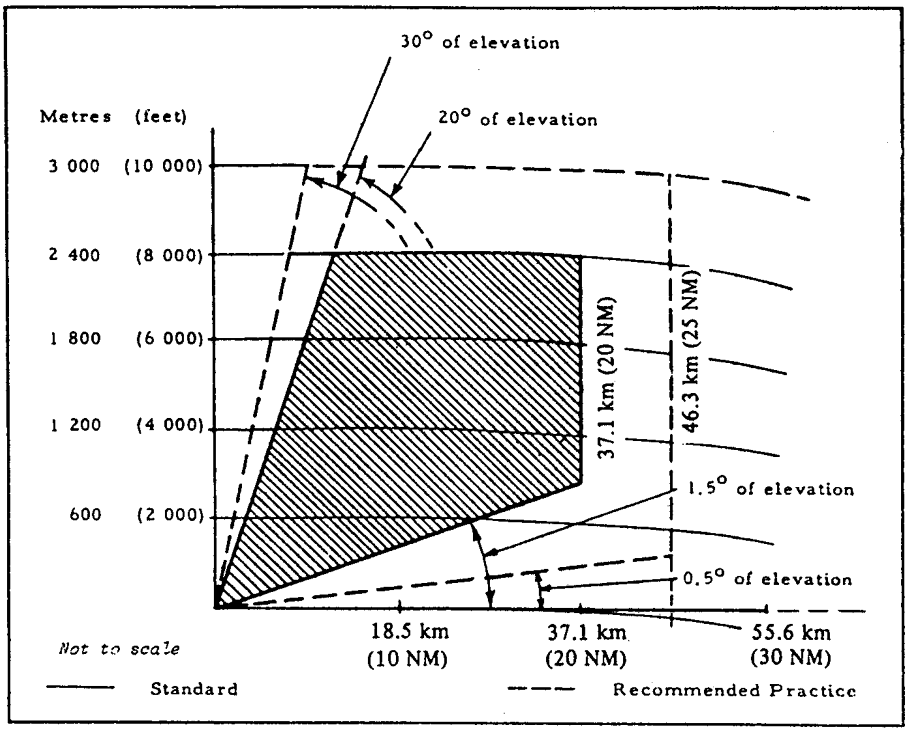


Figure C-18. SRE of precision approach radar system — Vertical coverage on a 15 m² echoing area aircraft

5. Specification for 75 MHz marker beacons (en-route)

5.1 Marker beacon antenna arrays

5.1.1 *General.* The following describes types of marker antenna arrays that are frequently used in current practice. These types are the simplest forms meeting normal requirements; in special cases, arrays having a better performance (see Note to 5.1.4 below) may be required.

5.1.2 *Z marker beacons.*

a) *Radiating systems.* A radiating system consisting of two horizontal dipole arrays crossed at right angles, each comprising two co-linear half-wave radiating elements with centres spaced approximately a half wavelength apart and mounted one-quarter wavelength above the counterpoise. The currents in the dipoles and their respective elements are adjusted so that:

1) the current in one set of dipole arrays relative to that in the other set is equal but differs in time phase by 90 degrees;

2) the currents in the radiating elements of a particular dipole array are equal and in time phase.

b) *Counterpoise.* A square counterpoise with minimum dimensions of 9 m × 9 m, usually elevated about 1.8 m (6 ft) above the ground and, if fabricated from wire mesh, with the dimension of the mesh not exceeding 7.5 cm × 7.5 cm.

5.1.3 *Fan marker beacons for use only at low altitudes (low power fan marker beacons).* A radiating system capable of providing the field strengths indicated in Part I, 3.1.7.3.2.

5.1.4 *Fan marker beacons for general use (high power fan marker beacons).*

a) *Radiating system.* A radiating system consisting of four horizontal co-linear half-wave (approximate) radiating elements mounted approximately one-quarter wavelength above the counterpoise. The current in each of the antenna elements should be in phase and should have a current ratio of 1:3:3:1.

Note.— The current distribution between elements and their height above the counterpoise may be altered to provide patterns for specific operational requirements. Improved vertical patterns for certain operational needs may be achieved by adjusting the height of the dipole arrays above the counterpoise to a value of one-quarter wavelength or greater, but less than a half wavelength.

b) *Counterpoise.* A rectangular counterpoise with minimum dimensions of 6 m × 12 m, usually elevated about 1.8 m (6 ft) above the ground and, if fabricated from wire mesh, with the dimension of the mesh not exceeding 7.5 cm × 7.5 cm.

5.2 Identification coding for fan marker beacons associated with a four-course radio range

5.2.1 Fan marker beacons located on the legs of a four-course radio range do not normally require an identification signal relating to a particular geographic location, but only a signal that will indicate the leg with which they are associated.

5.2.2 In the case of a four-course radio range having not more than one marker on any leg, it is current practice to identify a marker by a single dash if on the leg bearing true north or nearest to north in a clockwise direction (east), and to identify a marker on other legs by two, three or four dashes according to whether the leg with which it is associated is the second, third or fourth leg from north in a clockwise direction. Where more than one fan marker beacon is associated with one leg of a four-course radio range, the marker nearest to the station is identified by dashes only, the next nearest by two dots preceding the dashes, and the third by three dots preceding the dashes, and so on.

Note.— In certain special circumstances, the above coding system may lead to ambiguities due to two markers associated with the legs of different but overlapping radio ranges being geographically close together. In such cases, it is desirable to use a distinctive identification coding with one of the marker beacons.

6. Material concerning NDB

6.1 Guidance material on NDB field strength requirements in latitudes between 30°N and 30°S

6.1.1 In order to obtain a satisfactory service within the rated coverage of an NDB located in latitudes between 30°N and 30°S, a minimum value of field strength of 120 microvolts per metre would be required, except where practical experience in the operation of NDBs over several years has revealed that a minimum field strength of 70 microvolts per metre would be adequate to meet all the operational needs. In some specific areas, field strength values considerably in excess of 120 microvolts per metre would be required. Such areas are:

a) Indonesia and Papua New Guinea, Burma, Malay Peninsula, Thailand, Lao People's Democratic Republic, Democratic Kampuchea, Viet Nam and Northern Australia;

b) Caribbean and northern parts of South America;

c) Central and South Central Africa.

6.1.2 The field strength of 120 microvolts per metre is based upon practical experience to date and is a compromise between what is technically desirable and what it is economically possible to provide.

6.2 Guidance material on meaning and application of rated and effective coverage

6.2.1 *Rated coverage*

6.2.1.1 The rated coverage as defined in Part I, 3.4.1, is a means of designating actual NDB performance, in a measurable way, which is dependent on the frequency, the radiated power, and the conductivity of the path between the NDB and a point on the boundary where the minimum value of field strength is specified.

6.2.1.2 The rated coverage has been found to be a useful means of facilitating regional planning and, in some instances, may be related to effective coverage.

6.2.1.3 The application of rated coverage to frequency planning is governed by the following criteria:

6.2.1.3.1 Frequencies should be deployed having regard to the rated coverage of the NDBs concerned, so that the ratio of the signal strength of any NDB at the boundary of its rated coverage to the total field strength due to co-channel stations and adjacent channel stations (with an appropriate allowance for the selectivity characteristics of a typical airborne receiver) is not less than 15 dB by day.

6.2.1.3.2 The figures set forth in Attachment B to Part II should be applied, as appropriate, in determining the allowance to be made for the attenuation of adjacent channel signals.

6.2.1.4 It follows from the application of rated coverage to frequency deployment planning that, unless otherwise specified, protection against harmful interference can only be ensured within the rated coverage of an NDB and, then, only if the radiated power of the NDBs is adjusted to provide within reasonably close limits the field strength required at the limit of the rated coverage. In areas where the density of NDBs is high, any NDB providing a signal at the limit of its rated coverage materially in excess of that agreed in the region concerned will give rise, in general, to harmful interference within the rated coverages of co-channel or adjacent channel NDBs in the area concerned, and will limit the number of NDBs which can be installed in the region within the available spectrum. It is important, therefore, that increases in radiated power beyond that necessary to provide the rated coverage, particularly at night when sky wave propagation may give rise to interference over long distances, should not be made without co-ordination with the authorities of the other stations likely to be affected (see Part I, 3.4.3).

6.2.1.5 Frequency planning is considerably facilitated if a common value of minimum field strength within the desired coverage is used.

6.2.1.6 Extensive experience has shown that in relatively low noise level areas, such as Europe, the figure of 70 microvolts per metre is satisfactory.

6.2.1.6.1 Experience has also shown that the figure of 120 microvolts per metre is generally satisfactory for higher noise level areas but will be inadequate in areas of very high noise. In such areas, the information given in 6.3 below may be used for general guidance.

6.2.2 *Relationship to effective coverage*

6.2.2.1 Rated coverage may have a close correlation to effective coverage under the following conditions:

1) when the minimum field strength within the rated coverage is such that, for most of the time, it exceeds the field strength due to atmospheric and other noise sufficiently to ensure that the latter will not distort the information presented in the aircraft to the extent that it is unusable;

2) when the ratio of the strength of the wanted signal to that of interfering signals exceeds the minimum required value at all points within the coverage, in order to ensure that interfering signals will also not distort the information presented in the aircraft to the extent that it is unusable.

6.2.2.2 Since, normally, the lowest signal within the coverage will occur at its boundary, these conditions imply that at the boundary the field strength should be such that its ratio to atmospheric noise levels would ensure usable indications in the aircraft for most of the time and that, in respect of the boundary value, over-all planning should ensure that the ratio of its value to that of interfering signals exceeds the required value for most of the time.

6.2.2.3 Although the value of 70 microvolts per metre used for frequency deployment has been found successful in Europe (i.e. north of 30° latitude) in giving coverage values which closely approximate to effective coverage most of the time, experience is too limited to prove the suitability of the 120 microvolts per metre value for general application in areas of high noise. It is to be expected that rated coverages in high noise based on a boundary value of 120 microvolts per metre will, on many occasions, be substantially greater than the effective coverage achieved. In such areas, in order to secure a better correlation between rated coverage and an average of the achieved effective coverage, it may be advisable to choose a boundary value based more closely on the proportionality of noise in that area to the noise in areas where a boundary value has been satisfactorily established (e.g. Europe), or to determine an appropriate value from a statistical examination of achieved effective coverages in respect of an NDB in the area of known performance.

6.2.2.4 It is important to appreciate, however, that minimum values of field strength based on a simple comparison of noise levels in different areas may be insufficient, because factors such as the frequency of occurrence of noise, its character and effect on the airborne receiver and the nature of the air operation involved may all modify ratios determined in this way.

6.2.2.5 Values of diurnal and seasonal noise in various parts of the world are given in Report 322 of the CCIR, published as a separate booklet.

6.2.2.5.1 Correlation of these values to actual local conditions and the derivation of required signal-to-noise ratios for effective operational use of ADF equipment is not yet fully established.

6.2.3 *Effective coverage*

6.2.3.1 Effective coverage as defined in Part I, 3.4.1, is the area surrounding an NDB, within which useful information to the operator concerned can be obtained at a particular time. It is, therefore, a measure of NDB performance under prevailing conditions.

6.2.3.2 The effective coverage is limited by the *ratio* of the strength of the steady (non-fading) signal received from the NDB to the total noise intercepted by the ADF receiver. When this ratio falls below a limiting value, useful bearings cannot be obtained. It should also be noted that the effective coverage of an NDB may in some cases be limited to the range of the usable identification signal.

6.2.3.3 The strength of signal received from the NDB is governed by:

1) the power supplied to the antenna of the NDB;

2) the radiation efficiency of the antenna, which varies according to the height of the antenna and other characteristics of the radiating system;

3) the conductivity of the path between the NDB and the receiver, which may vary considerably as between one site and another, and is always less over land than over seawater;

4) the operating radio frequency.

6.2.3.4 The noise admitted by the receiver depends on:

1) the bandwidth of the receiver;

2) the level of atmospheric noise, which varies according to the geographical area concerned, with the time of day and the season of the year, and which may reach very high levels during local thunderstorms;

3) the level of the interference produced by other radio emissions on the same or on adjacent frequencies, which is governed to a large extent by the NDB density in the area concerned and the effectiveness of regional planning;

4) the level of noise due to electrical noise in the aircraft or to industrial noise (generated by electric motors, etc.), when the coverage of the NDB extends over industrial areas.

6.2.3.4.1 It has to be noted that the effect of noise depends on characteristics of the ADF receiver and the associated equipment, and also on the nature of the noise (e.g. steady noise, impulsive noise).

6.2.3.5 A further factor which limits the effective coverage of an NDB is present at night when interaction occurs between components of the signal which are propagated respectively in the horizontal plane (ground wave propagation) and by reflection from the ionosphere (sky wave propagation). When there is interaction between these components, which arrive at the ADF receiver with a difference of phase, bearing errors are introduced (night effect).

6.2.3.6 It will thus be seen that the effective coverage of an NDB depends on so many factors, some of which are variable, that it is impossible to specify the effective coverage of an NDB in any simple manner. The effective coverage of any NDB, in fact, varies according to the time of day and the season of the year.

6.2.3.6.1 Hence any attempt to specify an effective coverage, which would be obtainable at any time throughout the day or throughout the year, would result either in a figure for coverage which would be so small (since this would be the coverage obtained under the worst conditions of atmospheric noise, etc.) as to give quite a misleading picture of the effectiveness of the NDB, or would involve such high power and costly antenna systems (to provide the required coverage under the worst conditions), that the installation of such an NDB would usually be precluded by considerations of initial and operating costs. No specific formula can be given in determining what rated coverage would be equivalent to a desired effective coverage and the relation must be assessed regionally.

6.2.3.7 Those concerned with the operational aspects of NDB coverage will normally consider requirements in terms of a desired operational coverage and, in regional planning, it will usually be necessary to interpret such requirements in terms of a rated coverage from which may be derived the essential characteristics of the NDB required and which will also define the area to be protected against harmful interference. No specific formula can be given in determining what rated coverage would be equivalent to a desired operational coverage and the relation must be assessed regionally.

6.2.3.8 Some States have recorded data on NDBs and their effective coverage; and collection of similar information would be a practical way of obtaining an assessment of effective coverage in terms of rated coverage of facilities in a given area. This information would also be useful for future regional planning. In order to reduce the number of factors involved in assessing effective coverage, it would be desirable to establish criteria for determining the limit of useful coverage in terms of the reaction of the bearing indicator. The data referred to previously, together with measurements of actual field strength within the coverage of the NDB, would also permit determination of the effectiveness of existing installations and provide a guide to improvements that may be necessary to achieve a desired effective coverage.

6.3 Coverage of NDBs

6.3.1 *Introduction*

6.3.1.1 The following studies have been based on the latest propagation and noise data available to the ITU. They are included in this Attachment as general guidance in respect of NDB planning. Attention is called particularly to the assumptions made.

6.3.1.2 When applying the material, the validity of the assumptions in respect of the particular conditions under consideration should be carefully examined and, in particular, it should be noted that the assumed signal-to-noise ratios require considerable further study before they can be accepted as representative of the ratios limiting useful reception.

6.3.2 *Assumptions.*

1. Operating frequency — 300 kHz.
   Reference is made, however, where appropriate, to frequencies of 200 kHz and 400 kHz.

2. a) Average soil conductivity:
   ($\sigma = 10^{-13}$ e.m.u.)

   b) Average seawater conductivity:
   ($\sigma = 4.10^{-11}$ e.m.u.)

3. The level of atmospheric noise (RMS) which is likely to prevail: 1) by day, 2) by night, over land masses, within the belts of latitude mentioned. [The values of expected noise have been derived from Report No. 65 of the VIIIth Plenary Assembly of the CCIR (Warsaw, 1956), and the IXth Plenary Assembly of the CCIR (Los Angeles, 1959) and have been taken as the average noise by day and by night during equinox periods, i.e. the values which are likely to be exceeded during 20-25 per cent of the year.]

4. Input powers to the antenna of the NDB of:

   a) 5 kW
   b) 1 kW
   c) 500 W
   d) 100 W
   e) 50 W
   f) 10 W

5. The following average values of radiation efficiencies of antennas, i.e. the ratio of:

$$\left[\frac{\text{Radiated power}}{\text{Input power to antenna}}\right]$$

Input power to antenna	*Radiation efficiency of antenna*
a) 5 kW	20% (−7 dB)
b) 5 kW	10% (−10 dB)
c) 1 kW	8% (−11 dB)
d) 500 W	5% (−13 dB)
e) 100 W	3% (−15 dB)
f) 50 W	2% (−17 dB)
g) 10 W	1% (−20 dB)
h) 10 W	0.3% (−25 dB)

i) The figure for a) is included because it is possible to realize this efficiency by the use of a more elaborate antenna system than is usually employed.

ii) The figure for h) is included because many low power NDBs use very inefficient antennas.

6. An admittance band of the ADF receiver of 6 kHz.

7. Required ratios of signal-(median) to-noise (RMS) of:

a) 15 dB by day;

b) 15 dB by night.

6.3.3 *Results of studies*

A.— *Minimum field strengths required at the boundary of the rated coverage:*

Latitude	*By day for 15-dB S/N ratio*	*By night for 15 dB S/N ratio*
5°N - 5°S	320 μV/m (+50 dB)	900 μV/m (+59 dB)
5° - 15°N&S	85 μV/m (+39 dB)	700 μV/m (+57 dB)
15° - 25°N&S	40 μV/m (+32 dB)	320 μV/m (+50 dB)
25° - 35°N&S	18★μV/m (+25 dB)	120 μV/m (+42 dB)
>35°N&S	18★μV/m (+25 dB)	50 μV/m (+35 dB)

A star shown against a figure indicates that a higher value of field strength — probably 2 or 3 times the values shown (plus 6 to plus 10 dB) — may be necessary in the presence of high aircraft noise and/or industrial noise.

B.— *Coverage of NDBs (expressed in terms of the radius of a circle, in* kilometres, *with the NDB at the centre) which may be expected under the assumptions made:*

1) By *day,* over *land,* and for *15 dB S/N ratio* at the boundary of the coverage:

Latitude	*Input power to antenna*			
	(a) 5 kW	*(b)* 5 kW	*(c)* 1 kW	*(d)* 500 W
5°N - 5°S	320	300	170	120
5° - 15°N&S	510	470	320	250
15° - 25°N&S	>600	600	450	350
25° - 35°N&S	>600★	>600★	600★	500★
>35°N&S	>600★	>600★	>600★	500★

Latitude	*Input power to antenna*			
	(e) 100 W	*(f)* 50 W	*(g)* 10 W	*(h)* 10 W
5°N - 5°S	50	30	10	<10
5° - 15°N&S	150	90	40	10
15° - 25°N&S	220	160	70	45
25° - 35°N&S	330★	250★	130★	80★
>35°N&S	330★	250★	130★	100★

2) By *night,* over *land,* and for *15 dB S/N ratio* at the boundary of the coverage:

Latitude	*Input power to antenna*			
	(a) 5 kW	*(b)* 5 kW	*(c)* 1 kW	*(d)* 500 W
5°N - 5°S	190	150	85	50
5° - 15°N&S	210	180	110	70
15° - 25°N&S	320	300	170	120
25° - 35°N&S	390	390	280	200
>35°N&S	390	390	390	310

Latitude	*Input power to antenna*			
	(e) 100 W	*(f)* 50 W	*(g)* 10 W	*(h)* 10 W
5°N - 5°S	20	<10	<10	<10
5° - 15°N&S	25	15	<10	<10
15° - 25°N&S	50	30	10	<10
25° - 35°N&S	100	70	25	15
>35°N&S	180	120	50	30

6.3.3.1 In all of the above tables, it has to be noted that:

1) the distances are given in kilometres, in accordance with ITU practice;

2) the figures in the final columns, with the heading 10 W, are calculated on the assumption that the low power NDB uses a very inefficient antenna [see 6.3.2, assumption 5 h) above];

3) a star shown against a figure indicates that the coverage may be limited by aircraft and industrial noises.

6.3.3.2 It has also to be noted that:

a) if a frequency of 200 kHz were used in place of 300 kHz, this would not appreciably affect the coverage of low power short range NDBs, but the coverage of the higher power, longer range beacons (for example, those with a range of 150 km or more) would be *increased,* as compared with those shown in the tables, by about 20 per cent;

b) if a frequency of 400 kHz were used in place of 300 kHz this would not appreciably affect the coverage of low power short range NDBs, but the coverage of the higher power, longer range beacons (for example, those with a range of 150 km or more) would be *decreased,* as compared with those shown in the tables, by about 25 per cent;

c) use of an ADF receiver with a narrower band would, other things being equal, provide wider coverage for the same radiated power of the NDB or, for the same coverage, an improved effective signal-to-noise ratio.

For example, if an admittance band of 1 kHz instead of 6 kHz were used, the coverage might be increased by as much as 30 per cent for the same radiated power or, alternatively, the effective signal-to-noise ratio might be increased by as much as 8 dB;

d) if a sector of the coverage of an NDB is over seawater, a greater coverage may be expected within that sector due to:

1) better ground wave propagation over seawater than over land;

2) the noise level, which is highest over land, often drops fairly steeply with increasing distance from the land. It might be assumed, therefore, that the distances shown in the tables could be increased by about 30 per cent by day, and by about 20 per cent by night, when the path is over seawater;

e) if, however, the beacon is sited on an island remote from land masses (for example, in mid-Pacific or mid-Atlantic, but not in the Caribbean), the coverage of the beacon is likely to be much greater, particularly in tropical latitudes, than is indicated in the tables; and in such cases figures for coverage similar to those shown for latitudes more than 35°N and S may be assumed for all latitudes, due to the much lower level of atmospheric noise which prevails in mid-ocean as compared with that experienced over, or in proximity to, land masses.

6.3.4 *Limitation of coverage of a beacon at night due to "night effect".*

a) The distances, at night, at which the ground wave and sky wave components of the received field are likely to be equal are as follows:

Frequency	*Over land*	*Over sea*
200 kHz	500 km	550 km
300 kHz	390 km	520 km
400 kHz	310 km	500 km

b) The distances, at night, at which the ground wave component of the received field is likely to exceed the sky wave component by 10 dB are as follows:

Frequency	*Over land*	*Over sea*
200 kHz	300 km	320 km
300 kHz	230 km	300 km
400 kHz	200 km	280 km

c) It is, therefore, unlikely that reliable bearings can be obtained, at night, due to interaction of the two components of the received field, at much greater distances than those shown in 6.3.4 b) above. *These distances are independent of the power of the NDB.*

d) It has to be noted, moreover, that, while with overland paths of good conductivity, night effect will only be serious at somewhat greater distances than those indicated over paths of poor conductivity, night effect may become pronounced at much shorter ranges. This will also depend to some extent upon the characteristics of the radiation system.

6.4 Considerations affecting operations of NDBs

6.4.1 *Depth of modulation*

6.4.1.1 In specifying that the depth of modulation should be maintained as near to 95 per cent as is practicable, it must be noted that, at the frequencies used for NDBs, the small antennas generally in use can affect the effective modulation depth of the NDB system due to attenuation of the sidebands.

6.4.1.2 At this order of frequency, the antennas are normally only a small fraction of a wavelength long; they are therefore highly reactive and tend to have a high Q.

6.4.1.3 The effect is illustrated in Figure C-19, which was compiled from measurements made by one State. The modulating frequency in these measurements was 1 020 Hz. If a lower modulating frequency were used, the effect would be less.

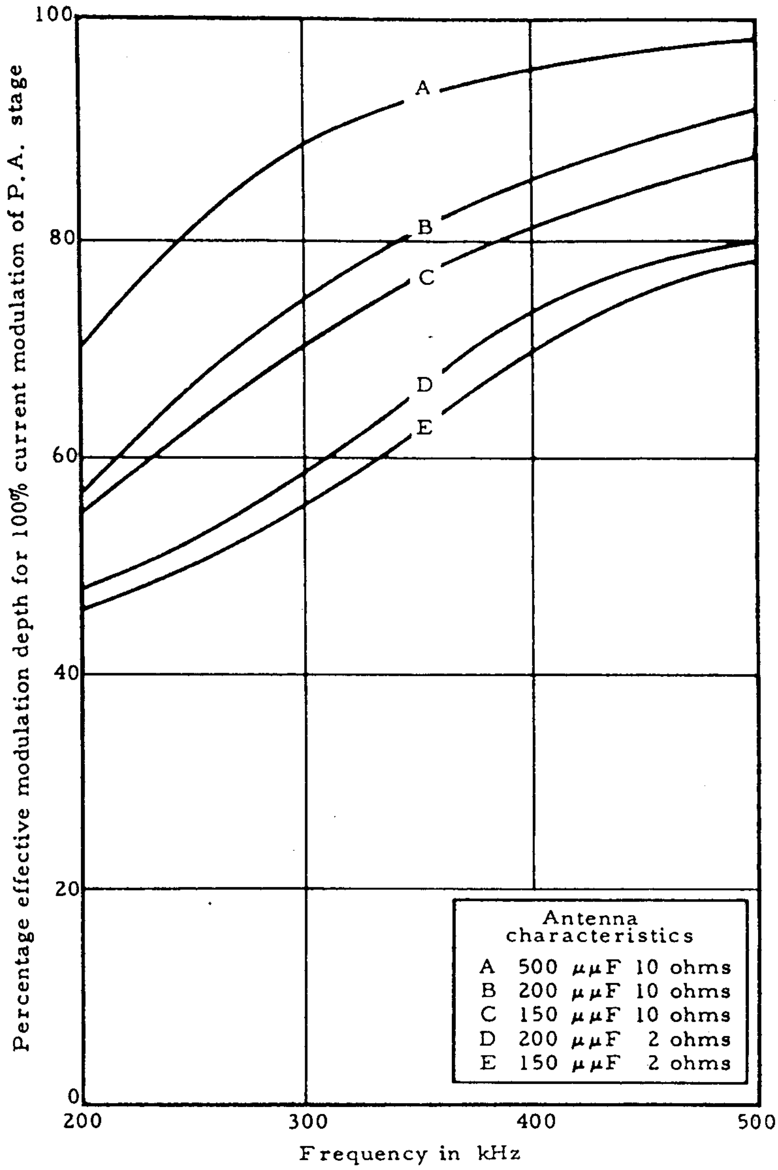
6.4.1.4 In order to reduce the attenuation, attempts should be made to reduce the Q of the antenna. This can be done in two ways, by increasing either its capacity or resistance.

6.4.1.5 Inserting additional resistance in an antenna wastes power, whereas increasing the capacity does not. Additionally, the effect of increasing the capacity is to reduce the voltage across the system and hence to reduce the insulation problems.

6.4.1.6 For these reasons, it is considered desirable to increase antenna capacity by the use of a top load as, for example, in the so-called umbrella top capacity.

6.4.2 *Earth systems*

6.4.2.1 Frequency planning is done on the assumption that the field strength will be maintained at the correct value. If the earth resistance is high (i.e. an insufficient earth system), not only will the radiation efficiency be low but the power radiated will be sensitive to changes in climatic conditions and other factors affecting the earth loss. In all



Note.—The modulating frequency in these measurements was 1 020 Hz.

Figure C-19. The effect of antenna Q on the depth of modulation of the radiated signal

cases, the earth system needs to be the best possible, taking into account all local circumstances.

6.5 Considerations affecting the choice of the modulating frequency for NON/A2A NDBs

6.5.1 Recognition of the fact that modern narrow band ADF receivers have improved selectivity characteristics requires consideration of the fact that, in so far as attenuation of the audio sidebands by these receivers results in a reduction of the effective depth of modulation of the signal, the distance at which satisfactory identification is obtained is consequently reduced. In such circumstances, it is considered that 400 Hz would provide a better identification service than 1 020 Hz. There is some evidence, however, that under conditions of high atmospheric noise, the higher frequency of 1 020 Hz may provide a more easily readable signal.

6.6 Guidance material on the testing of NDBs

6.6.1 In the following paragraphs an indication is given of the desirable periodicity for various tests. These figures are intended as only general guidance, it being recognized that many local circumstances will influence a State in establishing its test programmes.

6.6.1.1 *Carrier frequency*

6.6.1.1.1 The carrier frequency should periodically be tested against an accurate standard to ensure that the tolerance specified in Part I, 3.4.4.2, is maintained. A standard such as a crystal controlled frequency meter having an accuracy of 0.001 per cent of the operating frequency is recommended for this purpose.

6.6.1.1.2 This test of carrier frequency stability should be carried out:

a) at least semi-annually for crystal controlled transmitters;

b) at least once a month for non-crystal controlled transmitters.

6.6.1.1.3 If practicable, tests at shorter intervals should be made.

6.6.1.2 *Frequency of the modulating tone*

6.6.1.2.1 The identification frequency requirements are specified in Part I, 3.4.5.4. An audio signal generator calibrated to an accuracy of 0.5 per cent or better at the specified frequency is recommended as a calibration standard.

6.6.1.2.2 This test should be made at least once a month.

6.6.1.3 *Ground wave field strength*

6.6.1.3.1 It is recommended that remote field strength measurements be made using a field strength indicator set capable of checking that the power radiated from an NDB is in accordance with Part I, 3.4.3.

6.6.1.3.2 This test should be carried out at least once a month.

6.6.1.4 *Modulation depth*

6.6.1.4.1 Part I, 3.4.6.2, requires that the depth of modulation of the carrier frequency should be maintained as near to 95 per cent as practicable. Use of an oscilloscope capable of operation at the transmitting frequency of the NDB is recommended for this purpose.

6.6.1.4.2 This test, using an oscilloscope, should be made at least every three months. Additionally, rough checks of modulation depth may be made frequently by using a calibrated diodevoltmeter, but these are not a satisfactory substitute for the test using the oscilloscope.

6.6.1.4.3 Unwanted audio frequency modulation should be measured at least every three months to ensure that it does not exceed the limits of Part I, 3.4.6.5. An oscilloscope is also recommended for this test.

6.6.1.5 *Fall of carrier power with modulation*

6.6.1.5.1 When modulation is applied, the carrier power should not decrease by more than the amount specified in Part I, 3.4.6.4. A recommended method of ensuring this is to use, at a suitable remote site, a calibrated communication receiver having a continuous wave IF crystal filter as an indicator of transmitter field strength and having sufficient selectivity to reject the audio sidebands.

6.6.1.5.2 An alternative but probably less accurate method of determining the fall of carrier power would be a comparison of the current fed into the antenna when the transmitter is modulated with that when it is not modulated.

6.6.1.5.3 This test should be done at least once a month.

7. Material concerning DME

7.1 Guidance material concerning both DME/N and DME/P

7.1.1 *System efficiency*

7.1.1.1 System efficiency is the combined effect of down-link garble, ground transponder dead time, up-link garble, and interrogator signal processor efficiency. Since each of these efficiency components are statistically independent, they can be computed individually and then combined to yield the system efficiency. The effect of a single component is defined as the percentage ratio of valid replies processed by the interrogator in response to its own interrogations assuming all other components are not present. The system efficiency is then the product of the individual components.

7.1.1.2 In computing system efficiency, the number of missing replies as well as the accuracy of the range measurement made with the received replies should be considered. Missing replies may result from signal interference due to garble or from interrogations being received at the transponder during a dead time period. Replies which contain significant errors large enough to be rejected by the interrogator signal processing also should be treated as missing replies when computing the efficiency component.

7.1.1.3 The interference rate due to garble is dependent upon the channel assignment plan, traffic loading, and the ground transponder and interrogator receiver bandwidths. Because the FA mode has a wider receiver bandwidth than the IA mode, it is more susceptible to interference. These factors were accommodated in the DME/P system definition and normally do not require special consideration by the operating authority.

7.1.2 *Down-link garble*

7.1.2.1 Down-link garble occurs when valid interrogations at the ground transponder are interfered with by coincident interrogations from other aircraft and results in loss of signal or errors in time-of-arrival measurement. This undesired air-to-ground loading is a function of the number of interrogating aircraft in the vicinity of the serving transponder and the corresponding distribution of interrogation frequencies and signal amplitudes received at the transponder.

Note.— Transponder to transponder garbling is controlled by the channel assignment authorities.

7.1.3 *Up-link garble*

7.1.3.1 Up-link garble occurs when valid replies at the interrogator are interfered with by other transponders and results in loss of signal or errors in pulse time-of-arrival measurement. The garble can be interference from any transponder whose frequency is within the bandwidth of the interrogator, including those on the same frequency, but with different pulse coding. This undesired ground-to-air loading is a function of the number of transponders in the vicinity of the interrogator and the corresponding distribution of reply frequencies and signal amplitudes received at the interrogator.

7.1.4 *Interrogator processor efficiency*

7.1.4.1 The interrogator signal processor efficiency is the ratio of the number of replies processed by the interrogator to the number of interrogations in the absence of garble and transponder dead time effects. This efficiency depends on the reply pulse threshold level and the receiver noise level.

7.1.5 *Relationship between aircraft served and transmission rate*

7.1.5.1 Specification of the maximum transponder transmission rate establishes the maximum average transmitter power level. Part I, 3.5.4.1.5.5 recommends that the transponder have a transmission rate capability of 2 700 pulse pairs per second if 100 aircraft are to be served. This represents typical transponder loading arising from 100 aircraft. To determine the actual transmission rate capability that should be accommodated at a given facility during peak traffic conditions requires that the maximum number of interrogators be estimated. To compute the interrogation loading on the transponder, the following should be considered:

a) the number of aircraft that constitutes the peak traffic load;

b) the number of interrogators in use on each aircraft;

c) the distribution of operating modes of the interrogators in use (e.g. search, initial approach, final approach, ground test);

d) the appropriate pulse repetition frequency as given in Part I, 3.5.3.4.

7.1.5.2 Given the interrogation loading which results from the peak traffic as well as the reply efficiency of the transponder in the presence of this load, the resulting reply rate can be computed, thereby establishing the required transmitter capability. This reply rate is the level that, when exceeded, results in a reduction in receiver sensitivity (as specified in Part I, 3.5.4.2.4) in order to maintain the reply rate at or below this maximum level.

7.1.6 *Siting of DME associated with ILS or MLS*

7.1.6.1 The DME should, where possible, provide to the pilot an indicated zero range at touchdown in order to satisfy current operational requirements.

7.1.6.2 The optimum site for a DME transponder is dependent upon a number of technical and operational factors. DME/N may be installed with ILS or MLS where operational requirements permit. DME/P, which provides higher accuracy and coverage throughout the entire runway region, is required to support the more flexible and advanced operations that are available with MLS.

7.1.6.3 In the case of DME/N, the provision of zero range indication may be achieved by siting the transponder as close as possible to the point at which zero range indication is required. Alternatively, the transponder time delay can be adjusted to permit aircraft interrogators to indicate zero range at a specified distance from the DME antenna. When the indicated DME zero range has a reference other than the DME antenna, consideration should be given to publishing this information.

7.1.6.4 In the case of DME/P, in order to meet accuracy and coverage requirements, particularly in the runway region, it is recommended that the DME/P be sited as closely as possible to the MLS azimuth facility, consistent with obstacle clearance criteria. For aircraft equipped with a full MLS capability, the desired zero range indication can then be obtained by utilizing MLS basic data. Note that the DME/P transponder time delay must not be adjusted for this purpose.

7.1.6.5 In the transition from ILS to MLS, it may be desired that all users obtain indicated zero range at touchdown irrespective of the airborne equipment fitted. This would necessitate location of the DME/P abeam the runway at the touchdown point. In this case accuracy requirements for DME/P would not be met on the runway. It must be noted that MLS Basic Data Word 3 only permits the coding of DME/P coordinates within certain limits.

7.1.6.6 The nominal location of the zero range indication provided by a DME/N interrogator needs to be published.

7.1.6.7 In considering DME sites, it is also necessary to take into account technical factors such as runway length, profile, local terrain and transponder antenna height to assure adequate signal levels in the vicinity of threshold and along the runway. Care should also be taken that where distance information is required in the runway region, the selected site is not likely to cause the interrogator to lose track due to excessive rate of change of velocity.

7.1.7 *Geographical separation criteria*

7.1.7.1 In order to allow consideration of actual antenna designs, equipment characteristics, and service volumes, the signal ratios needed to assure interference-free operation of the various facilities operating on DME channels are provided in 7.1.8, 7.1.9 and 7.1.10 below. Given these ratios, the geographical separations of facilities may be readily evaluated by accounting for power losses over the propagation paths.

7.1.8 *Desired to undesired (D/U) signal ratios at the airborne receiver*

7.1.8.1 Table C-4 indicates the necessary D/U signal ratios needed to protect the desired transponder reply signal at an airborne receiver from the various co-frequency/adjacent frequency, same code/different code, undesired transponder reply signal combinations that may exist. For initial assignments, the D/U ratios necessary to protect airborne equipment with 6-microsecond decoder rejection should be used. In making an assignment, each facility must be treated as the desired source with the other acting as the undesired. If both satisfy their unique D/U requirement, then the channel assignment may be made.

7.1.8.2 Accordingly, DME channel assignments depend upon the following:

a) *For co-channel assignments:* This condition occurs when both the desired and undesired signals operate on a channel (W, X, Y or Z) that is co-frequency, same code. The D/U signal ratio should be at least 8 dB throughout the service volume.

b) *For co-frequency, different code assignments:* This condition occurs when one facility operates on an X channel with the other on a W channel. A similar Y channel and a Z channel combination also applies.

c) *For first adjacent frequency, same code assignments:* This condition occurs when both the desired and undesired facilities are of W, X, Y or Z type.

d) *For first adjacent frequency, different code assignments:* This condition occurs when one facility operates on an X channel with the other on a W channel, but with a frequency offset of 1 MHz between transponder reply frequencies. A similar Y channel and a Z channel combination also applies.

e) *For second adjacent frequency, same or different code assignments:* The second adjacent frequency combinations generally need not be frequency protected.

Table C-4. Protection ratio D/U (dB)

Type of assignment:	A	B
Co-frequency:		
Same pulse code	8	8
Different pulse code	8	−42
First adjacent frequency:		
Same pulse code	$-(P_u - 1)$	−42
Different pulse code	$-(P_u + 7)$	−75
Second adjacent frequency:		
Same pulse code	$-(P_u + 19)$	−75
Different pulse code	$-(P_u + 27)$	−75

Note 1.— The D/U ratios in column A protect those DME/N interrogators operating on X or Y channels. Column A applies to decoder rejection of 6 microseconds.

Note 2.— The D/U ratios in column B protect those DME/N or DME/P interrogators utilizing discrimination in conformance with 3.5.5.3.4.2 and 3.5.5.3.4.3 of Part I and providing a decoder rejection conforming to 3.5.5.3.5 of Part I.

Note 3.— P_u is the peak effective radiated power of the undesired signal in dBW.

Note 4.— The frequency protection requirement is dependent upon the antenna patterns of the desired and undesired facility and the ERP of the undesired facility.

Note 5.— In assessing adjacent channel protection, the magnitude of D/U ratio in column A should not exceed the magnitude of the value in column B.

However, special attention should be given to Note 4 of Table C-4, especially if the undesired facility is a DME/P transponder.

7.1.9 *Special considerations for DME Y and Z channel assignments*

7.1.9.1 Assignment of a Y or Z channel whose reply frequency is 63 MHz removed from the reply frequency of another channel (either a W, X, Y or Z channel) or vice versa requires a distance separation of at least 28 km (15 NM) between facilities.

7.1.10 *Special considerations for DME W or Z channel assignments*

7.1.10.1 Assignment of a W or Z channel whose reply frequency is 63 MHz removed from the reply frequency of a Y channel or vice versa requires a distance separation of at least equal to the service volume range of the Y channel facility plus 28 km (15 NM).

7.1.11 *Special considerations for making pulse spectrum measurements*

7.1.11.1 The effective radiated power contained in the 0.5 MHz measurement frequency band specified in 3.5.4.1.3 e) can be calculated by integrating the power spectral density in the frequency domain or equivalently by integrating the instantaneous power per unit time in the time domain using the appropriate analogue or digital signal processing techniques. If the integration is performed in the frequency domain then the resolution bandwidth of the spectrum analyser must be commensurate with the 5 per cent duration interval of the DME pulse. If the integration is performed in the time domain at the output of a 0.5 MHz five pole (or more) filter then the time sample rate must be commensurate with the pulse spectrum width.

7.2 Guidance material concerning DME/N only

7.2.1 *Effective radiated power (ERP) of DME/N facilities*

7.2.1.1 The power density figure prescribed in 3.5.4.1.5.1 of Part I is on the following assumptions:

Airborne receiver sensitivity	-112 dBW
Airborne transmission line loss	+3 dB
Airborne polar pattern loss relative to an isotopic antenna	+4 dB
Necessary power at antenna	-105 dBW

Minus 105 dBW at the antenna corresponds to minus 83 dBW/m² at the mid-band frequency.

Note.— The power density for the case of an isotropic antenna may be computed in the following manner:

$$P_d = P_a - 10 \log \frac{\lambda^2}{4\pi}$$

where P_d = *power density in dBW/m²;*

P_a = *power at receiving point in dBW;*

λ = *wavelength in metres.*

(Reference: *"Antennas" by J.D. Kraus gives aperture figures for other types of antennas.)*

7.2.1.2 Nominal values of the necessary ERP to achieve a power density of minus 83 dBW/m² are given in Figure C-20. For coverage under difficult terrain and siting conditions it may be necessary to make appropriate increases in the ERP. Conversely, under favourable siting conditions, the stated power density may be achieved with a lower ERP.

7.2.1.3 The use of Figure C-20 is illustrated by the following examples. In order to achieve the necessary nominal power density at slant range/levels of 342 km (185 NM)/ 12 000 m (40 000 ft), 263 km (142 NM)/12 000 m (40 000 ft) and 135 km (73 NM)/6 000 m (20 000 ft), ERPs of the order of plus 42 dBW, plus 36 dBW and plus 30 dBW respectively would be required.

7.3 Guidance material concerning DME/P only

7.3.1 *DME/P system description*

7.3.1.1 The DME/P is an integral element of the microwave landing system described in Part I, 3.11. The DME/P signal format defines two operating modes, initial approach (IA) and final approach (FA). The IA mode is compatible and interoperable with DME/N and is designed to provide improved accuracies for the initial stages of approach and landing. The FA mode provides substantially improved accuracy in the final approach area. Both modes are combined into a single DME/P ground facility and the system characteristics are such that DME/N and DME/P functions can be combined in a single interrogator. The IA and FA modes are identified by pulse codes which are specified in Table A in Part I, Chapter 3. In the MLS approach sector, the DME/P coverage is at least 41 km (22 NM) from the ground transponder. It is intended that the interrogator does not operate in the FA mode at ranges greater than 13 km (7 NM) from the transponder site, although the transition from the IA mode may begin at 15 km (8 NM) from the transponder. These figures were selected on the assumption that the transponder is installed beyond the stop end of the runway at a distance of approximately 3 600 m (2 NM) from the threshold.

7.3.1.2 A major potential cause of accuracy degradation encountered in the final phases of the approach and landing operation is multipath (signal reflection) interference. DME/P FA mode minimizes these effects by using wideband signal processing of pulses having fast rise time leading edges, and by measuring the time of arrival at a low point on the received pulse where it has not been significantly corrupted by multipath. This is in contrast to the slower rise time pulses and higher thresholding at the 50 per cent level used in DME/N.

7.3.1.3 Because the FA mode is used at ranges less than 13 km (7 NM), the transmitter can provide an adequate signal level to meet the required accuracy without the fast rise time pulse violating the transponder pulse spectrum requirements. Use of the 50 per cent threshold and a narrow receiver bandwidth in the IA mode permits an adequate but less demanding performance to the coverage limits. The transponder determines the interrogation mode in use by the interrogation code in order to time the reply delay from the proper measurement reference. The IA mode is interoperable with DME/N permitting a DME/N interrogator to be used with a DME/P transponder to obtain at least the accuracy with a DME/N transponder. Similarly, a DME/P interrogator may be used with a DME/N transponder.

7.3.2 *DME/P system accuracy*

7.3.2.1 *DME/P accuracy requirements*

7.3.2.1.1 When considering the DME/P accuracy requirement, the operations that can be performed in the service volume of the final approach mode tend to fall into one of two groups. This has led to two accuracy standards being defined for the final approach mode:

a) accuracy standard 1: This is the least demanding and is designed to cater for most CTOL operations;

b) accuracy standard 2: This gives improved accuracy that may be necessary for VTOL and STOL operations, CTOL flare manoeuvres using MLS flare elevation guidance and CTOL high-speed turnoffs.

7.3.2.1.2 Table C-5 shows applications of DME and typical accuracy requirements. This will assist in selecting the appropriate accuracy standard to meet the operational requirement. The calculations are based on a distance of 1 768 m (5 800 ft) between the DME antenna and the runway threshold. The following paragraphs refer to Table C-5.

7.3.2.1.3 It is intended that the DME/P accuracy approximately corresponds to the azimuth function PFE at a distance of 37 km (20 NM) from the MLS reference datum both along the extended runway centre line and at an azimuth angle of 40 degrees. Also the DME/N error at the limits of MLS coverage is consistent with the 0.37 km (0.2 NM) system accuracy in Part I, 3.5.3.1.3.3. The CMN is the linear equivalent of the plus or minus 0.1 degree CMN specified for the azimuth angle function.

7.3.2.1.4 PFE corresponds to azimuth angular error; CMN is approximately the linear equivalent of the plus or minus 0.1 degree CMN specified for the azimuth angle system.

7.3.2.1.5 The plus or minus 30 m PFE corresponds to a plus or minus 1.5 m vertical error for a 3-degree elevation angle.

7.3.2.1.6 Flare initiation begins in the vicinity of the MLS approach reference datum; MLS elevation and DME/P provide vertical guidance for automatic landing when the terrain in front of the runway threshold is uneven.

7.3.2.1.7 Sensitivity modification or autopilot gain scheduling requirements are not strongly dependent on accuracy.

7.3.2.1.8 It is intended that this specification applies when vertical guidance and sink rate for automatic landing are derived from the MLS flare elevation and the DME/P.

7.3.2.1.9 It indicates to the pilot if the aircraft is landing beyond the touchdown region.

7.3.2.1.10 The roll-out accuracy requirement reflects system growth potential. In this application the roll-out PFE would be dictated by the possible need to optimize roll-out deceleration and turnoff so as to decrease runway utilization time.

7.3.2.1.11 It is intended to assure the pilot that the aircraft is over the landing pad before descending.

7.3.2.1.12 It may be desirable to translate the MLS coordinates from one origin to another when the antennas are not installed in accordance with Part I, 3.11.5.2.6 or 3.11.5.3.5. The figures in the table are typical of a VTOL application; actual values will depend on the geometry of the installation.

7.3.3 *DME/P error budgets*

7.3.3.1 Example error budgets for DME/P accuracy standards 1 and 2 are shown in Table C-6. If the specified error components are not individually exceeded in practice, it can be expected that the over-all system performance, as specified in 3.5.3.1.3.4, will be achieved. A garbling contribution to the system error is computed by taking the root sum square (RSS) of the errors obtained in the specified down-link environment with those obtained in the specified up-link environment and removing, on an RSS basis, the error obtained in a non-garbling environment.

7.3.4 *System implementation*

7.3.4.1 While the DME/P may be implemented in various ways, the instrumental and propagation errors assumed are typical of those obtainable with equipment designs which provide internal time delay drift compensation and which establish timing reference points by thresholding on the leading edge of the first pulse of a pulse pair using the following techniques:

a) *IA mode.* A conventional technique which thresholds at the 50 per cent amplitude point;

b) *FA mode.* A delay-attenuate-and-compare (DAC) technique which thresholds between the 5 per cent and 30 per cent amplitude points.

7.3.4.2 Accuracy standard 1 can be achieved using a delay of 100 nanoseconds and an attenuation of 5 to 6 dB. It is also

Table C-5

Function	*Typical distance from the threshold*	*PFE (95% probability)*	*CMN (95% probability)*
Approach (7.3.2.1.2)			
— extended runway centre line	37 km (20 NM)	±250 m (±820 ft)	±68 m (±223 ft)
— at 40° azimuth	37 km (20 NM)	±375 m (±1 230 ft)	±68 m (±223 ft)
Approach (7.3.2.1.3)			
— extended runway centre line	9 km (5 NM)	±85 m (±279 ft)	±34 m (±111 ft)
— at 40° azimuth	9 km (5 NM)	±127 m (±417 ft)	±34 m (±111 ft)
Marker replacement			
— outer marker	9 km (5 NM)	±800 m (±2 625 ft)	not applicable
— middle marker	1 060 m (0.57 NM)	±400 m (±1 312 ft)	not applicable
30 m decision height determination (100 ft) (7.3.2.1.4)			
— 3° glide path (CTOL)	556 m (0.3 NM)	±30 m (±100 ft)	not applicable
— 6° glide path (STOL)	556 m (0.3 NM)	±15 m (±50 ft)	not applicable
Flare initiation over uneven terrain (7.3.2.1.5)			
— 3° glide path (CTOL)	0	±30 m (±100 ft)	±18 m (±60 ft)
— 6° glide path (STOL)	0	±12 m (±40 ft)	±12 m (±40 ft)
Sensitivity modifications (7.3.2.1.6) (autopilot gain scheduling)	37 km (20 NM) to 0	±250 m (±820 ft)	not applicable
Flare manoeuvre with MLS flare elevation (7.3.2.1.7)			
— CTOL	0	±30 m (±100 ft)	±12 m (±40 ft)
— STOL	0	±12 m (±40 ft)	±12 m (±40 ft)
Long flare alert (7.3.2.1.8)	Runway region	±30 m (±100 ft)	not applicable
CTOL high speed roll-out/turnoffs (7.3.2.1.9)	Runway region	±12 m (±40 ft)	±30 m (±100 ft)
Departure climb and missed approach	0 to 9 km (5 NM)	±100 m (±328 ft)	±68 m (±223 ft)
VTOL approaches (7.3.2.1.10)	925 m (0.5 NM) to 0	±12 m (±40 ft)	±12 m (±40 ft)
Co-ordinate translations (7.3.2.1.11)	—	±12 m to ±30 m (±40 ft to ±100 ft)	±12 m (±40 ft)

required that the threshold amplitude point of both the delayed pulse and the attenuated pulse lie within the partial rise time region.

7.3.4.3 The example above does not preclude time of arrival measurement techniques other than the DAC from being used but it is necessary in any case that threshold measurements take place during the pulse partial rise time.

7.3.5 *DME/P interrogator signal processing*

7.3.5.1 *During acquisition*

a) The interrogator acquires and validates the signal within 2 seconds before transitioning to track mode even in the presence of squitter and random pulse pairs from adjacent channels, which result in a 50 per cent system efficiency.

b) After loss of the acquired signal in either the IA or FA mode, the interrogator provides a warning output within 1 second, during which time the guidance information continues to be displayed. After loss of signal, the interrogator returns to the search condition in the IA mode in order to re-establish track.

7.3.5.2 *During track*

7.3.5.2.1 When track is established, the receiver output consists of valid guidance information before removing the warning. The validation process continues to operate as long

Table C-6. Example of DME/P error budget

Error source	*Error component*	*FA mode Standard 1* PFE m (ft)	*FA mode Standard 1* CMN m (ft)	*FA mode Standard 2* PFE m (ft)	*FA mode Standard 2* CMN m (ft)	*IA mode 3* PFE m (ft)	*IA mode 3* CMN m (ft)
Instrumentation	Transponder	± 10 (± 33)	± 8 (± 26)	± 5 (± 16)	± 5 (± 16)	± 15 (± 50)	± 10 (± 33)
	Interrogator	± 15 (± 50)	± 10 (± 33)	± 7 (± 23)	± 7 (± 23)	± 30 (± 100)	± 15 (± 50)
Site related	Down-link specular multipath	± 10 (± 33)	± 8 (± 26)	± 3 (± 10)	± 3 (± 10)	± 37 (± 121)	± 20 (± 66)
	Up-link specular multipath	± 10 (± 33)	± 8 (± 26)	± 3 (± 10)	± 3 (± 10)	± 37 (± 121)	± 20 (± 66)
	Non-specular (diffuse) multipath	± 3 (± 10)	± 3 (± 10)	± 3 (± 10)	± 3 (± 10)	± 3 (± 10)	± 3 (± 10)
	Garble	± 6 (± 20)	± 6 (± 20)	± 6 (± 20)	± 6 (± 20)	± 6 (± 20)	± 6 (± 20)

Note 1.— The figures for "non-specular multipath" and for "garble" are the totals of the up-link and down-link components.

Note 2.— It should be noted that PFE contains both bias and time varying components. In the above table the time varying components and most site related errors are assumed to be essentially statistically independent. The bias components may not conform to any particular statistical distribution.

In considering these error budgets, caution should be exercised when combining the individual components in any particular mathematical manner.

Note 3.— The transmitter wave form is assumed to have a 1 200 nanosecond rise time.

as the interrogator is in track. The interrogator remains in track as long as the system efficiency is 50 per cent or greater. While in track, the receiver provides protection against short duration, large amplitude erroneous signals.

7.3.5.3 *Range date filter*

7.3.5.3.1 The accuracy specifications in Part I, 3.5.3.1.3.4, as well as the error budgets discussed in 7.3.3 above, assume that the higher frequency noise contributions are limited by a low pass filter with a corner frequency of ω_2 as specified in Figure C-21. Depending upon the user's application, additional filtering for noise reduction can be used provided that the induced phase delay and amplitude variation do not adversely affect the aircraft flight control system's dynamic response. The following sections recommend additional features which should be incorporated into the data filter.

7.3.5.4 *Velocity memory*

7.3.5.4.1 The data filter may require a velocity memory in order to achieve the specified accuracies in Part I, 3.5.3.1.3.4 with a system efficiency of 50 per cent. It should be noted that low system efficiencies can occur in the IA mode during identification transmissions.

7.3.5.5 *Outlier rejection*

7.3.5.5.1 Range estimates which are significantly different from previous filtered range estimates, because they cannot be the result of aircraft motion, should be assumed in error. Such data should be rejected at the input to the data filter.

7.3.6 *DME/P error measurement methods*

7.3.6.1 *System errors*

7.3.6.1.1 The DME/P system accuracies are specified in Part I, 3.5.4.1.3.4 in terms of path following error (PFE) and control motion noise (CMN). These parameters describe the interaction of the DME/P guidance signal with the aircraft in terms directly related to aircraft position errors and flight control system design.

7.3.6.1.2 For the purposes of determining compliance with the accuracy standard, the PFE and CMN components are evaluated over any T second interval (where T = 40 seconds in the IA mode and 10 seconds in the FA mode) of the flight error record taken within the DME/P coverage limits. The 95 per cent probability requirement is interpreted to be satisfied if the PFE and CMN components do not exceed the specified error limits for a total period that is more than 5 per cent of the evaluation time interval. This is illustrated in Figure C-21. To evaluate the PFE and CMN components of the DME/P guidance data, the true aircraft position, as determined by a suitable position reference, is subtracted from the guidance data to form an error signal. This error signal is then filtered by the PFE and CMN filters, where the outputs provide suitable estimates of the PFE and CMN components, respectively. These filters are defined in Figure C-21.

7.3.6.1.3 These filters can be utilized to determine the transponder instrumentation error components specified in Part I, 3.5.4.5.3 and 3.5.4.5.4. Similarly, the interrogator instrumentation error components, specified in Part I, 3.5.5.4, can be determined.

Table C-7. CTOL ground-to-air power budget

Power budget items	*41 km (22 NM)*	*13 km (7 NM)*	*Ref datum*	*Roll-out*
Peak effective radiated power, dBm	55	55	55	55
Ground multipath loss, dB	-5	-3	-4	-17
Antenna pattern loss, dB	-4	-2	-5	-5
Path loss, dB	-125	-115	-107	-103
Monitor loss, dB	-1	-1	-1	-1
Polarization and rain loss, dB	-1	-1	0	0
Received signal at aircraft, dBm	-81	-67	-62	-71
Power density at aircraft, dBW/m^2	-89	-75	-70	-79
Aircraft antenna gain, dB	0	0	0	0
Aircraft cable loss, dB	-4	-4	-4	-4
Received signal at interrogator, dBm	-85	-71	-66	-75
Receiver noise video, dBm (Noise factor (NF) = 9 dB)				
IF BW: 3.5 MHz		-103	-103	-103
IF BW: 0.8 MHz	-109			
Signal-to-noise ratio (video), dB	24	32	37	28

Table C-8. CTOL air-to-ground power budget

Power budget items	*41 km (22 NM)*	*13 km (7 NM)*	*Ref datum*	*Roll-out*
Interrogator transmitter power, dBm	57	57	57	57
Aircraft antenna gain, dB	0	0	0	0
Aircraft cable loss, dB	-4	-4	-4	-4
Peak effective radiated power, dBm	53	53	53	53
Ground multipath loss, dB	-5	-3	-4	-17
Path loss, dB	-125	-115	-107	-103
Polarization and rain loss, dB	-1	-1	0	0
Received signal at transponder antenna, dBm	-78	-66	-58	-67
Ground antenna gain, dB	8	8	8	8

Power budget items	*41 km (22 NM)*	*13 km (7 NM)*	*Ref datum*	*Roll-out*
Pattern loss, dB	-4	-2	-5	-5
Cable loss, dB	-3	-3	-3	-3
Received signal at transponder, dBm	-77	-63	-58	-67
Receiver noise video, dBm (Noise factor (NF) = 9 dB) IF BW: 3.5 MHz		-106	-106	-106
IF BW: 0.8 MHz	-112			
Signal-to-noise ratio (video), dB	35	43	48	39

Table C-9. Power supply switch-over times for ground-based radio aids used in the vicinity of aerodromes

Type of runway	*Aids requiring power*	*Maximum switch-over times*
Instrument approach	SRE	15 seconds
	VOR	15 seconds
	NDB	15 seconds
	D/F facility	15 seconds
Precision approach category I	ILS localizer	10 seconds
	ILS glide path	10 seconds
	ILS middle marker	10 seconds
	ILS outer marker	10 seconds
	PAR	10 seconds
Precision approach category II	ILS localizer	0 seconds
	ILS glide path	0 seconds
	ILS inner marker	1 second
	ILS middle marker	1 second
	ILS outer marker	10 seconds
Precision approach category III	(Same as categorv II)	

7.3.7 *Multipath effects*

7.3.7.1 Under the multipath conditions likely to exist, the accuracy specifications of the DME/P assume that the performance is not degraded beyond a certain limit and that this degradation is equally applied to both interrogator and transponder receiver.

7.3.7.2 To ensure that the equipment is working according to the specifications, the following should apply to FA mode operation of the system:

a) If a signal of sufficient power to make thermal noise contributions insignificant is applied to the receivers, a second signal delayed between 0 and 350 nanoseconds with respect to the first, with an amplitude 3 dB or more below the first and with a scalloping frequency between 0.05 and 200 Hz should not produce errors in the receiver output of more than plus or minus 100 nanoseconds (15 m).

b) For delays more than 350 nanoseconds the error contribution will be reduced considerably. A typical value will be plus or minus 7 nanoseconds (1 m).

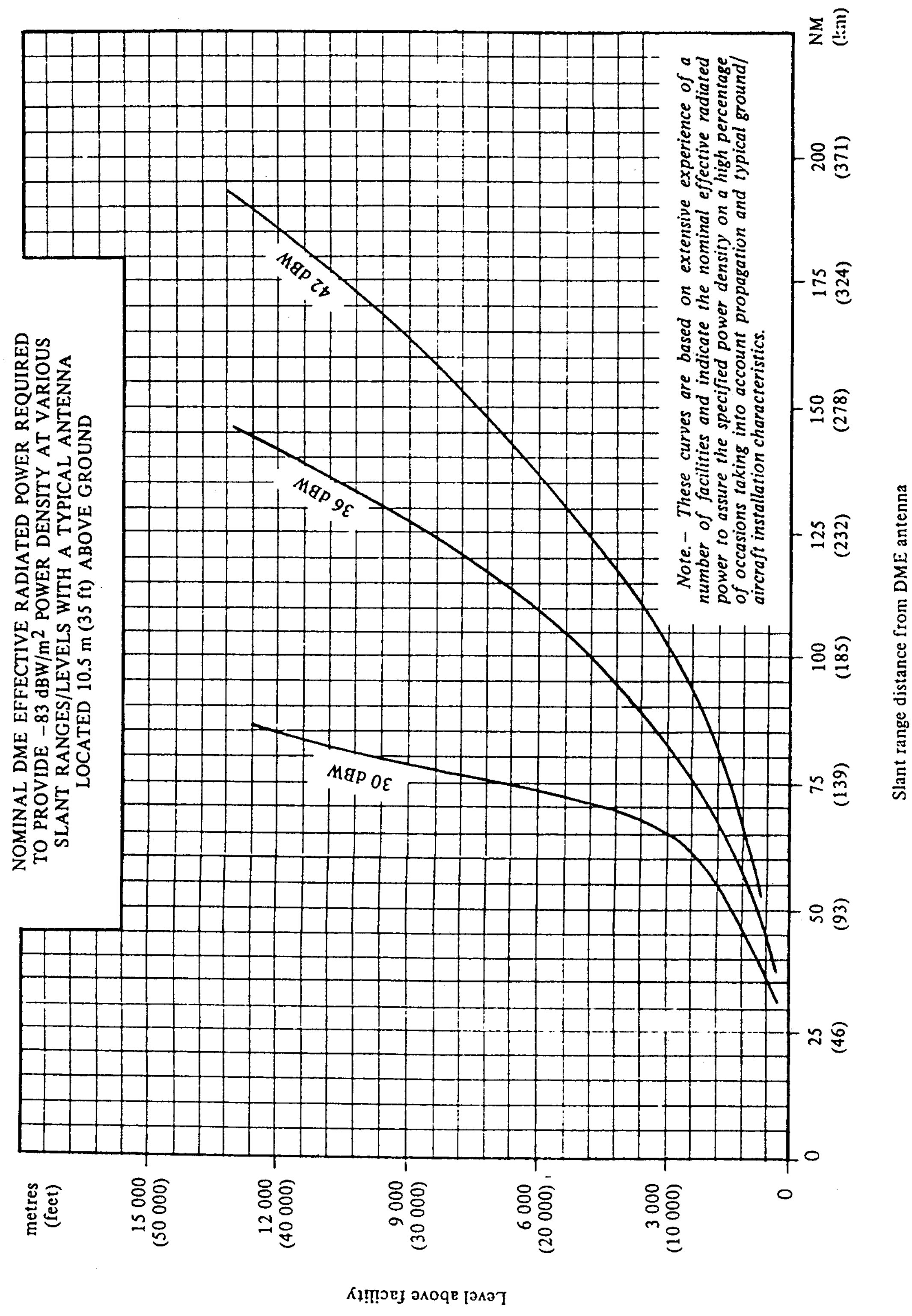
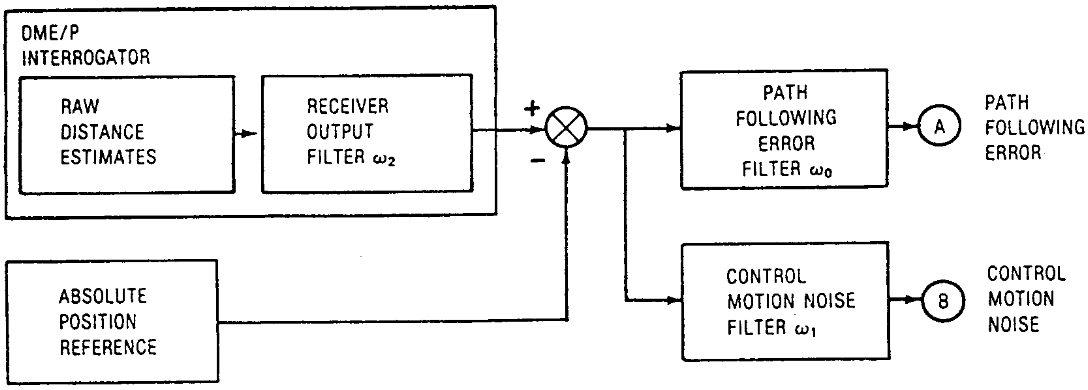

NOMINAL DME EFFECTIVE RADIATED POWER REQUIRED TO PROVIDE −83 dBW/m² POWER DENSITY AT VARIOUS SLANT RANGES/LEVELS WITH A TYPICAL ANTENNA LOCATED 10.5 m (35 ft) ABOVE GROUND
42 dBW
36 dBW
30 dBW
Note.— These curves are based on extensive experience of a number of facilities and indicate the nominal effective radiated power to assure the specified power density on a high percentage of occasions taking into account propagation and typical ground/aircraft installation characteristics.
metres (feet)
15 000 (50 000)
12 000 (40 000)
9 000 (30 000)
6 000 (20 000)
3 000 (10 000)
0
Level above facility
0
25 (46)
50 (93)
75 (139)
100 (185)
125 (232)
150 (278)
175 (324)
200 (371)
NM (km)
Slant range distance from DME antenna

Figure C-20



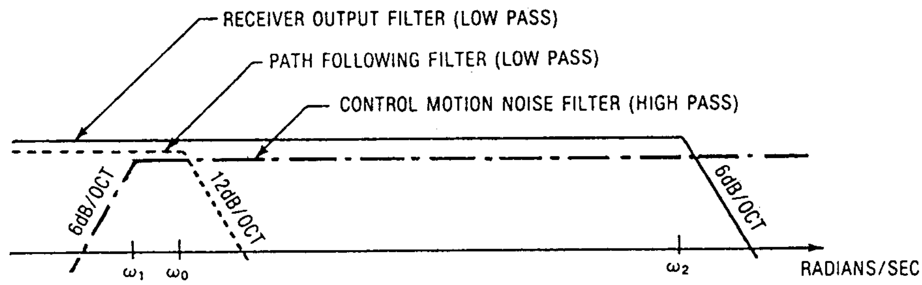
GUIDANCE FUNCTION	CORNER FREQUENCIES (RADIANS/SEC)		
	ω_0	ω_1	ω_2*
DME/P	1.5	0.5	10

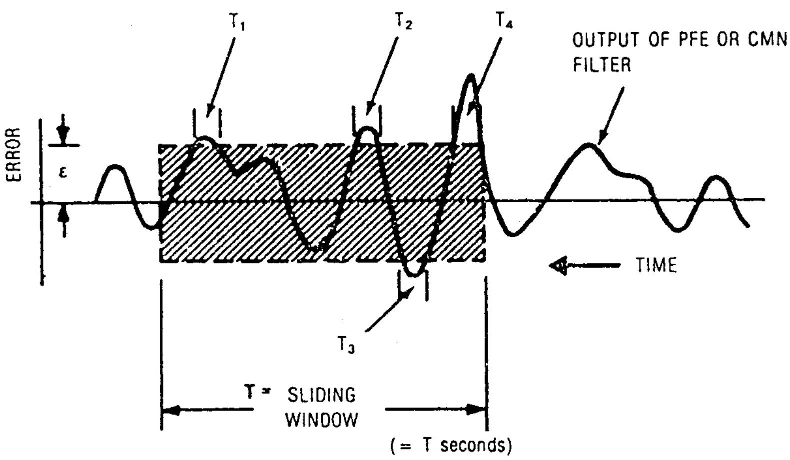
* This corner frequency may be less than 10 rad/sec for some applications.

RECEIVER OUTPUT FILTER $\frac{\omega_2}{S + \omega_2}$

PATH FOLLOWING FILTER $\frac{\omega_n^2}{S^2 + 2\zeta\,\omega_n\,S + \omega_n^2}$ $\zeta = 1;\ \omega_0 = .64\,\omega_n$

CONTROL MOTION NOISE FILTER: $\frac{S}{S + \omega_1}$





	IA MODE	FA MODE
T	40 sec	10 sec

DME/P measurement methodology. ε is the error specification; T region to be evaluated; T_1, T_2, T_3 .....time intervals that error exceeds specifications. For the equipment to be acceptable in this region, the following inequality should be true: $(T_1 + T_2 + T_3 + ...)/\ T \leq 0.05$.

Figure C-21

7.3.7.3 The airborne DME antenna should be located so as to preclude antenna gain reductions in the forward direction with the aircraft in the landing configuration. Any such antenna gain reductions could enhance the multipath error component when the aircraft is on approach and landing phases when highest DME accuracies are required.

7.3.8 *DME/P power budget*

7.3.8.1 Tables C-7 and C-8 are an example of CTOL air-to-ground and ground-to-air power budgets. The permitted peak ERP value is based on a pulse shape which meets the spectral constraints in Part I, 3.5.4.1.3 e).

7.3.8.2 In the power budget calculations, it is assumed that the aircraft antenna is not shielded by the aircraft structure including the landing gear when extended.

7.3.8.3 The video power signal-to-noise ratio is related to the IF power signal-to-noise ratio in the following manner:

$$S/N\ (\text{Video}) = S/N\ (\text{IF}) + 10 \log \frac{\text{IF noise bandwidth}}{\text{Video noise bandwidth}}$$

Note 1.— The distances are measured from the transponder antenna.

Note 2.— Frequency dependent parameters were calculated for 1 088 MHz.

7.3.9 *DME/P monitor time delay measurement*

7.3.9.1 The required time delay measurement can be accomplished by measuring the output of a PFE filter and making a control decision within 1 second. However, since the transponder PFE is a slowly varying error component, an equivalent measurement is to average the unfiltered time delay samples for 1 second.

8. Material concerning power supply switch-over times

8.1 Power supply switch-over times for ground-based radio aids used in the vicinity of aerodromes

8.1.1 The power supply switch-over times for radio navigation aids and ground elements of communications systems are dependent on the type of runway and aircraft operations to be supported. Table C-9 above indicates representative switch-over times which may be met by power supply systems currently available.

21/11/85

ATTACHMENT D TO PART I.— GUIDANCE MATERIAL FOR COMMUNICATION SYSTEMS

1. VHF communications

1.1 Audio characteristics of VHF communication equipment

The aeronautical radiotelephony services represent a special case of the application of radiotelephony, in that the requirement is for the transmission of messages in such a way that fidelity of wave form is of secondary importance, emphasis being upon fidelity of basic intelligence. This means that it is not necessary to transmit those parts of the wave form which are solely concerned with individuality, accent and emphasis.

1.2 Off-set carrier system

The following are examples of off-set carrier systems which meet the requirements of Part I, 4.6.1.1.1:

a) *2-carrier system.* Carriers should be spaced at plus and minus 5 kHz. This requires a frequency stability of plus or minus 2 kHz (15.3 parts per million at 130 MHz).

b) *3-carrier system.* Carriers should be spaced at zero and plus and minus 7.3 kHz. This requires a frequency stability of plus or minus 0.65 kHz (5 parts per million at 130 MHz).

The following are examples or 4- and 5-carrier systems which meet the requirements of Part I, 4.6.1.1.1:

c) *4-carrier system.* Carriers should be spaced at plus and minus 2.5 kHz and plus and minus 7.5 kHz. This requires a frequency stability of plus or minus 0.5 kHz (3.8 parts per million at 130 MHz).

d) *5-carrier system.* Carriers should be spaced at zero, plus and minus 4 kHz and plus and minus 8 kHz. A frequency stability in the order of plus or minus 40 Hz (0.3 parts per million at 130 MHz) is an achievable and practicable interpretation of the requirement in this case.

Note 1.— The carrier frequency spacings referred to above are with respect to the assigned channel frequency.

Note 2.— In aircraft receivers which employ a measurement of the received carrier-to-noise ratio to operate the mute, the audio heterodynes caused by the reception of two or more off-set carriers can be interpreted as noise and cause the audio *output to be muted even when an adequate wanted signal is present. In order that the airborne receiving system can conform with the sensitivity recommendations contained in 4.7.2.1, the design of the receivers may need to ensure that their sensitivity is maintained at a high level when receiving off-set carrier transmissions. The use of a carrier level override is an unsatisfactory solution to this requirement, but where it is employed, setting the override level as low as possible can ameliorate the problem.*

1.3 Immunity performance of COM receiving systems in the presence of VHF FM broadcast interference

1.3.1 With reference to the Note of 4.7.3 of Part I, the immunity performance defined there must be measured against an agreed measure of derogation of the receiving system's normal performance, and in the presence of, and under standard conditions for the input wanted signal. This is necessary to ensure that the checking of receiving station equipment on bench test can be performed to a repeatable set of conditions, and results, and to facilitate their subsequent approval. An adequate measure of immunity performance may be obtained by the use of wanted signal of minus 87 dBm into the receiving equipment and the signal modulated with a 1 kHz tone at 30 per cent modulation depth. The signal-to-noise ratio should not fall below 6 dB when the interfering signals specified at Part I, 4.7.3.1 and 4.7.3.2 are applied. The broadcast signals should be selected from frequencies in the range between 87.5 and 107.9 MHz and should be modulated with a representative broadcast type signal.

Note 1.— The signal level of minus 87 dBm assumes a combined antenna and feeder gain of 0 dB.

Note 2.— The reduction in the signal-to-noise ratio quoted above is for the purpose of standardization when checking that receiving station equipment on bench measurements meet the required immunity. In the planning of frequencies and in the assessment of protection from FM broadcast interference, a value not less than this, and in many cases higher, depending on the operational circumstances in individual cases, should be chosen as the basis of the interference assessment.

2. SELCAL system

2.1 This material is intended to provide information and guidance relating to the operation of the SELCAL system. It is associated with the Recommended Practices contained in Part I, 4.8.

1) *Function.* The purpose of the SELCAL system is to permit the selective calling of individual aircraft over radiotelephone channels linking the ground station with the aircraft, and is intended to operate on en-route frequencies with existing HF and VHF ground-to-air communications transmitters and receivers with a minimum of electrical and mechanical modification. The normal functioning of the ground-to-air communications link should be unaffected, except at such time as the selective calling function is being formed.

2) *Principles of operation.* Selective calling is accomplished by the coder of the ground transmitter sending a single group of coded tone pulses to the aircraft receiver and decoder. The airborne receiver and decoder equipment is capable of receiving and interpreting, by means of an indicator, the correct code and rejecting all other codes in the presence of random noise and interference. The ground portion of the coding device (ground selective calling unit) supplies coded information to the ground-to-air transmitter. The airborne selective calling unit is the special airborne equipment which operates with existing communications receivers on the aircraft to permit decoding of the ground-to-air signals for display on the signal indicator. The type of signal indicator can be chosen to suit operational requirements of the user and may consist of a lamp, a bell, a chime or any combination of such indicating devices.

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No. 70

ATTACHMENT E TO PART I. — GUIDANCE MATERIAL ON THE PRE-FLIGHT CHECKING OF VOR AIRBORNE EQUIPMENT

1. Specification for a VOR airborne equipment test facility (VOT)

1.1 Introduction

For the guidance of States wishing to provide a test signal for the pre-flight checking of VOR airborne equipment, suggested characteristics for a VOR airborne equipment test facility (VOT) are given hereafter.

1.2 General

1.2.1 The VOT must be designed to provide signals that will permit satisfactory operation of a typical VOR aircraft installation in those areas of the aerodrome where pre-flight checking is convenient and desirable.

1.2.2 The VOT must be constructed and adjusted so that the VOR bearing indicator in the aircraft will indicate zero degrees "FROM" when the receiver has not departed from calibration. This indication remains constant irrespective of the aircraft's angular position with respect to the VOT within the intended coverage.

1.2.3 In view of the manner in which use is made of a VOT, there is no fundamental need for its duplication at any one site.

1.2.4 The VOT is required to radiate a radio frequency carrier with which are associated two separate 30 Hz modulations. The characteristics of these modulations shall be identical with the reference phase and variable phase signals associated with VOR. The phases of these modulations shall be independent of azimuth and shall be coincident with each other at all times.

1.3 Radio frequency

The VOT shall operate in the band 108 MHz to 117.975 MHz on an appropriate VOR channel selected so as not to interfere with any VHF navigation or communication services. The highest assignable frequency shall be 117.95 MHz. The frequency tolerance of the radio frequency carrier shall be plus or minus 0.005 per cent, except as specified in Part I, 3.3.2.2 and 3.3.2.3.

1.4 Polarization and accuracy

1.4.1 The emission from the VOT should be horizontally polarized.

1.4.2 The accuracy of the "bearing" information conveyed by the radiation from the VOT shall be plus or minus 1 degree.

Note.— Since the two modulations on the radio frequency carrier are in phase coincidence at all times, the vestigial vertically polarized energy will have no effect on the accuracy of the facility.

1.5 Coverage

1.5.1 Coverage requirements, and hence the power which must be radiated, will necessarily depend to a considerable extent on local circumstances. For some installations, a small fraction of 1 W will suffice while in other cases, particularly if two or more closely adjacent aerodromes are to be served by a single test facility, several watts of radio frequency energy may need to be emitted.

1.5.2 Where there is a need to protect co-channel VORs, VOTs and ILS localizers from VOT interference, the radio emission must be limited to that required to provide satisfactory operation and to ensure that interference with other co-channel assignments does not occur.

1.6 Modulation

1.6.1 The radio frequency carrier as observed at any point in space shall be amplitude modulated by two signals as follows:

a) a subcarrier of 9 960 Hz of constant amplitude, frequency modulated at 30 Hz and having a deviation ratio of 16 plus or minus 1 (i.e. 15 to 17);

b) 30 Hz.

1.6.2 The depth of modulation due to the 9 960 Hz and the 30 Hz signals shall be within the limits of 28 per cent for each component.

1.6.3 The signal which frequency modulates the 9 960 Hz subcarrier and the signal which amplitude modulates the radio frequency carrier shall both be maintained at 30 Hz within plus or minus 1 per cent.

1.6.4 The frequency of the 9 960 Hz subcarrier shall be maintained within plus or minus 1 per cent.

1.6.5 The percentage of amplitude modulation on the 9 960 Hz subcarrier present at the output of the transmitter shall not be greater than 5 per cent.

1.7 Identification

1.7.1 The VOT shall transmit a 1 020 Hz identification signal. The identification code for a VOT installation shall be selected by the competent authority so as to be unmistakably distinctive as to the test function and, if necessary, as to the location.

Note.— In one State, when the VOT coverage is confined to a single aerodrome, the identification consists of a continuous series of dots.

1.7.2 The depth to which the radio frequency carrier is modulated by the identification signal shall be approximately 10 per cent.

1.8 Monitoring

1.8.1 Basically, there is no need for continuous automatic monitoring of VOT provided the relative phase of the AM and FM 30 Hz components are mechanically locked and facilities exist for periodic inspection and remote supervision of the state of the VOT.

1.8.2 Provision of automatic monitoring can double the cost of a VOT installation and, consequently, many competent authorities are likely to employ only remote supervision at a control point. However, where, in the light of the operational use to be made of a VOT, a State decides to provide automatic monitoring, it should possess the following capabilities. The monitor should transmit a warning to a control point and cause a cessation of transmission if either of the following deviations from established conditions arises:

a) a change in excess of 1 degree at the monitor site of the "bearing" information transmitted by the VOT;

b) a reduction of 50 per cent in the signal level of the 9 960 Hz or 30 Hz signals at the monitor.

Failure of the monitor should automatically cause a cessation of transmission.

2. Selection and use of VOR aerodrome check-points

2.1 General

2.1.1 When a VOR is suitably located in relationship to an aerodrome, the pre-flight checking of an aircraft VOR installation can be facilitated by the provision of suitably calibrated and marked check-points at convenient parts of the aerodrome.

2.1.2 In view of the wide variation in circumstances encountered, it is not practicable to establish any standard requirements or practices for the selection of VOR aerodrome check-points. However, States wishing to provide this facility should be guided by the following considerations in selecting the points to be used.

2.2 Siting requirements for check-points

2.2.1 The signal strength of the nearby VOR has to be sufficient to ensure satisfactory operation of a typical aircraft VOR installation. In particular, full flag action (no flag showing) must be ensured.

2.2.2 The check-points should, within the limits of operating convenience, be located away from buildings or other reflecting objects (fixed or moving) which are likely to degrade the accuracy or stability of the VOR signal.

2.2.3 The observed VOR bearing at any selected point should ideally be within plus or minus 1.5 degrees of the bearing accurately determined by survey or chart plotting.

Note.— The figure of plus or minus 1.5 degrees has no direct operational significance in that the observed bearing becomes the published bearing; however, where a larger difference is observed, there is some possibility of poor stability.

2.2.4 The VOR information at a selected point should be used operationally only if found to be consistently within plus or minus 2 degrees of the published bearing. The stability of the VOR information at a selected point should be checked periodically with a calibrated receiver to ensure that the plus or minus 2-degree tolerance is satisfied, irrespective of the orientation of the VOR receiving antenna.

Note.— The tolerance of plus or minus 2 degrees relates to the consistency of the information at the selected point and includes a small tolerance for the accuracy of the calibrated VOR receiver used in checking the point. The 2-degree figure does not relate to any figure for acceptance or rejection of an aircraft VOR installation, this being a matter for determination by Administrations and users in the light of the operation to be performed.

2.2.5 Check-points which can satisfy the foregoing requirements should be selected in consultation with the operators concerned. Provision of check-points in holding bays, at runway ends and in maintenance and loading areas, is usually desirable.

2.3 Marking of VOR check-points

Each VOR check-point must be distinctively marked. This marking must include the VOR bearing which a pilot would observe on his aircraft instrument if his VOR installation were operating correctly.

2.4 Use of VOR check-points

The accuracy with which a pilot must position his aircraft with respect to a check-point will depend on the distance from the VOR station. In cases where the VOR is relatively close to a check-point, particular care must be taken to place the aircraft's VOR receiving antenna directly over the check-point.

ATTACHMENT F TO PART I. — GUIDANCE MATERIAL CONCERNING RELIABILITY AND AVAILABILITY OF RADIOCOMMUNICATIONS AND NAVIGATION AIDS

1. Introduction and fundamental concepts

Due to the rapid increase in numbers of aircraft and the trend towards all-weather operations, aircraft are increasingly dependent upon ground-based navigation and communication facilities. This Attachment is intended to provide guidance material which Member States may find helpful in providing the degree of facility reliability and availability consistent with their operational requirement.

The material in this Attachment is intended for guidance and clarification purposes, and is not to be considered as part of the Standards and Recommended Practices contained in this Annex. It should be noted that this material is tentative, and is still under review.

1.1 Definitions

Facility availability. The ratio of actual operating time to specified operating time.

Facility failure. Any unanticipated occurrence which gives rise to an operationally significant period during which a facility does not provide service within the specified tolerances.

Facility reliability. The probability that the ground installation operates within the specified tolerances.

Note.— This definition refers to the probability that the facility will operate for a specified period of time.

Mean time between failures (MTBF). The actual operating time of a facility divided by the total number of failures of the facility during that period of time.

Note.— The operating time should in general be chosen so as to include at least five, and preferably more, facility failures in order to give a reasonable measure of confidence in the figure derived.

Signal reliability. The probability that a signal-in-space of specified characteristics is available to the aircraft.

Note.— This definition refers to the probability that the signal is present for a specified period of time.

1.2 Facility reliability

1.2.1 Reliability is achieved by a combination of factors. These factors are variable and may be individually adjusted for an integrated approach that is optimum for, and consistent with, the needs and conditions of a particular environment. For example, one may compensate to some extent for low reliability by providing increased maintenance staffing and/or equipment redundancy. Similarly, low levels of skill among maintenance personnel may be offset by providing equipment of high reliability.

1.2.2 The following formula expresses facility reliability as a percentage:

$$R = 100\, e^{-t/m}$$

where R = reliability (probability that the facility will be operative within the specified tolerances for a time t, also referred to as probability of survival, P_s.);

e = base of natural logarithms;

t = time period of interest;

m = mean time between facility failures.

It may be seen that reliability increases as mean time between failures (MTBF) increases. For a high degree of reliability, and for operationally significant values of t, we must have a large MTBF; thus, MTBF is another more convenient way of expressing reliability.

1.2.3 Experimental evidence indicates that the above formula is true for the majority of electronic equipments where the failures follow a Poisson distribution. It will not be applicable during the early life of an equipment when there is a relatively large number of premature failures of individual components; neither will it be true when the equipment is nearing the end of its useful life.

1.2.4 At many facility types utilizing conventional equipment, MTBF values of 1 000 hours or more have been consistently achieved. To indicate the significance of a 1 000-hour MTBF, the corresponding 24-hour reliability is approximately 97.5 per cent (i.e. the likelihood of facility failure during a 24-hour period is about 2.5 per cent).

1.2.5 Figure F-1 shows the probability of facility survival, P_s, after a time period, t, for various values of MTBF.

Note.— It is significant that the probability of surviving a period of time equal to the MTBF is only 0.37 (37 per cent); thus, one should not succumb to the temptation to assume that the MTBF is a failure-free period.

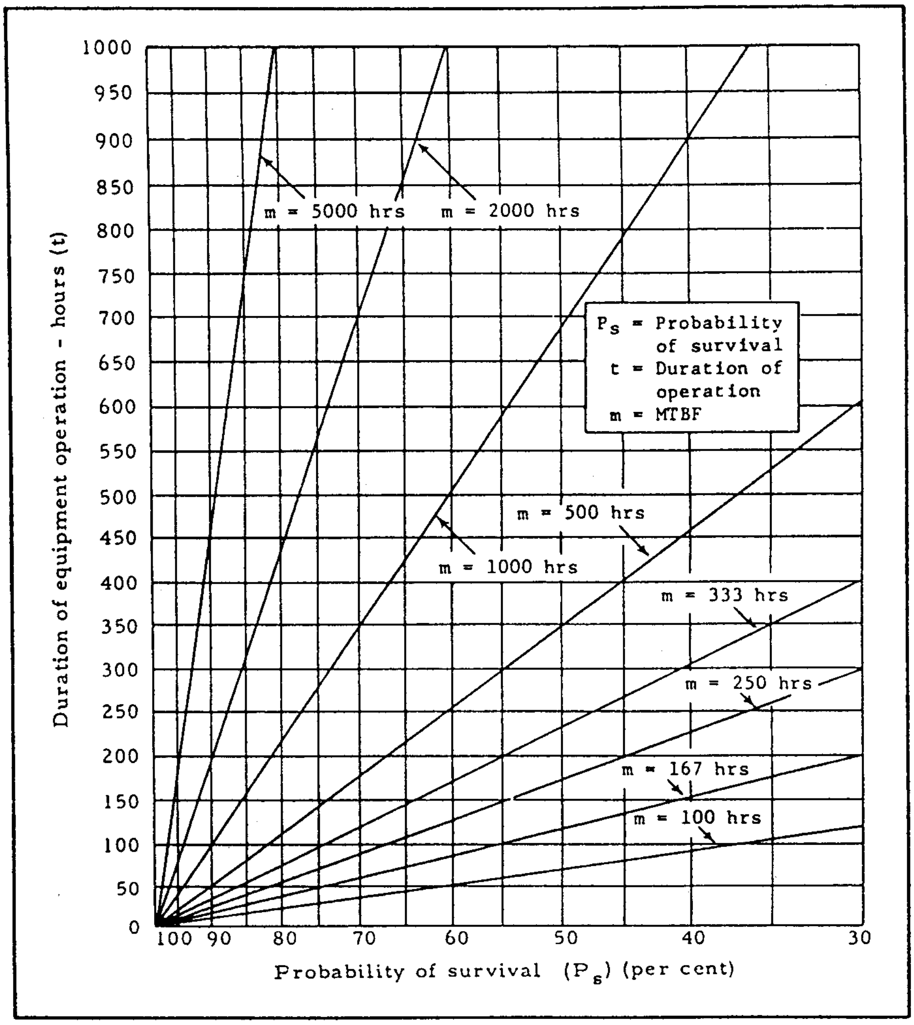


Figure F-1. Plot of $P_s = 100\ e^{-t/m}$

1.2.6 It may be seen that adjustment of MTBF will produce the desired degree of reliability. Factors which affect MTBF and hence facility reliability are:

a) inherent equipment reliability;

b) degree and type of redundancy;

c) reliability of the serving utilities such as power and telephone or control lines;

d) degree and quality of maintenance;

e) environmental factors such as temperature and humidity.

1.3 Facility availability

1.3.1 Availability, as a percentage, may be expressed in terms of the ratio of actual operating time divided by specified operating time taken over a long period.

Symbolically,

$$A = \frac{\text{Actual operating time (100)}}{\text{Specified operating time}}$$

For example, if a facility was operating normally for a total of 700 hours during a 720 hour month, the availability for that month would be 97.2 per cent.

1.3.2 Factors important in providing a high degree of facility availability are:

a) facility reliability;

b) quick response of maintenance personnel to failures;

c) adequate training of maintenance personnel;

d) equipment designs providing good component accessibility and maintainability;

e) efficient logistic support;

f) provision of adequate test equipment;

g) standby equipment and/or utilities.

2. Practical aspects of reliability and availability

2.1 Measurement of reliability and availability

2.1.1 *Reliability.* The value that is obtained for MTBF in practice must of necessity be an estimate since the measurement will have to be made over a finite period of time. Measurement of MTBF over finite periods of time will enable Administrations to determine variations in the reliability of their facilities.

2.1.2 *Availability.* This is also important in that it provides an indication of the degree to which a facility (or group of facilities) is available to the users. Availability is directly related to the efficiency achieved in restoring facilities to normal service.

2.1.3 The basic quantities and manner of their measurement are indicated in Figure F-2. This figure is not intended to represent a typical situation which would normally involve a larger number of inoperative periods during the specified operating time. It should also be recognized that to obtain the most meaningful values for reliability and availability the specified operating time over which measurements are made should be as long as practicable.

2.1.4 Using the quantities illustrated in Figure F-2, which includes one scheduled shutdown period and five failure periods, one may calculate mean time between failures (MTBF) and availability (A) as follows:

Let:

$$a_1 + a_2 + a_3 + a_4 + a_5 + a_6 + a_7 = 5\,540 \text{ hours}$$
$$s_1 = 20 \text{ hours}$$
$$f_1 = 2\tfrac{1}{2} \text{ hours}$$
$$f_2 = 6\tfrac{1}{4} \text{ hours}$$
$$f_3 = 3\tfrac{3}{4} \text{ hours}$$
$$f_4 = 5 \text{ hours}$$
$$f_5 = 2\tfrac{1}{2} \text{ hours}$$
$$\text{Specified operating time} = 5\,580 \text{ hours}$$

$$\text{MTBF} = \frac{\text{Actual operating time}}{\text{Number of failures}}$$

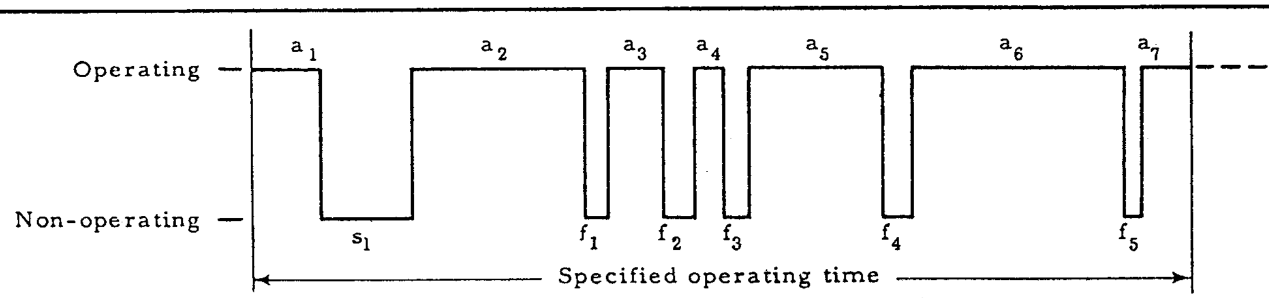
$$= \frac{\sum_{i=1}^{7} a_i}{5}$$

$$= \frac{5\,540}{5} = 1\,108 \text{ hours}$$

$$A = \frac{\text{Actual operating time} \times 100}{\text{Specified operating time}}$$

$$= \frac{\sum_{i=1}^{7} a_i \times 100}{\sum_{i=1}^{7} a_i + s_1 + \sum_{i=1}^{5} f_i}$$

$$= \frac{5\,540}{5\,580} \times 100 = 99.3 \text{ per cent.}$$



Actual operating time = $a_1 + a_2 + a_3 + a_4 + \ldots + a_n$

a = operating period

Non-operating time = $s_1 + \ldots + s_n + f_1 + f_2 + \ldots + f_n$

s = scheduled shutdown period

f = failure period

Specified operating time = Sum of actual operating time and non-operating time

Figure F-2. Evaluation of facility availability and reliability

ATTACHMENT G TO PART I. — INFORMATION AND MATERIAL FOR GUIDANCE IN THE APPLICATION OF THE MLS STANDARDS AND RECOMMENDED PRACTICES IN ANNEX 10

1. Definitions

Dynamic side-lobe level. The level that is exceeded 3 per cent of the time by the scanning antenna far field radiation pattern exclusive of the main beam as measured at the function scan rate using a 26 kHz beam envelope video filter. The 3 per cent level is determined by the ratio of the side-lobe duration which exceeds the specified level to the total scan duration.

Effective side-lobe level. That level of scanning beam side-lobe which in a specified multipath environment results in a particular guidance angle error.

Standard receiver. The airborne receiver model assumed in partitioning the MLS error budgets. The salient characteristics are: (1) signal processing based on the measurement of beam centres; (2) negligible centring error; (3) control motion noise (CMN) less than or equal to the values contained in Part I, 3.11.6.1.1.2; (4) a 26 kHz bandwidth 2-pole low pass beam envelope filter; and (5) angle data output filtering by a single pole, low pass filter with a corner frequency of 10 radians per second.

2. Signal-in-space characteristics — angle and data functions

2.1 Signal format organization

2.1.1 The signal format is based on time-division multiplexing wherein each angle guidance function is transmitted in sequence and all are transmitted on the same radio frequency. The angle information is derived by measuring the time difference between the successive passes of highly directive, unmodulated fan beams. Functions may be transmitted in any order. Recommended time slots are provided for the approach azimuth, approach elevation, flare, and back azimuth angle functions. The format includes additional time for growth of future functions such as 360-degree azimuth. Preceding each scanning beam and data transmission is a preamble which is radiated throughout the coverage volume by a sector antenna. The preamble identifies the next scan function and also synchronizes the airborne receiver signal processing circuits and logic.

2.1.2 In addition to the angle scan function, there are basic and auxiliary data functions, each with its own preamble, which are also transmitted from the sector antennas. The preamble permits each function to be recognized and processed independently. Consequently, functions can be added to or deleted from the ground configurations without affecting the operation of the receiver. The codes used in the preamble and data functions are modulated by differential phase shift keying (DPSK).

2.1.2.1 *DPSK data signal characteristics.* The DPSK data is transmitted by differential phase modulation of the radio frequency carrier with relative phase states of 0 or 180 degrees. The DPSK data signal has the following characteristics:

data rate — 15.625 kHz
bit length — 64 microseconds
logic "0" — no phase transition
logic "1" — phase transition

2.1.3 Examples of the angle function organization and timing are shown in Figures G-1 and G-2. Details and definitions of the data items shown in Figure G-1 are given in Part I, 3.11.4.8.

2.1.4 The sequences of angle guidance and data transmissions shown in Figures G-3A, G-3B and G-3C have been demonstrated to provide freedom from synchronous interference.

2.1.4.1 These sequences are intended to provide sufficient randomization to preclude synchronous interference such as may be caused by propeller rotation effects.

2.1.4.2 The sequence pair shown in Figure G-3A accommodates the transmission of all functions. Any function not required may be deleted so long as the remaining functions are transmitted in the designated time positions.

2.1.4.3 The sequence pair shown in Figure G-3B accommodates the high rate approach azimuth function. Any function not required may be deleted so long as the remaining functions are transmitted in the designated time positions.

2.1.4.4 Figure G-3C shows the complete time multiplex transmission cycle which may be composed of the sequence pairs from Figure G-3A or from Figure G-3B. The open time periods between sequences can be used for the transmission of auxiliary data words as indicated. Basic data words also may be transmitted in any open time period.

2.2 Angle guidance parameters

2.2.1 The angle guidance parameters that define the MLS angle measurement process are specified in Part I, 3.11.4.5. Two additional parameters that are useful in visualizing the operation of the system are the midscan time (T_m) and the pause time. They may be derived from the Part I specifications, and are shown for reference in the following table.

Signal format midscan and pause times
(see Figure G-2)

Function	Midscan* time, T_m (μs)	Pause time (μs)
Approach azimuth	7 972	600
High rate approach azimuth	5 972	600
Back azimuth	5 972	600
Approach elevation	2 518	400
Flare elevation	2 368	800

* Measured from the receiver reference time (Part I, Table A)

2.2.2 *Function timing accuracy.* Because of the inaccuracy in the determination of the reference time of the Barker code, and because the transmitter circuits smooth the phase or amplitude during phase transitions of the DPSK modulation, it is not possible to determine the timing of the signal with an accuracy better than 2 microseconds from the signal-in-space. It is therefore necessary to measure the timing accuracy specified in Part I, 3.11.4.3.4 on the ground equipment. Suitable test points should be provided in the ground equipment.

2.3 Azimuth guidance functions

2.3.1 *Scanning conventions.* Figure G-4 shows the approach azimuth and back azimuth scanning conventions.

2.3.2 *Coverage requirements.* Figures G-5 and G-6 illustrate the azimuth coverage requirements specified in Part I, 3.11.5.2.2.

2.3.2.1 When the approach or back azimuth antenna sites are necessarily offset from the runway centre line, the following factors should be considered:

a) coverage requirements throughout the runway region;

b) accuracy requirements at the applicable reference datum;

c) approach azimuth to back azimuth transition; and

d) potential disturbances due to moving vehicles, aircraft or airport structures.

2.3.2.2 An offset azimuth antenna should normally be adjusted such that the zero-degree radial is either parallel to the runway centre line or intersects the centre line extended at an operationally preferred point for the intended application. The alignment of the azimuth zero-degree radial with respect to the runway centre line is transmitted on the auxiliary data.

2.3.3 *High rate approach azimuth.* Where the approach proportional guidance sector is plus or minus 40 degrees or less and the flare elevation function or other growth functions are not used, it is possible to use a higher scanning rate for the azimuth function. The high rate approach azimuth function is available to offset the increase in CMN caused by large beamwidth antennas (e.g. 3 degrees). Reducing the CMN provides two benefits: 1) angle guidance signal-in-space power density requirements can be reduced; and 2) dynamic side-lobe level requirements can be relaxed.

2.3.3.1 In general, this function will reduce the CMN caused by wide bandwidth, uncorrelated sources such as diffuse multipath or receiver thermal noise by a factor of $\sqrt{1/3}$ relative to the basic 13 Hz function rate. However, the full reduction of power density by $\sqrt{1/3}$ cannot be realized for all ground antenna beamwidths because of the requirement to provide sufficient power density for signal acquisition on a single scan basis. Figure G-12 shows that power requirements can be reduced by a factor of $\sqrt{1/3}$ (= 4.8 dB) by using the higher data rate for 3-degree beamwidth antennas, 2.8 dB for 2-degree beamwidth antennas, and no reduction occurs for the 1-degree beamwidth antenna.

It should be noted that the power required for DPSK transmissions may be such that no economies are realized in the ground equipment transmitters by using the higher data rate (see Table G-1).

2.3.3.2 However, with respect to the CMN performance, the full benefit of the increased data rate can be realized. For example, at the minimum signal levels shown in Table G-2, the azimuth CMN can be reduced from 0.12 degree to 0.07 degree for the 1-degree beamwidth and from 0.2 degree to 0.12 degree for the 2-degree and 3-degree beamwidth antennas. Thus, the application of high rate azimuth is most beneficial to wider beamwidth antennas.

2.3.4 *Clearance*

2.3.4.1 Where used, clearance pulses are transmitted adjacent to the scanning beam signals at the edges of proportional coverage as shown in the timing diagram in Figure G-14. The proportional coverage boundary is established at one beamwidth inside the scan start/stop angles, such that the transition between scanning beam and clearance signals occurs outside the proportional coverage sector. Examples of composite waveforms which may occur during transition are shown in Figure G-16.

2.3.4.2 When clearance guidance is provided in conjunction with a narrow beamwidth (e.g. one degree) scanning antenna, the scanning beam antenna should radiate for 15 microseconds while stationary at the scan start/stop angles.

2.3.4.3 At some locations it may be difficult to satisfy the amplitude criteria of Part I, 3.11.6.2.5.2, because of clearance signal reflections. At these locations the scan sector may be extended.

2.3.4.4 Care should be taken with respect to the fly-right/fly-left clearance convention change when approaching azimuth stations in an opposite direction (e.g. approach towards the back azimuth antenna).

2.3.5 *Approach azimuth monitoring.* The intention of monitoring is to guarantee the guidance integrity appropriate for the promulgated approach procedure. It is not intended that all azimuth radials be monitored independently, but that at least one approach radial, normally the extended runway centre line, be monitored and that adequate means be provided to ensure that the performance and integrity of the other radials are maintained.

2.3.6 *Lower coverage limit determination.* When the threshold is not in line of sight of the approach azimuth antenna, the height of the lower limit of the approach azimuth coverage in the runway region should be determined by finding the lowest point above the runway centre line at the threshold which is in line of sight of the azimuth antenna. This point can be determined on the field or computed as in the example of Figure G-15. The lower limit of the azimuth coverage, to be published, is the height of this point over the threshold plus 2.5 m (8 ft).

2.3.6.1 If operations require coverage below the coverage limits obtainable from 2.3.6, the azimuth antenna can be offset from the runway centre line and moved toward the runway threshold to cover the touchdown region. The airborne installation must use the azimuth guidance, precision distance and siting co-ordinates of the ground equipment to compute the centre line approach.

2.3.6.2 The landing minima obtainable from a computed centre line approach are, among other things, a function of the combined reliability and integrity of the MLS approach azimuth, DME/P transponder and airborne equipment.

2.4 Elevation guidance functions

2.4.1 *Scanning conventions.* Figure G-7 shows the approach elevation and flare scanning conventions.

2.4.2 *Coverage requirements.* Figures G-8 and G-9 illustrate the elevation requirements specified in Part I, 3.11.5.3.2.

2.4.3 *Elevation monitoring.* The intention of monitoring is to guarantee the guidance integrity appropriate for the promulgated approach procedure. It is not intended that all glide paths be monitored independently, but that at least one, normally the minimum glide path, be monitored, and that adequate means be provided to ensure that the performance and integrity of the other glide paths are maintained.

2.5 Accuracy

2.5.1 *General*

2.5.1.1 System accuracy is specified in Part I, in terms of the path following error (PFE), path following noise (PFN), and control motion noise (CMN). These parameters are intended to describe the interaction of the angle guidance signal with the aircraft in terms which can be directly related to aircraft guidance errors and the flight control system design.

2.5.1.2 The system PFE is the difference between the airborne receiver angle measurement and the true position angle of the aircraft. The guidance signal is distorted by ground and airborne equipment errors and errors due to propagation effects. To assess the suitability of the signal-in-space for aircraft guidance, these errors are viewed in the pertinent frequency region. The PFE includes the mean course error and the PFN.

2.5.2 *MLS measurement methodology*

2.5.2.1 The PFE, PFN, and CMN are evaluated by using the filters defined in Figure G-10. The filter characteristics are based on a wide range of existing aircraft response properties, and are considered adequate for foreseeable aircraft designs as well.

2.5.2.2 While the term "PFE" suggests the difference between a desired flight path and the actual flight path taken by an aircraft following the guidance signal, in practice, this error is evaluated by instructing the flight inspection pilot to fly a desired MLS course and recording the difference between the airborne equipment output guidance indication from the PFE filter and the corresponding aircraft position measurement as determined by a suitable position reference. A similar technique using the appropriate filter determines the CMN.

2.5.2.3 *Error evaluation.* The PFE estimates are obtained at the output of the PFE filter (test point A in Figure G-10). The CMN estimates are obtained at the output of the CMN filter (test point B in Figure G-10). Filter corner frequencies are shown in Figure G-10.

2.5.2.3.1 The PFE and CMN for approach azimuth or for back azimuth are evaluated over any 40-second interval of the flight error record taken within the coverage limits (i.e. T = 40 in Figure G-11). The PFE and CMN for approach elevation or for flare elevation are evaluated over any 10-second interval of the flight error record taken within the coverage limits (i.e. T = 10 in Figure G-11).

2.5.2.3.2 The 95 per cent probability requirement is interpreted to be met if the PFE or CMN does not exceed the specified error limits for more than 5 per cent of the evaluation interval (see Figure G-11).

2.5.2.3.3 An alternative flight inspection procedure can be used which does not rely on an absolute reference. In this procedure, only the fluctuating components of the flight record produced at the output of the PFE filter are measured and compared with the PFN standard. The average value of the PFE is assumed to not exceed the mean course alignment specified during the flight inspection period. Therefore, the mean course alignment is added to the PFN measurement for comparison with the specified system PFE. The CMN may be similarly evaluated without accounting for the mean course alignment.

2.5.2.4 *Ground and airborne instrumentation errors.* The instrumentation error induced by the ground and airborne equipment may be determined by measurements taken in an environment which is free from reflected signals or other propagation anomalies which can cause beam envelope perturbations.

2.5.2.4.1 First, the instrumentation errors associated with the standard airborne receiver are determined using a bench test instrument, and the centring error is adjusted to zero. Airborne equipment errors can be measured by recording 40 seconds of data using a standard bench test set. The data can then be divided into four 10-second intervals. The average of each interval is considered to be the PFE while twice the square root of its associated variance is the CMN.

Note.— The receiver output may be evaluated using the PFE and CMN filters, if desired.

2.5.2.4.2 Second, this standard receiver is used to measure the total system instrumentation error by operating the ground equipment on an antenna range or in some other reflection-free environment. Since the receiver centring error has been made negligible, the measured PFE can be attributed to the ground equipment. The ground equipment CMN is obtained by subtracting the known standard receiver CMN variance from the CMN variance of the measurement. The average error over a 10-second measurement interval is considered to be the PFE, while twice the square root of the differential variances is considered to be the instrumental CMN.

2.6. Power density

2.6.1 *General*

2.6.1.1 Three criteria establish the angle power budgets:

a) angle single-scan acquisition requires a 14-dB signal-to-noise ratio (SNR) as measured at the beam envelope filter (i.e. the video SNR);

b) the angle CMN must be maintained within specified limits;

c) the DPSK transmissions must have a detection probability at the extremes of coverage of at least 72 per cent.

2.6.1.2 The source of CMN at 37 km (20 NM) is primarily internal receiver thermal noise. The noise induced error ($d\theta$) can be estimated by:

$$d\theta = \frac{\theta_{BW}}{2(\sqrt{SNR}\sqrt{g})} \qquad \text{(95\% probability)}$$

$$g = \frac{\text{Function sample rate}}{2\ \text{(Filter noise bandwidth)}}$$

where θ_{BW} is the antenna beamwidth in degrees and g is the ratio of the function sample rate to the noise bandwidth of the receiver output filter. This expression reflects the CMN dependence upon ground antenna beamwidth and sample rate.

2.6.2 *System power budget*

2.6.2.1 The system power budget is presented in Table G-1. The power density specified in Part I, 3.11.4.10.1, is related to the signal power specified in Table G-1 at the aircraft antenna by the relation:

Power into isotropic antenna (dBm) =
Power density (dBW/m^2) - 5.5

2.6.2.2 The angle function measurement assumes a 26-kHz beam envelope filter bandwidth. The video (SNR) given in 2.6.1 above is related to the intermediate frequency (IF) SNR by:

$$\text{SNR (Video)} = \text{SNR (IF)} + 10 \log \left[\frac{\text{IF noise bandwidth}}{\text{Video noise bandwidth}}\right]$$

2.6.2.3 The DPSK preamble function analysis assumes: 1) a carrier reconstruction phase lock loop airborne receiver implementation; and 2) that the receiver preamble decoder rejects all preambles which do not satisfy the Barker code or fail the preamble parity check.

2.6.2.4 Items a) through e) in Table G-1 are functions of the aircraft position or weather, and thus have been assumed to be random events. That is, they will simultaneously reach their worst-case values only on rare occasions. Therefore, these losses are viewed as random variables and are root-sum-squared to obtain the loss component.

2.6.2.5 Figure G-12 interpolates the minimum power density required for ground antenna beamwidths other than those specified in Part I, 3.11.4.10.1.

2.6.2.6 To support autoland operations, power densities higher than those specified for the approach azimuth angle signals in 3.11.4.10.1 are required at the lower coverage limit above the runway surface to limit the CMN to 0.04 degree. Normally, this additional power density will exist as a natural consequence of using the same transmitter to provide the scanning beam and DPSK signals and considering other power margins such as the available aircraft antenna gain, propagation losses, coverage losses at wide angles and rain losses which can be, at least partially, discounted in the runway region. (See Table G-1.)

2.6.3 *Airborne power budget*

2.6.3.1 Table G-2 provides an example of an airborne power budget used in developing the power density standards.

2.7 Data applications

2.7.1 *Basic data.* The basic data transmissions are provided to enable airborne receivers to process scanning beam information for various ground equipment configurations and to adjust outputs so they are meaningful to the pilot or airborne system. Data functions are also used to provide additional information (e.g. station identification and equipment status) to the pilot or airborne system.

a) The approach azimuth antenna-to-threshold distance is intended for the scaling of deviation information for airborne systems which express deviation from a course in angular terms, as discussed in 7.4.1.

b) The proportional coverage limits are provided for both approach and back azimuth antennas. The angle coded in this data item is the boundary between the proportional guidance and the clearance guidance or out-of-coverage sectors, as appropriate to the ground equipment implementation.

c) Basic Data Word 2 containing back azimuth status is positioned in the format to facilitate airborne antenna selection for back azimuth reception for aircraft equipped with multiple receiving antennas. As a result, it also indicates the operational status of back azimuth equipment to aircraft in the approach azimuth sector.

d) The approach azimuth and back azimuth magnetic orientations are provided to enable selection in the airborne system of courses relative to Magnetic North.

2.7.2 *Auxiliary data.* The auxiliary data transmissions are provided to digitally uplink the following types of information:

a) data describing ground equipment siting;

b) data describing approach and missed approach paths and procedures; and

c) meteorological and operational data used for special interest applications.

2.8 Adjacent channel interference considerations

2.8.1 The standard has been structured such that there is at least a 5-dB margin to account for variations in the effective radiated power above the minimum power density specification. The interference specification is based upon worst-case antenna beamwidth combinations, data rate, and undesired interference synchronization.

3. Ground equipment

3.1 Scanning beam shape

3.1.1 The azimuth scanning beam envelope on the antenna boresight and the elevation scanning beam envelope at the preferred glide path angle, as detected by a standard receiver, should conform to the limits specified in Figure G-13 under conditions of high SNR and negligible multipath (e.g. during a trial on an antenna range).

3.2 Scanning beam side-lobes

3.2.1 *Performance specification.* The antenna side-lobe design should satisfy two conditions: 1) the dynamic side-lobe level should not prevent the airborne receiver from acquiring and tracking the main beam. Satisfactory performance cannot be assured if dynamic side-lobes persist at levels above minus 10 dB; 2) the effective side-lobe level should be compatible with the system error budget.

3.2.2 The effective side-lobe level (P_{ESL}) is related to the dynamic side-lobe level (P_{DYN}) by:

$$P_{ESL} = K \times P_{DYN}$$

where K is a reduction factor which depends upon the antenna implementation. The reduction factor may be dependent upon:

a) a directive antenna element pattern which reduces the multipath signal level relative to the coverage volume;

b) the degree of randomness in the dynamic side-lobes.

Note.— The dynamic side-lobes are of least concern, if the measured dynamic side-lobe levels are less than the specified effective side-lobe levels.

3.2.3 Lateral multipath reflections from the azimuth antenna side-lobes and ground multipath reflections from elevation antenna side-lobes can perturb the main beam and induce angular errors. To ensure that the error $d\theta$ generated by the antenna side-lobes is within the propagation error budgets, the required effective side-lobe level ESL can be estimated using:

$$P_{ESL} = \frac{d\theta}{\theta_{BW} P_R \, P_{MA}}$$

where P_R is the multipath obstacle reflection coefficient, θ_{BW} is the ground antenna beamwidth and P_{MA} is the motion averaging factor.

3.2.4 The motion averaging factor depends on the specific multipath geometry, the aircraft velocity, the function data rate and the output filter bandwidth. For combinations of multipath geometry and aircraft velocity such that the multipath scalloping frequency is greater than 1.6 Hz, the motion factor is:

$$P_{MA} = \sqrt{\frac{2 \text{ (output filter noise bandwidth)}}{\text{Function data rate}}}$$

3.2.5 This factor can be further reduced at higher multipath scalloping frequencies where the multipath-induced beam distortions are uncorrelated within the time interval between the TO and FRO scans.

3.3 Approach elevation antenna pattern

3.3.1 If required to limit multipath effects, the horizontal radiation pattern of the approach elevation and flare antenna should gradually de-emphasize the signal away from the antenna boresight. Typically the horizontal pattern of the approach elevation antenna should be reduced by 3 dB at 20 degrees off the boresight and by 6 dB at 40 degrees. Also typically the horizontal pattern of the flare antenna should be reduced to as low as practicable beyond 10 degrees off the boresight and by at least 12 dB at 40 degrees off the boresight. Depending on the actual multipath conditions, the horizontal radiation pattern may require more or less de-emphasis.

4. Siting considerations

4.1 *MLS/ILS collocation.* Siting of the MLS elevation facility will be affected by the presence or absence of an ILS glide path facility. When collocating MLS with an existing ILS glide path, the reference datum of the MLS and the reference datum of the ILS should be equal providing the latter is within Annex 10 tolerances. Since the phase centre height of the MLS elevation antenna may be 2.74 m (9 ft) (flat terrain assumed), the MLS antenna must then be positioned forward of the ILS antenna. The position inboard to the ILS antenna (nearer to runway centre line) is also preferred. For example, a 3-degree glide path will place a 2.74 m (9 ft) phase centre height MLS antenna 52 m (172 ft) in front of the ILS antenna.

4.1.1 At some sites where ILS and MLS are to be collocated, it may be found impossible because of physical restrictions to locate the MLS azimuth antenna in front of, or back of the ILS localizer antenna. At those sites an advantageous solution could be to offset the MLS and DME/P antennas. The siting information contained in auxiliary data would enable computation in the aircraft of an MLS centre line approach. The minima obtainable would need to consider the achievable integrity of the combined equipment involved in the computation.

4.2 *Critical and sensitive areas.* Objects in front of and near to the antennas can cause in-beam multipath or signal shadowing. MLS critical areas designed to protect straight-in centre line approaches are indicated in Figure G-17 and Figure G-18 for normal installations on flat sites.

4.2.1 Note that MLS critical areas are smaller than ILS critical areas, and where MLS antennas are located in close proximity to ILS antennas, the ILS critical areas will also protect the MLS for similar approach paths.

4.2.2 Note also that where MLS is installed without ILS, advantage can be taken of the closely defined beams of MLS to allow fixed and moving objects in front of the antennas so long as they remain below the beams as indicated in Figure G-17 and Figure G-18.

4.2.3 In the case of the azimuth antenna, and only to avoid signal shadowing along the runway when landing operations are in progress, additional protection should be provided in the form of a sensitive area as indicated in Figure G-17. No sensitive area is necessary for the elevation antenna.

5. Operational consideration on siting of DME ground equipment

5.1 The DME equipment should, whenever possible, provide indicated zero range to the pilot at the touchdown point in order to satisfy current operational requirements.

5.1.1 When DME/P is installed with the MLS, indicated zero range referenced to the MLS datum point may be obtained by airborne equipment utilizing coordinate information from the MLS data. DME zero range should be referenced to the DME/P site.

6. Interrelationship of ground equipment monitor and control actions

6.1 The interrelationship of monitor and control actions described is considered necessary to ensure that aircraft do not receive incomplete guidance which could jeopardize safety, but at the same time continue to receive valid guidance which may safely be utilized in the event of certain functions ceasing to radiate.

a) *Approach azimuth failure.* Control action should permit back azimuth, data and distance measuring functions to radiate.

b) *Approach elevation failure.* Control action should permit other angle, data and distance measuring functions to radiate.

c) *Flare elevation failure.* Control action should permit other angle, data and distance measuring functions to radiate.

d) *Back azimuth failure.* Control action should permit other angle, data and distance measuring functions to radiate.

e) *Basic data word failure.* Control action should permit other angle, data and distance measuring functions to radiate.

f) *Auxiliary data word failure.* Control action should permit other angle, data and distance measuring functions to radiate.

g) *DME failure.* Control action should permit other angle and data functions to radiate.

Note 1.— Basic data and auxiliary data monitors should have the ability to detect the failure of an individual data word and remove that word from the data transmission, while permitting radiation of the remaining data.

Note 2.— This information is presented in graphic form in Table G-3.

7. Airborne equipment

7.1 General

7.1.1 The airborne equipment parameters and tolerances included in this section are intended to enable an interpretation of the Standards contained in Part I, 3.11 and include allowances, where appropriate, for:

a) variation of the ground equipment parameters within the limits defined in Part I, 3.11;

b) aircraft manoeuvres, speeds and attitudes normally encountered within the coverage volume.

Note 1.— The airborne equipment includes the aircraft antenna(s), the airborne receiver, the pilot interface equipment and the necessary interconnexions.

Note 2.— Detailed "Minimum Performance Specifications" for MLS avionics have been compiled and co-ordinated by the European Organization for Civil Aviation Electronics (EUROCAE), and the Radio Technical Commission for Aeronautics (RTCA). ICAO periodically provides to Contracting States current lists of the publications of these organizations co-ordinated internationally in accordance with Recommendations 3/18(a) and 6/7(a) of the Seventh Air Navigation Conference.

7.1.2 The airborne equipment should be capable of decoding the approach azimuth, high rate approach azimuth, back azimuth, and approach elevation functions, and data essential to these functions. Range information should be decoded independently.

7.1.3 The receiver should decode the full range of angles permitted by the signal format for each function. The guidance angle is determined by measuring the time interval between the received envelopes of the TO and FRO scans. The decoded angle is related to this time interval by the equation given in Part I, 3.11.4.5.

7.1.4 The receiver should be capable of normal processing of each radiated function without regard to the position of the function in the transmitted sequences.

7.1.5 If the MLS azimuth being used is presented on the selector and/or flight instruments, it should be displayed as a magnetic course.

7.1.6 The receiver should have the capability for both manual and automatic selection of approach azimuth and elevation. When in the automatic mode, the selection should be made as follows:

7.1.6.1 *Approach azimuth* — select the angular reciprocal of the approach azimuth magnetic orientation in basic data word 4.

7.1.6.2 *Elevation* — select the minimum glide path in basic data word 2.

7.2 Radio frequency response

7.2.1 *Acceptance bandwidth*

7.2.1.1 The receiver should meet acquisition and performance requirements when the received signal frequency is offset by up to plus or minus 12 kHz from the normal channel centre frequency. This figure considers possible ground transmitter offsets of plus or minus 10 kHz and Doppler shifts of plus or minus 2 kHz. The receiver should decode all functions independently of the different frequency offsets of one function relative to another.

7.2.2 *Selectivity*

7.2.2.1 When the receiver is tuned to an inoperative channel and an unwanted MLS signal of a level 33 dB above that specified in Part I, 3.11.4.10.1 for the approach azimuth DPSK is transmitted on any one of the remaining channels, the receiver should not acquire the signal.

7.2.3 *In-channel spurious response*

7.2.3.1 The receiver performance specified in Part I, 3.11.6, should be met when, in addition, interference on the same channel is received at a level not exceeding that specified in Part I, 3.11.4.1.4.

7.3 Signal processing

7.3.1 *Acquisition*

7.3.1.1 The receiver should, in the presence of an input guidance signal which conforms to the requirements of 3.11.4, acquire and validate the guidance signal before transitioning to the track mode within two seconds along the critical portion of the approach and within six seconds at the limits of coverage.

7.3.2 *Track*

7.3.2.1 While tracking, the receiver should provide protection against short duration large amplitude spurious signals. When track is established, the receiver should output valid guidance information before removing the warning. During track mode, the validation process should continue to operate.

7.3.2.2 After loss of the tracked signal for more than one second, the receiver should provide a warning signal. Within the one-second interval, the guidance information should remain at the last output value.

Note 1.— A validated guidance signal is one that satisfies the following criteria:

a) The correct function identification is decoded;

b) The preamble timing signal is decoded;

c) The "TO" and "FRO" scanning beams or left/right clearance signals are present and symmetrically located with respect to the midpoint time; and

d) The detected beamwidth is from 25 to 250 microseconds.

Note 2.— Guidance signal validation also requires that the receiver repeatedly confirm that the signal being acquired or tracked is the largest and most persistent signal within the coverage.

7.3.3 *Data functions.* Recommended performance in the airborne processing of data provided on either the basic or auxiliary data function is broken into two items: the time allowed to acquire and validate the data and the probability of an undetected error in the validated data.

7.3.3.1 At the minimum signal power density, the time to acquire and validate basic data word 2 which is transmitted at a rate of 6.25 Hz should not exceed two seconds on a 95 per cent probability basis. The time to acquire and validate data that is transmitted at a rate of 1 Hz should not exceed 6 seconds on a 95 per cent probability basis.

7.3.3.2 In the acquisition process, the receiver should decode the appropriate data words and apply certain tests to ensure that the probability of undetected errors does not exceed 1×10^{-6} at the minimum signal power density for those data requiring this level of integrity. The recommended performance specifications for undetected errors may require additional airborne processing of the data beyond simple decoding. For example, these may be achieved by processing multiple samples of the same data words.

7.3.4 *Multipath performance*

7.3.4.1 Where the radiated signal power density is high enough to cause the airborne equipment thermal noise contribution to be insignificant, the following specifications should apply for scalloping frequencies between 0.05 Hz and 999 Hz.

7.3.4.1.1 *In-beam multipath.* Multipath signals coded less than two beamwidths from the direct signal and with amplitudes of 3 dB or more below the direct signal should not degrade the angle guidance accuracy output by more than plus or minus 0.5 beamwidth (peak error).

7.3.4.1.2 *Out-of-beam multipath.* Multipath signals coded 2 beamwidths or more from the direct signal and with amplitudes of 3 dB or more below the direct signal should not degrade the angle guidance accuracy by more than plus or minus 0.02 beamwidth.

7.3.5 *Clearance*

7.3.5.1 The airborne equipment should provide clearance guidance information whenever the antenna is in the presence of a valid clearance guidance signal.

7.3.5.2 When the decoded angle indication is outside the proportional guidance sector defined in Part I, Table A-7, the MLS guidance signal should be interpreted as clearance guidance.

7.3.5.3 When clearance pulses are transmitted, the receiver shall be able to process the range of pulse envelope shapes that may appear in the transition between clearance and scanning beam signals. A particular pulse envelope is dependent on the receiver position, scanning antenna beamwidth, and the relative phase and amplitude ratios of the clearance and scanning beam signals as shown in Figure G-16. The receiver shall also be required to process rapid changes of indicated angle of the order of 1.5 degrees (peak amplitude) when outside the proportional guidance limits.

7.3.5.4 In receivers with the capability to select or display azimuth angle guidance information greater than plus or minus 10 degrees, the proportional coverage limits in basic data must be decoded and used to preclude use of erroneous guidance.

7.3.6 *Data*

7.3.6.1 If the receiver does not decode data essential for the intended operation, a suitable warning should be provided.

7.4 Control and output

7.4.1 *Deviation scale factor*

7.4.1.1 When the approach azimuth deviation information is intended to have the same sensitivity characteristics as ILS, it should be a function of the "approach azimuth antenna to threshold distance", as supplied by the basic data, in accordance with the following table:

Approach Azimuth Antenna to Threshold Distance (ATT)	*Nominal Course Width*
0-400 m	± 3.6 degrees
500-1 900 m	± 3.0 degrees
2 000-4 100 m	$\pm \arctan\left(\frac{105}{ATT}\right)$ degrees
4 200-6 300 m	± 1.5 degrees

7.4.1.2 *Back azimuth.* The deviation information should be a function of the "back azimuth antenna distance" so as to provide a smooth transition from approach azimuth to back azimuth guidance.

7.4.2 *Angle data output filter characteristics*

7.4.2.1 *Phase lags.* To assure proper autopilot interface, the receiver output filter, for sinusoidal input frequencies, should not include phase lags which exceed:

a) 4 degrees from 0.0 to 0.5 rad/s for the azimuth function; and

b) 6.5 degrees from 0.0 to 1.0 rad/s and 10 degrees at 1.5 rad/s for the elevation function.

7.4.3 *Minimum glide path.* When there is capability of selecting the approach elevation angle, a suitable warning should be issued if the selected angle is lower than the minimum glide path as provided in basic data.

7.4.4 *Status bits.* A suitable warning should be provided when the function status bits in basic data indicate that the respective function is not being radiated or is being radiated in test modes.

8. Operations outside the promulgated MLS coverage sectors

8.1 The basic MLS antenna designs should preclude the generation of unwanted signals outside coverage. Under some unusual siting conditions, MLS signals might be reflected into regions outside the promulgated coverage with sufficient strength to cause erroneous guidance information to be presented by the receiver. As in current procedure the implementing authority would specify operational procedures based on the use of other navaids to bring the aircraft into landing system coverage without transiting the area of concern or may publish advisories which alert pilots to the condition. In addition, the MLS signal format permits the use of three techniques to further reduce the probability of encountering erratic flag activity.

8.1.1 If the undesired MLS signals are reflections and if operational conditions permit, the coverage sector can be adjusted (increased or decreased) such that, at the receiver, either the direct signal is greater than any reflection or the reflector is not illuminated. This technique is referred to as coverage control.

8.1.2 Out-of-coverage indication signals can be transmitted into the out-of coverage sectors for use in the receiver to ensure a flag whenever an undesired angle guidance signal is present. This is accomplished by transmitting an out-of-coverage indication signal into the region which is greater in magnitude than the undesired guidance signal.

9. Separation criteria in terms of signal ratios and propagation losses

9.1 Geographical separation

9.1.1 The separation criteria are provided in 9.2 and 9.3 below as desired to undesired (D/U) signal ratios and when combined with appropriate propagation losses allow evaluation of MLS C-Band frequency assignments as regards on-channel and adjacent channel interference. When selecting frequencies for MLS facilities, a similar criteria for the DME/P element or an associated DME/N as provided in Attachment C to this Part need to be considered.

9.2 Co-frequency requirements

9.2.1 Co-frequency MLS channel assignments should be made to preclude the acquisition of DPSK preambles of an undesired co-channel facility. The required level of the undesired signal is less than minus 120 dBm, which is 2 dB below a sensitive MLS airborne system, as shown below:

— receiver sensitivity	= −112 dBm
— margin for aircraft antenna gain above minimum	= −6 dB
	−118 dBm

Considering the system power budget in Table G-1, which shows the minimum signal level at the aircraft is required to be at least minus 95 dBm, the minus 120 dBm requirement corresponds to a D/U ratio of 25 dB.

Note.— The DPSK signal requires more protection than the scanning beam so that by limiting the undesired co-channel signal to minus 120 dBm, interference from the scanning beam is negligible.

9.3 Adjacent frequency requirements

9.3.1 The first and second MLS C-Band adjacent frequencies require a D/U ratio equal to or greater than minus 20.5 dB and minus 25 dB respectively. These D/U values are for the DPSK functions of the desired and undesired signals. Concerning the required frequency protection, the third adjacent frequency need not be protected. As the maximum undesired signal that can be coupled to the angle receiver operating at the worst case point in the MLS service volume is 23.5 dB, only the first and possibly the second adjacent frequencies require assignment protection.

9.3.2 Because of the small existing differentials, if either the off-frequency rejection ratio used (32.5 dB) or the coupled D/U values are other than indicated, adjusted values must be used to determine if the second adjacent frequency needs to be protected.

Table G-1. System power budget
(±40° azimuth coverage; 0-20° vertical coverage; 37 km (20 NM) range)

			Angle beamwidth		
			Azimuth		Elevation
Power budget items[1]	AZ DPSK	Clearance	2°	3°	2°
Signal required at aircraft (dBm)	−95	−93.5	−91	−87.5	−93.5
Propagation loss[2] (dB)	138.7	138.7	138.7	138.7	138.1
Probabilistic losses (dB)					
a) Polarization	0.5	0.5	0.5	0.5	0.5
b) Rain	2.2	2.2	2.2	2.2	2.2
c) Atmospheric	0.3	0.3	0.3	0.3	0.3
d) Horizontal multipath	3.0	3.0	0.5	0.5	—
e) Vertical multipath	2.0	2.0	2.0	2.0	1.0
Total a) through e) route sum square (RSS) (dB)	4.3	4.3	3.1	3.1	2.5
Horizontal and vertical pattern loss (dB)	—	1.0	2.0	2.0	6.0
Monitor loss (dB)	1.5	1.5	1.5	1.5	1.5
Antenna gain[3] (dB)	—	−13.3	−16.3	−14.4	−14.1
Net power gain at coverage extremes (dB)	−7.3	—	—	—	—
Required transmitter power (dBm)	42.1	38.6	38.0	43.4[4]	40.5

1) Losses and antenna gains are representative values.
2) Distance to azimuth antenna taken as 41.7 km (22.5 NM).
3) The required transmitter power can be reduced by using higher efficiency antennas.
4) High data rate for 3° azimuth beamwidth will reduce required transmitter power by 4.8 dB.

Table G-2. Airborne power budget

Power budget item	DPSK	Clearance	Azimuth beamwidth 1°	2°	3°	3°[1]	Elevation beamwidth 1°	2°
IF SNR required for:								
a) 72% preamble decode rate (dB)	5	–	–	–	–	–	–	–
b) 0.2° CMN (dB)	–	–	–	9	12.5	7.7	–	–
c) Acquisition (dB)	–	6.5	6.5	–	–	–	6.5	6.5
Noise figure (dB)	11	11	11	11	11	11	11	11
Noise power in 150 kHz IF bandwidth (dBm)	-122	-122	-122	-122	-122	-122	-122	-122
Cable loss (dB)	5	5	5	5	5	5	5	5
Airborne antenna gain (dBi)	0	0	0	0	0	0	0	0
Margin (dB)	6	6	6	6	6	6	6	6
Signal required at aircraft (dBm)	-95	-93.5	-93.5	-91	-87.5	-92.3	-93.5	-93.5

1) High rate azimuth function.

Table G-3. Interrelationship of ground equipment monitor and control action

Sub-system failure	Resultant action: Approach azimuth	Approach elevation	Flare	Back azimuth	Basic data word	DME or DME/P	Auxiliary data word
Approach azimuth	*	*	*				
Approach elevation		*					
Flare			*				
Back azimuth				*			
Basic data word					*		
DME or DME/P						*	
Auxiliary data word							*

* Indicates radiation should cease.

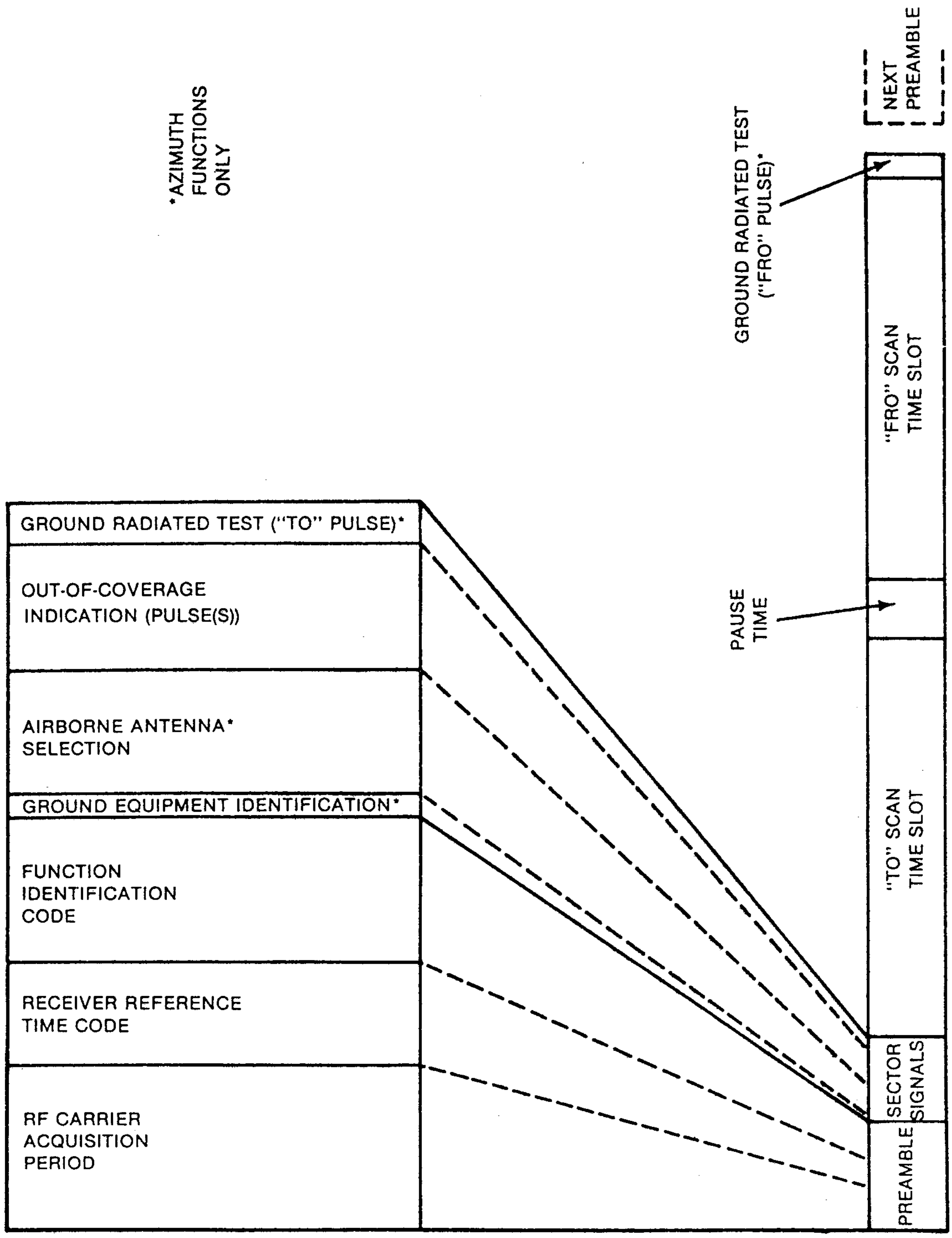


Figure G-1. Angle function organization

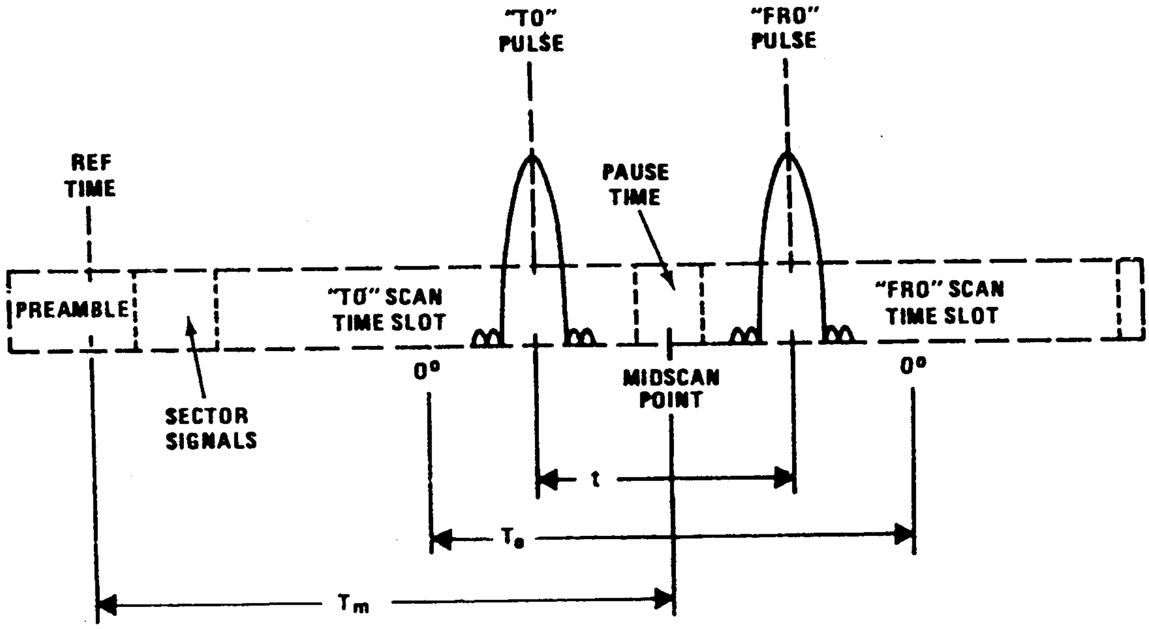
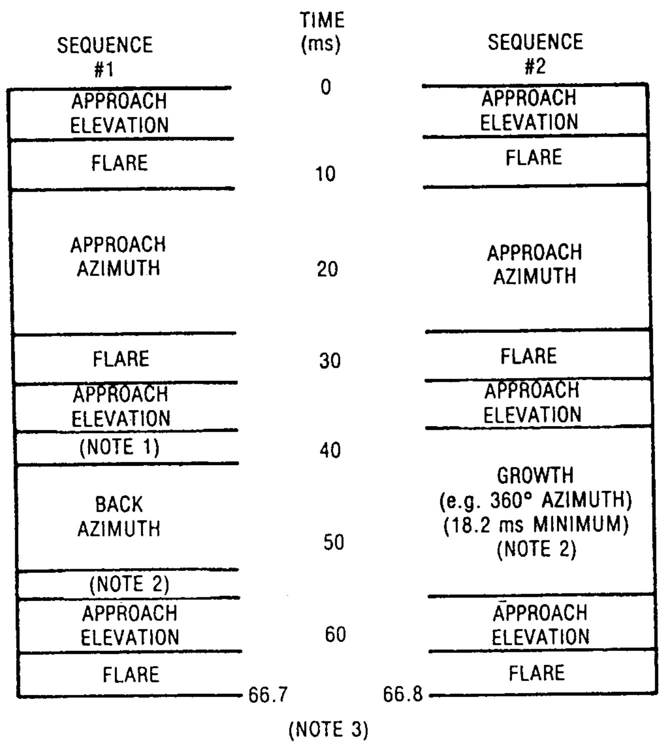


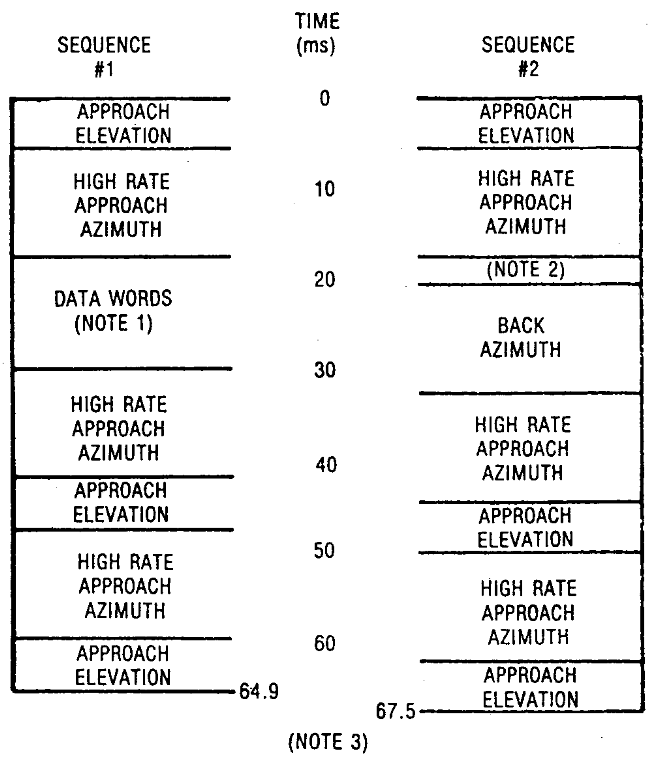
Figure G-2. Angle scan timing parameters



Notes:

1. *When back azimuth is provided, basic data word #2 must be transmitted only in this position.*
2. *Data words may be transmitted in any open time periods.*
3. *The total time duration of sequence #1 plus sequence #2 must not exceed 134 ms.*

Figure G-3A. Transmission sequence pair which provides for all MLS angle guidance functions



Notes:

1. *Data words may be transmitted in any open time periods.*
2. *When back azimuth is provided, basic data word #2 must be transmitted only in this position.*
3. *The total time duration of sequence #1 plus sequence #2 must not exceed 134 ms.*

Figure G-3B. Transmission sequence pair which provides for the MLS high rate approach azimuth angle guidance function

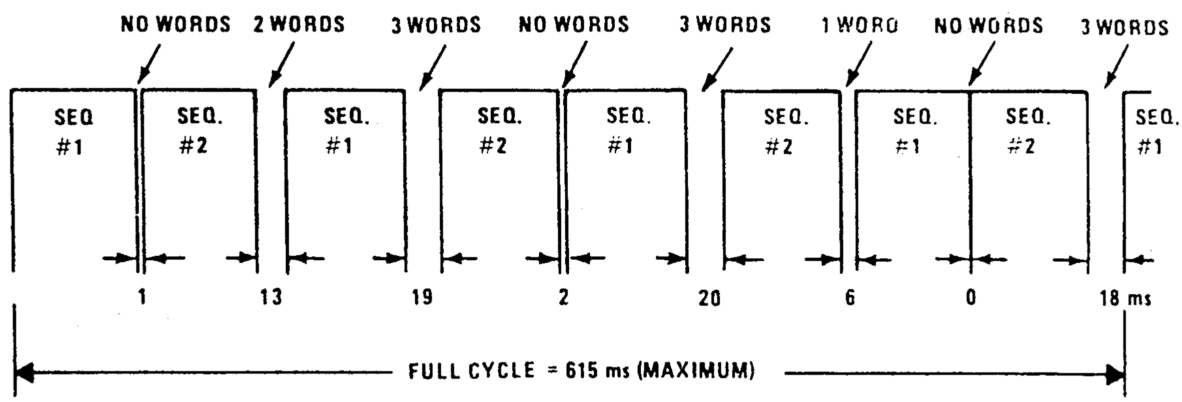


Figure G-3C. Complete multiplex transmission cycle showing open time periods available for auxiliary data words

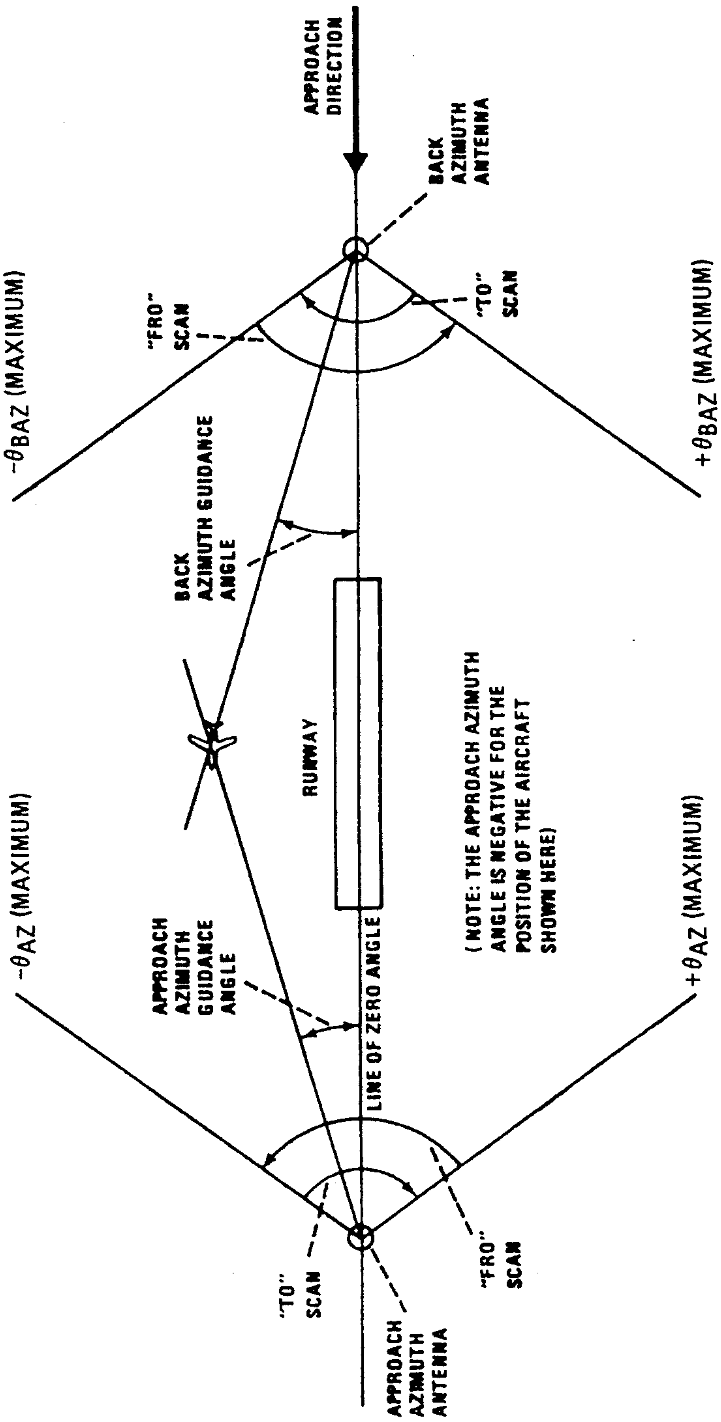


Figure G-4. Scanning conventions for azimuth guidance functions

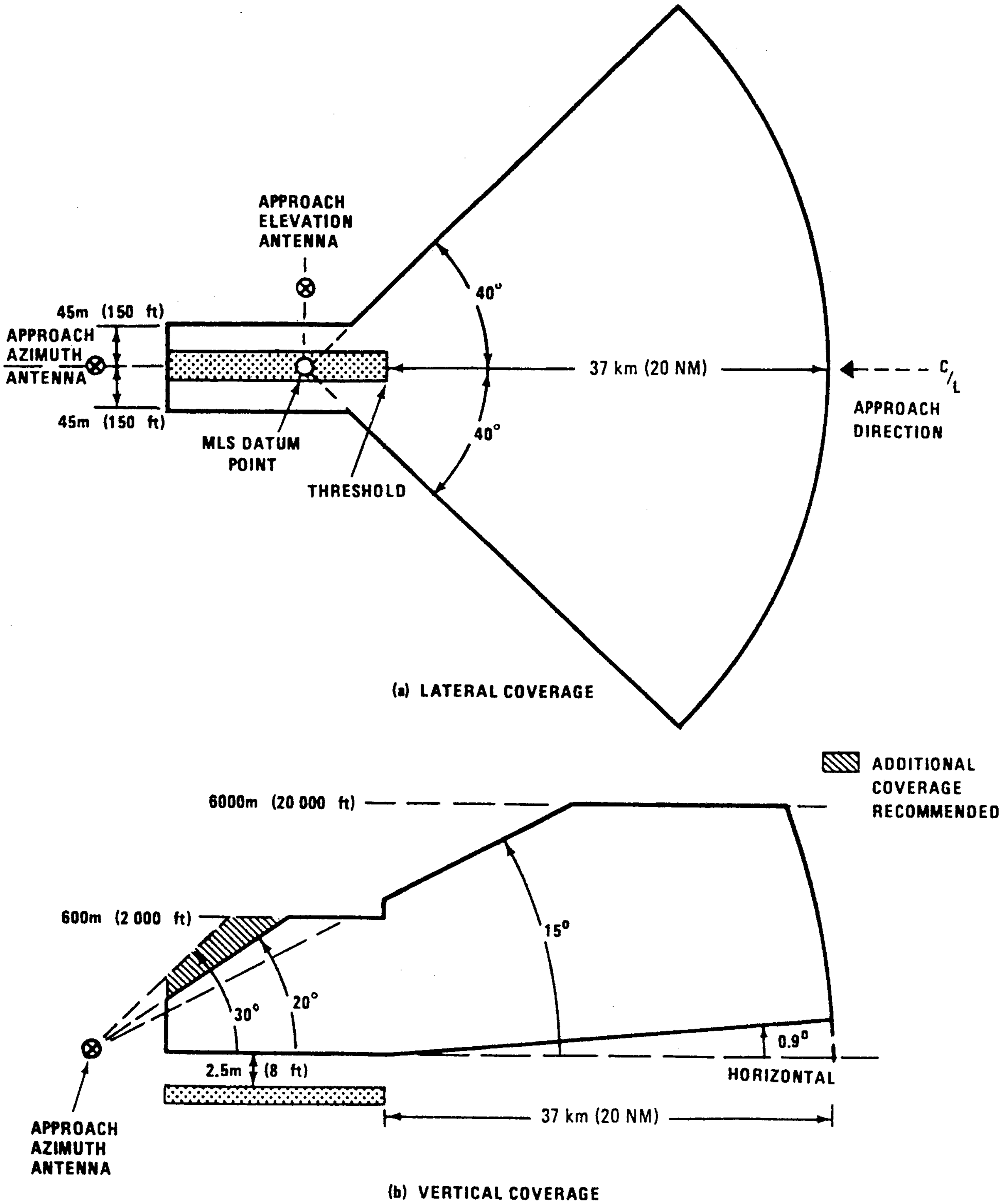


Figure G-5. Approach azimuth coverage

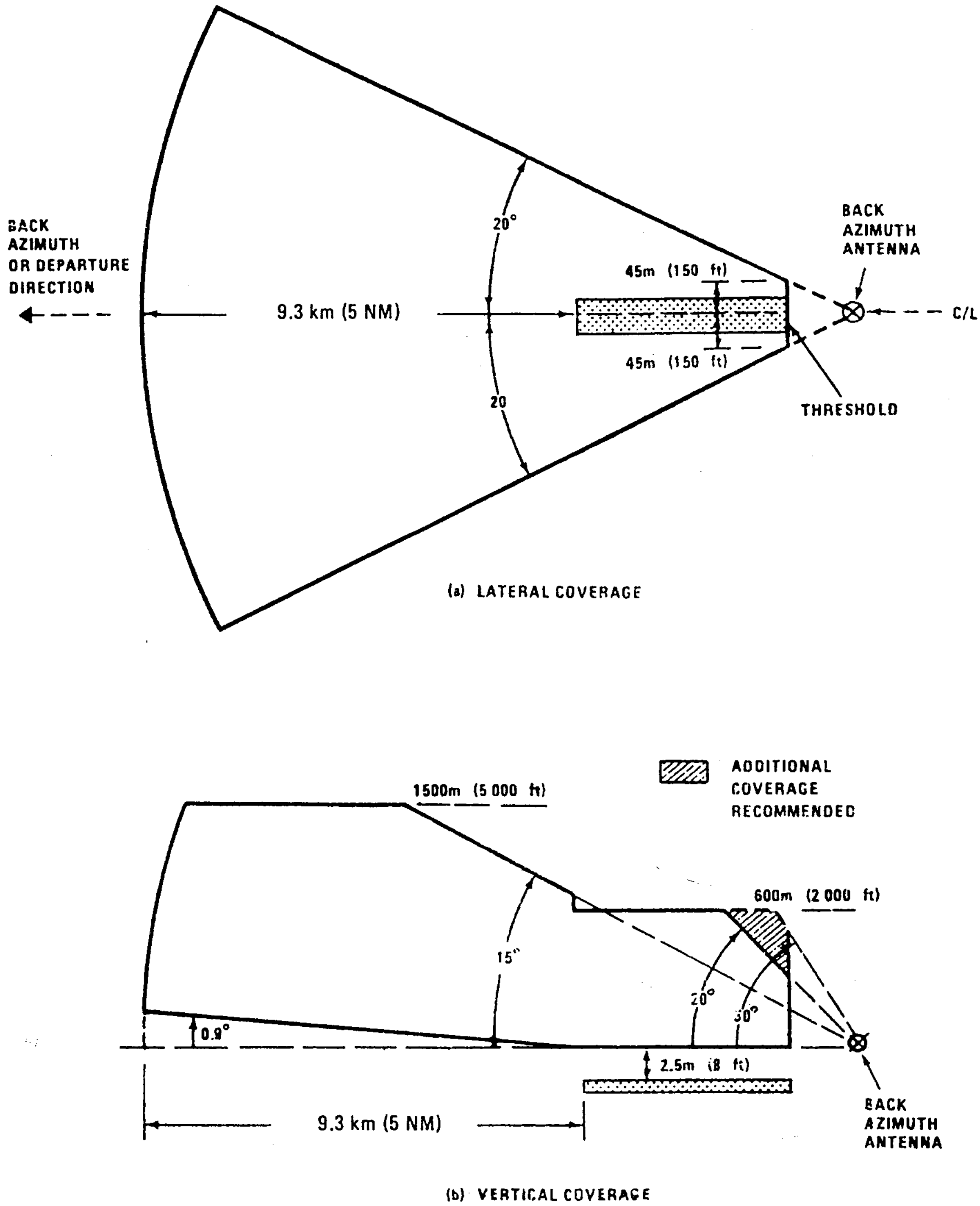


Figure G-6. Back azimuth coverage

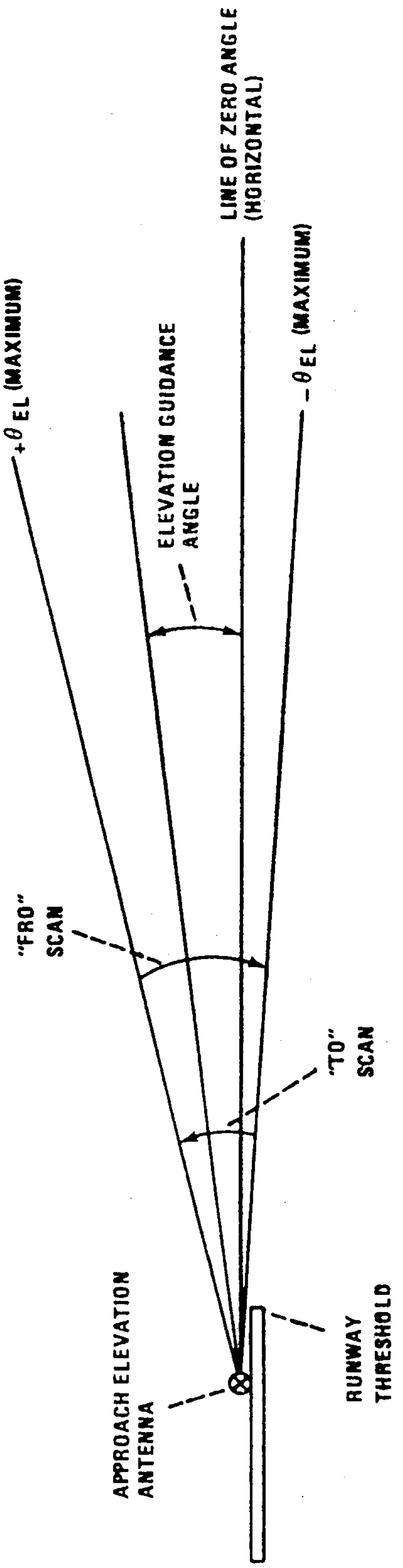
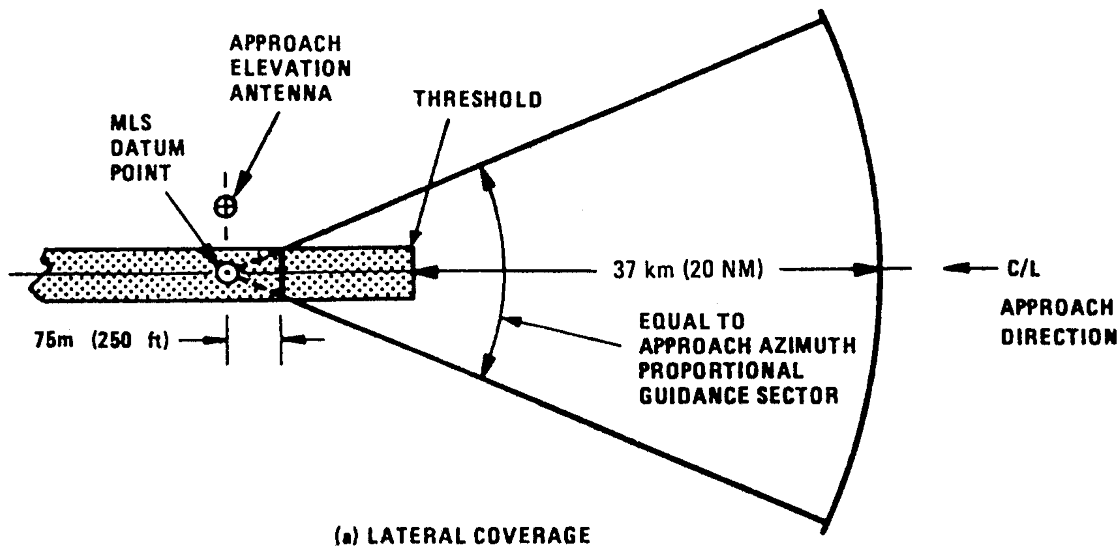


Figure G-7. Scanning conventions for approach elevation and flare guidance functions



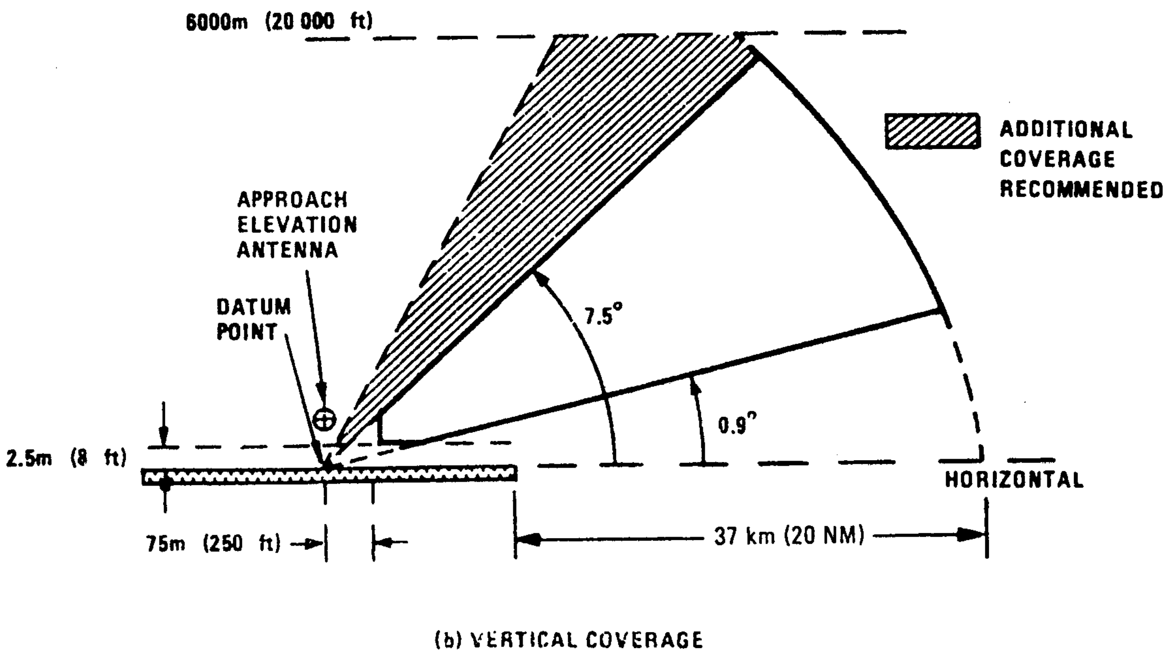
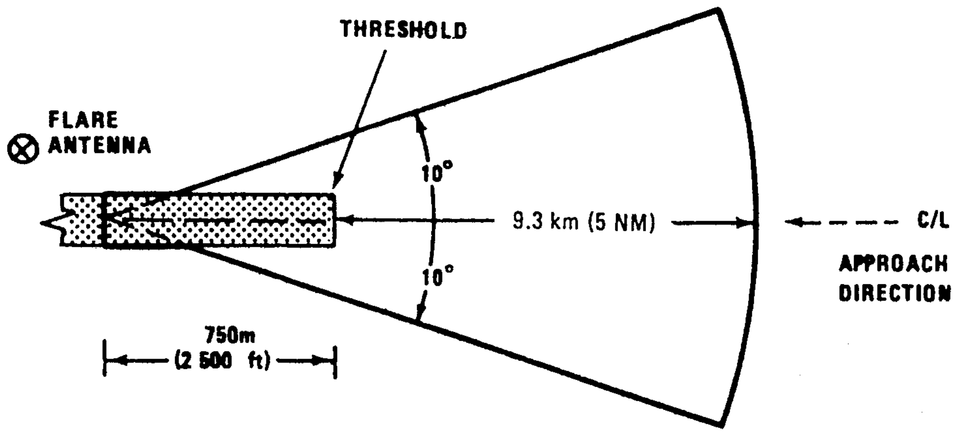
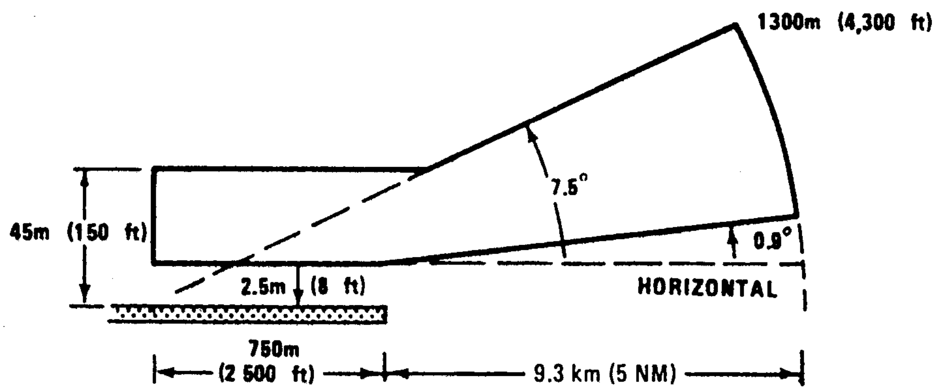


Figure G-8. Approach elevation coverage

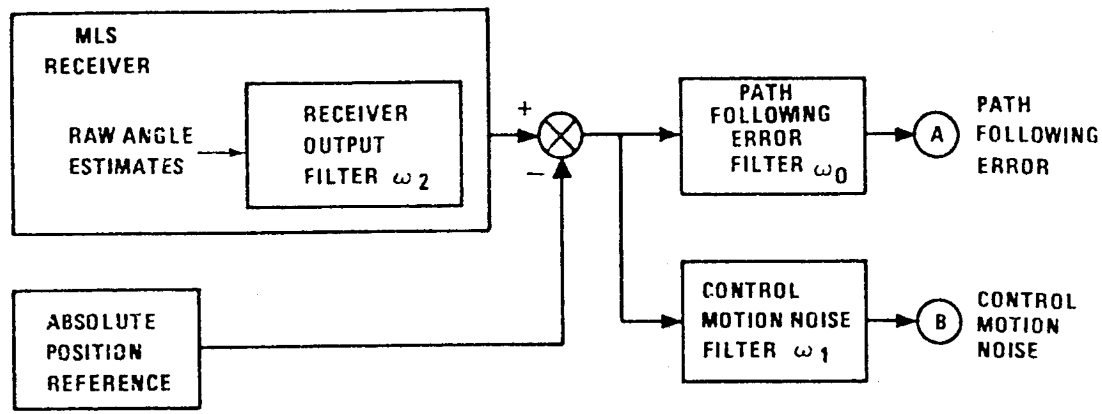


(a) LATERAL COVERAGE



(b) VERTICAL COVERAGE

Figure G-9. Flare coverage



GUIDANCE FUNCTION	CORNER FREQUENCIES (RADIANS/SEC)		
	ω 0	ω 1	ω 2
APPROACH AZIMUTH	0.5	0.3	10
APPROACH ELEVATION	1.5	0.5	10
FLARE	2.0	0.5	10

RECEIVER OUTPUT FILTER $\frac{\omega_2}{S+\omega_2}$

PATH FOLLOWING FILTER $\frac{\omega_n^2}{S^2 + 2\zeta\,\omega_n\,S + \omega_n^2}$ $\zeta = 1;\ \omega_0 = .64\,\omega_n$

CONTROL MOTION NOISE FILTER: $\frac{S}{S+\omega_1}$

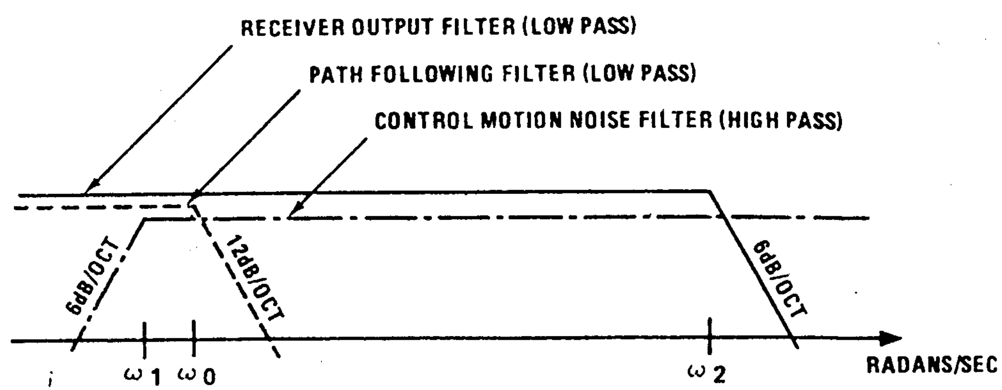
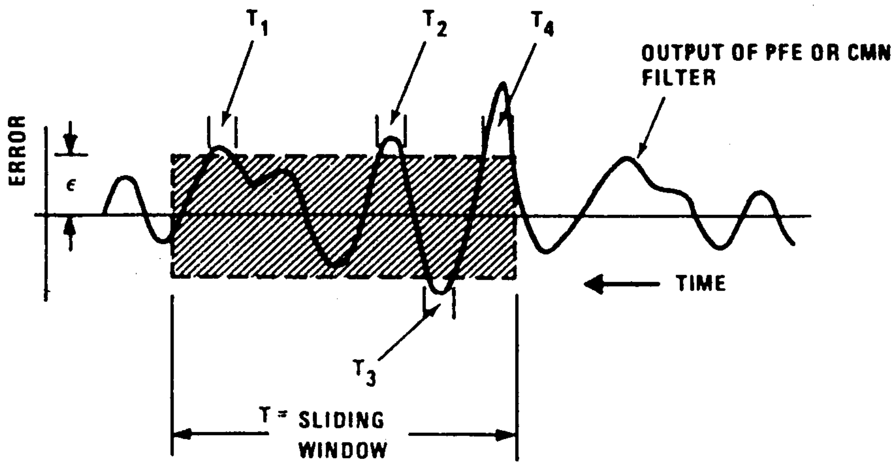


Figure G-10. Filter configurations and corner frequencies



NOTES:

ϵ = ERROR SPECIFICATION

T = REGION TO BE EVALUATED

$T_1\ T_2\ T_3 \ldots$ = TIME INTERVALS THAT ERROR EXCEEDS SPECIFICATIONS. FOR THE GROUND EQUIPMENT TO BE ACCEPTABLE IN THIS REGION, THE FOLLOWING INEQUALITY SHOULD BE TRUE:

$$\frac{(T_1 + T_2 + T_3 + \ldots)}{T} \leq 0.05$$

Figure G-11. MLS measurement methodology

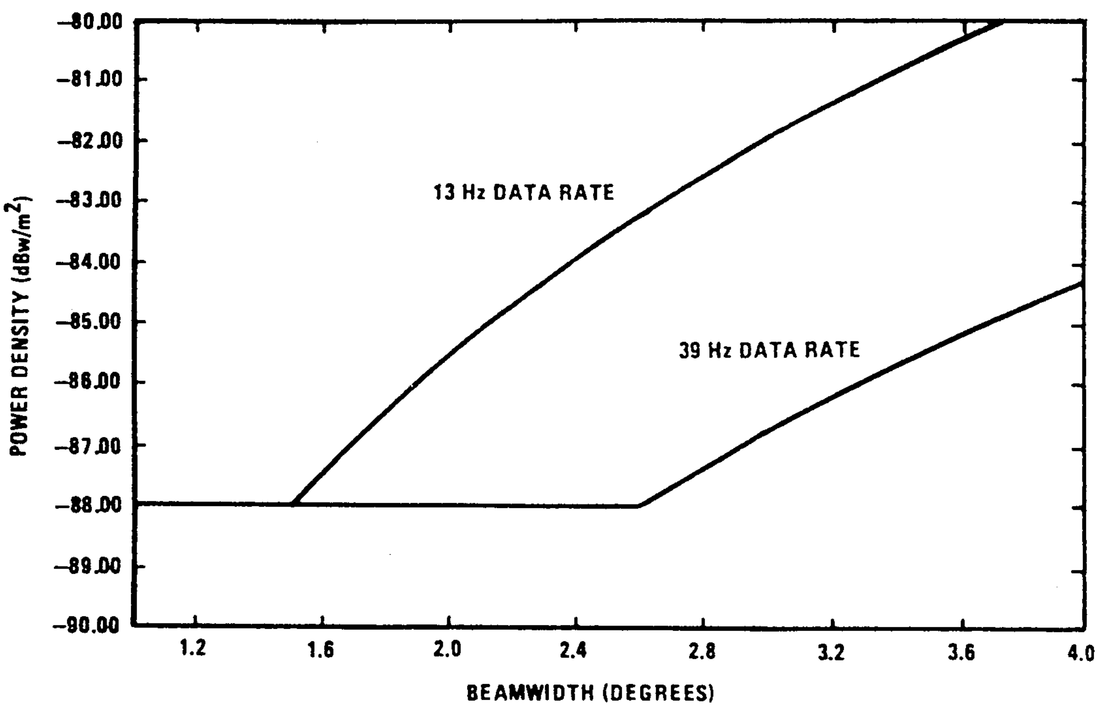
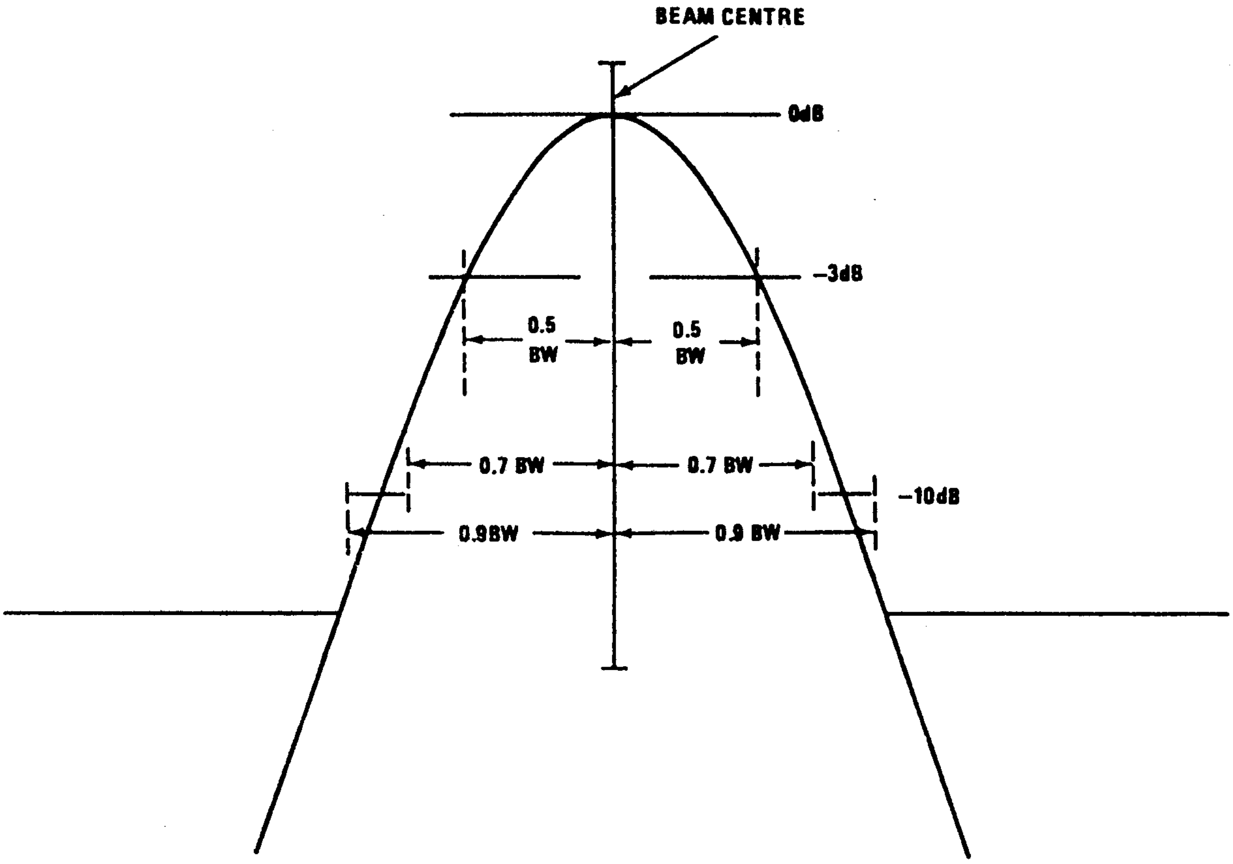


Figure G-12. Power density requirements for various antenna beamwidths

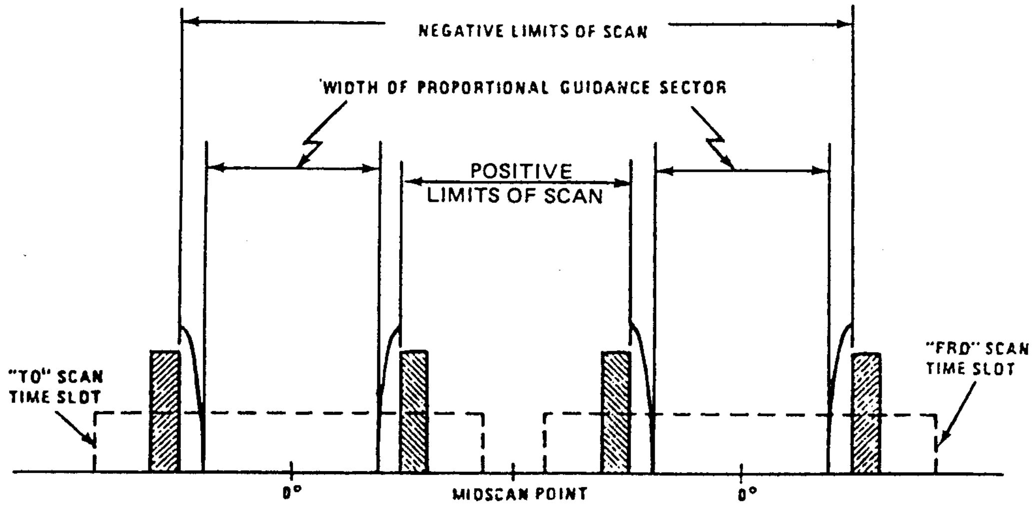


NOTES:

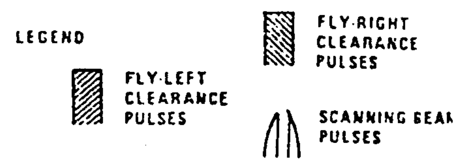
THE BEAM ENVELOPE IS SMOOTHED BY A 26 kHz VIDEO FILTER BEFORE MEASUREMENT.

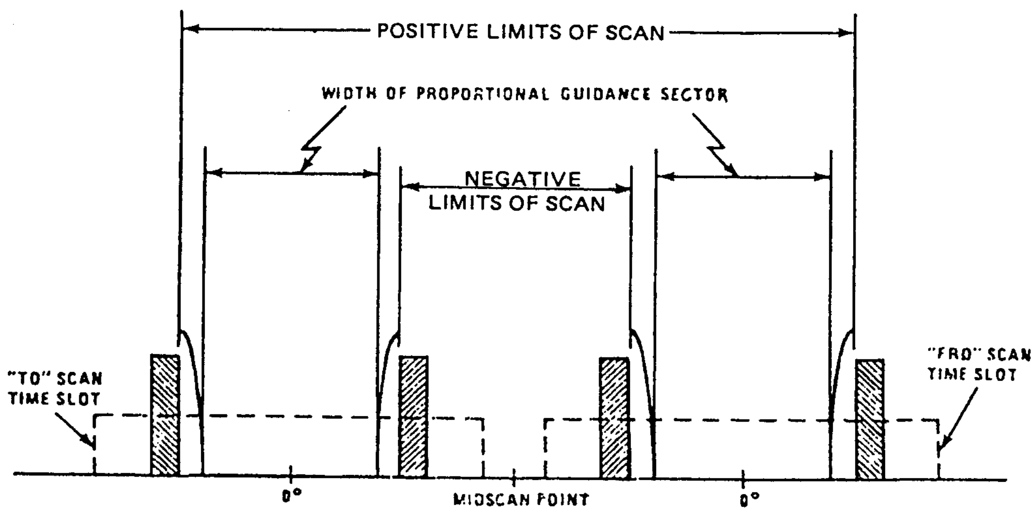
BW = BEAMWIDTH.

Figure G-13. Far field dynamic signal-in-space



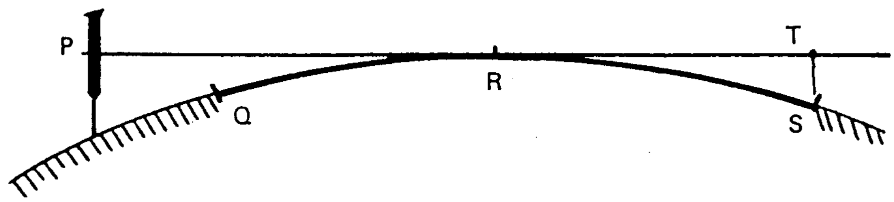
(a) APPROACH AZIMUTH





(b) BACK AZIMUTH

Figure G-14. Clearance pulse conventions for azimuth functions



P: azimuth antenna phase centre

Q: stopend

R: point of contact of tangent PR with runway (this point may be constructed on a vertical scale diagram derived from the longitudinal profile of the runway; typical horizontal scale 1 cm for 100 m; typical vertical scale 1 cm for 1 m).

S: runway threshold

T: point above threshold on extension of PR. (see paragraph 2.3.6).

Figure G-15. Lower coverage limit determination

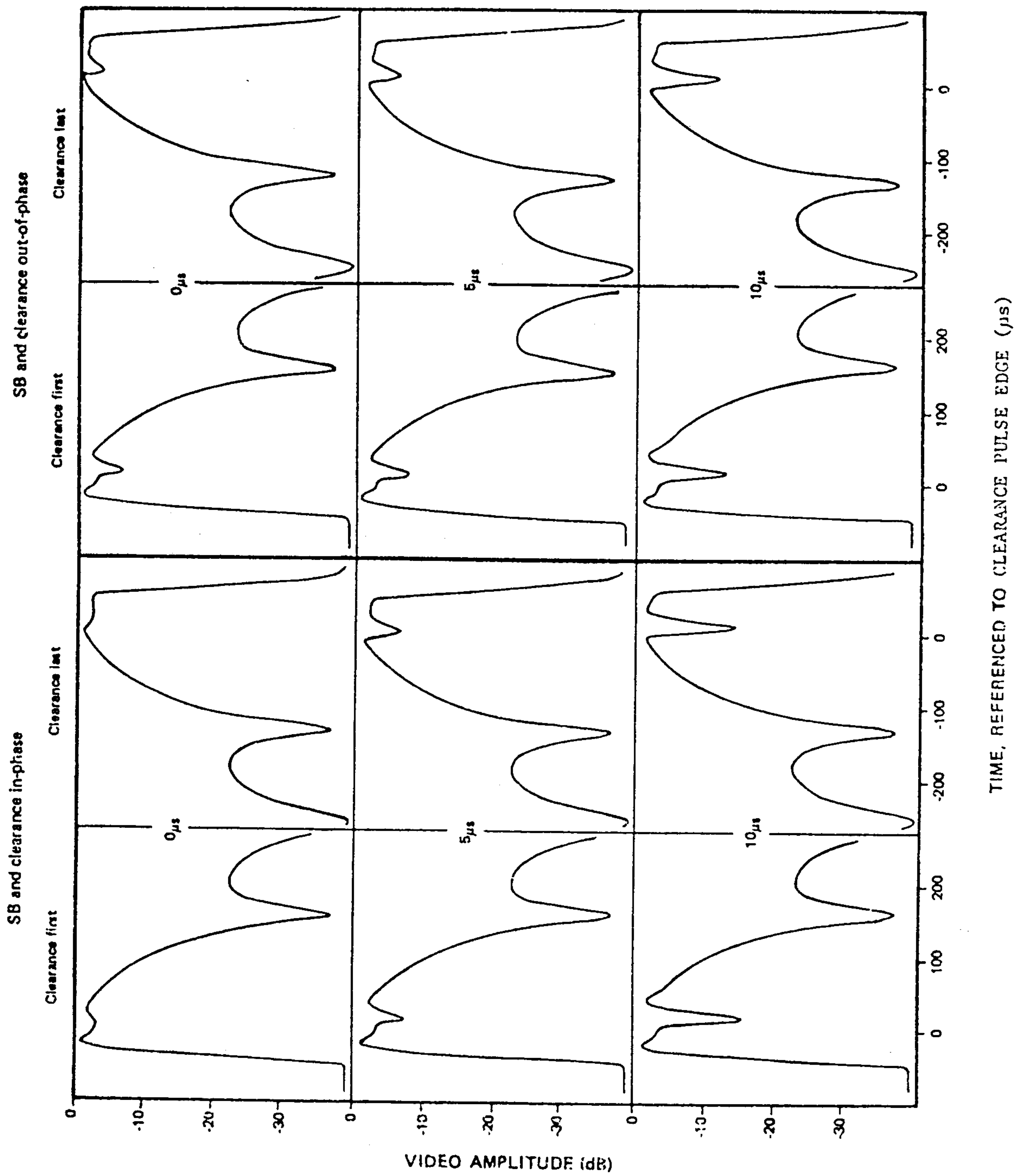


Figure G-16. Examples of received video waveforms in SB/clearance transition region for switching times of 0, 5 and 10 microseconds

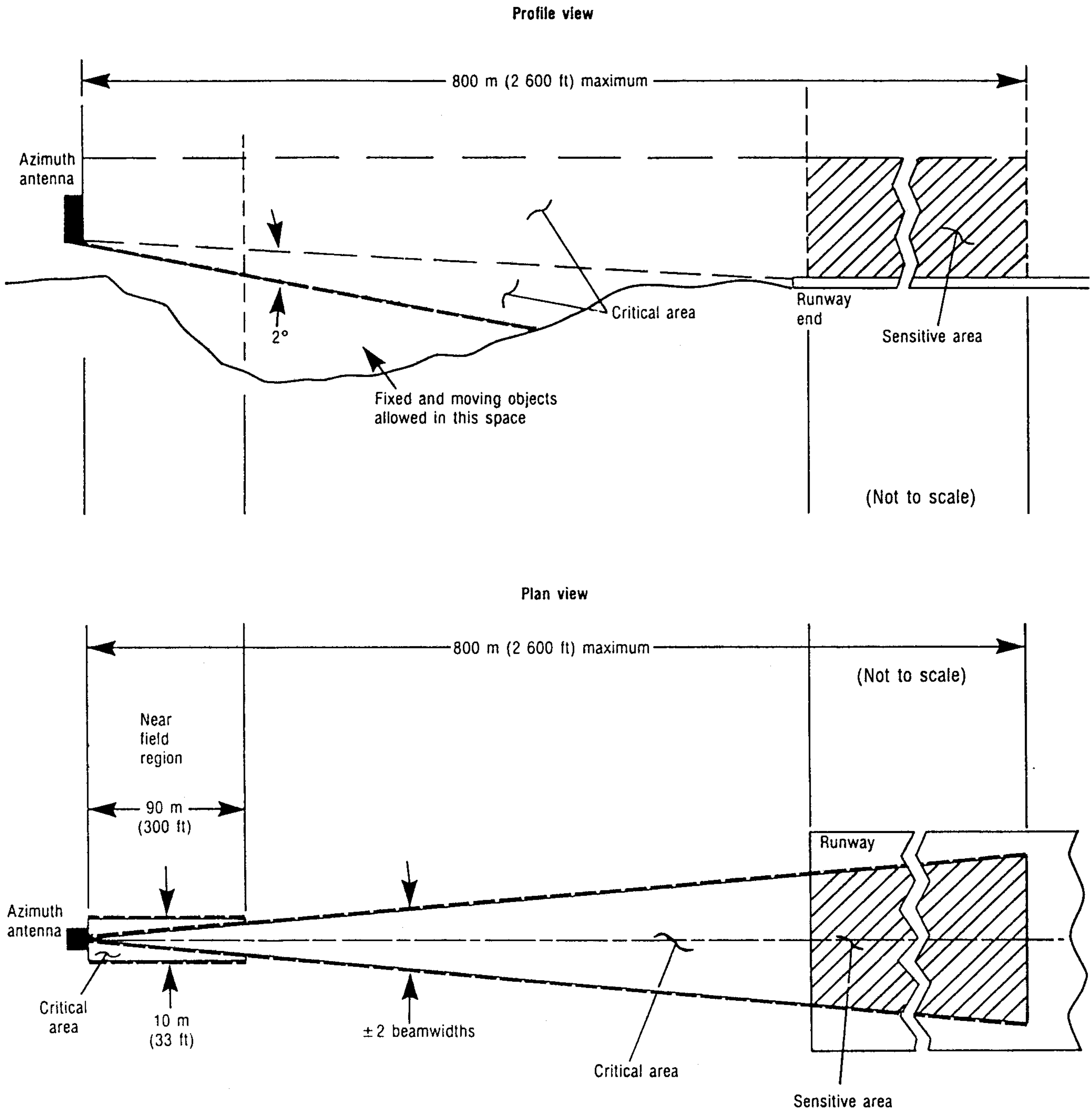
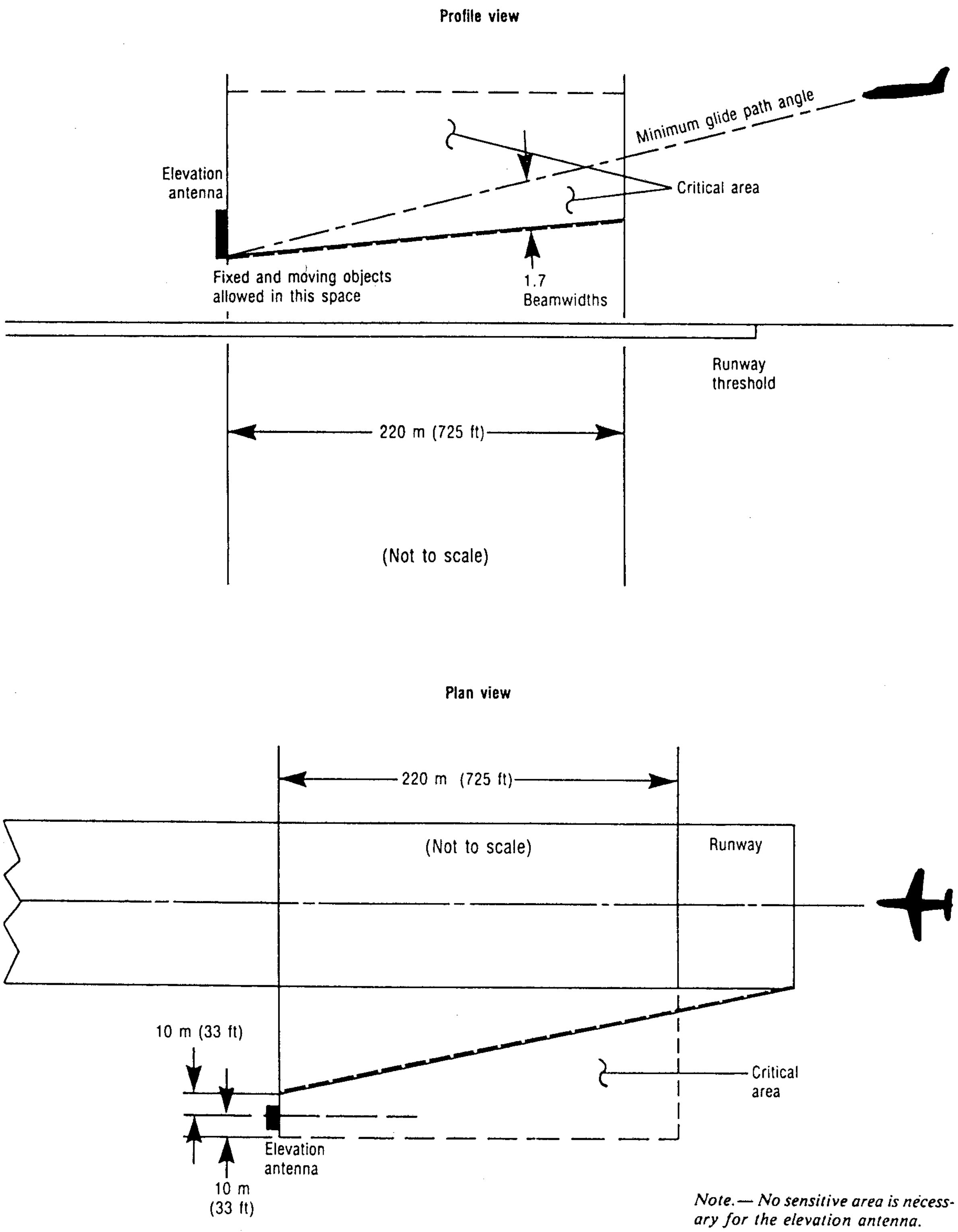


Figure G-17. Typical azimuth critical and sensitive areas



Note.— No sensitive area is necessary for the elevation antenna.

Figure G-18. Typical elevation critical area

ATTACHMENT A TO PART II. — CONSIDERATIONS AFFECTING THE DEPLOYMENT OF VHF COMMUNICATION FREQUENCIES

Introduction

Paragraphs 4.1.5.2 and 4.1.5.3 of Part II specify the geographical separation required for co-channel operation of VHF facilities in the Aeronautical Mobile Service. In Figure A-1 the distance AB indicates the separation required in order that aircraft *a* and *b* operating at the protection heights and at the limits of the functional service range of stations A and B respectively, will not experience harmful interference.

Paragraph 4.1.6.1 of Part II recommends the maximum antenna gain outside the main beam of facilities which provide service beyond the radio horizon. Figure A-2 illustrates the azimuthal angle to be protected and the method of derivation. Smaller beamwidths than 30 degrees are not considered practical at present.

Note.— The term "main beam" includes all azimuths where antenna gain exceeds 3 dB above that of a dipole.

1. Criteria employed in establishing adjacent channel frequency deployment with respect to receiver rejection and other system characteristics

1.1 For aircraft receivers designed for operation in a 50 kHz channel spacing environment and a ground station frequency tolerance of 50 parts in 10^6 (plus or minus 0.005 per cent), an effective adjacent channel rejection characteristic of 60 dB or better is assumed. This assumption will result in a geographical separation distance between the nearest limits of the functional service ranges of the two facilities of at least 5.6 km (3 NM).

1.2 For aircraft receivers designed for operation in a 25 kHz channel spacing environment and a ground station frequency tolerance of plus or minus 0.002 per cent, an effective adjacent channel rejection characteristic of 60 dB or better is assumed. This assumption will result in a geographical separation distance between the nearest limits of the functional service ranges of the two facilities of at least 5.6 km (3 NM).

1.3 The above criteria are based on the concept of protection by receiver muting, except in the case of area control and FIR channels where a minimum field strength is specified in order to secure the desired wanted-to-unwanted signal ratio.

1.4 The following additional assumptions were made in establishing the criteria:

1) *Propagation:* free space propagation between aircraft. The CCIR curves for 100 MHz vertical polarization over land in conjunction with an assumed ground antenna height of 20 m (65 ft) were used in computing ground-air field strengths.

2) *Minimum field strength at limit of functional service range:* 45 dB above 1 microvolt per metre at 3 000 m (10 000 ft) in the case of area control and FIR channels.

   Note.— To meet this requirement, a station radiating 100 W from an antenna 20 m (65 ft) high should be not more than 185 km (100 NM) from the limit of its functional service range.

3) *Effective radiated power (ERP)*: a maximum ERP of 20 W from ground and airborne stations with the exception that, in case of ground stations providing flight information or area control service communications, it was necessary to assume a minimum ERP of 100 W.

4) *Airborne antenna polar patterns:* total variations not exceeding 10 dB. Since a maximum ERP was assumed

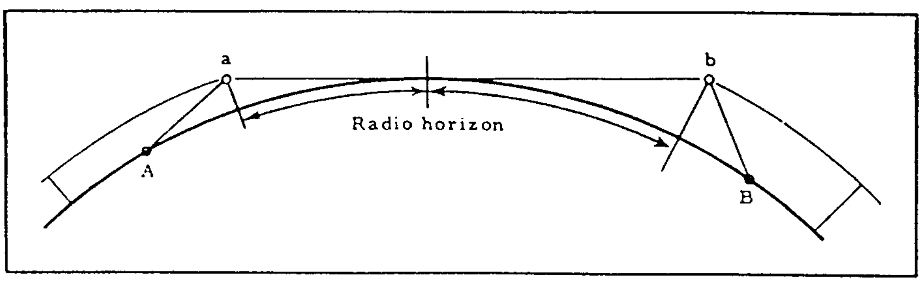


Figure A-1. Geographical separation required for co-channel operation of VHF facilities

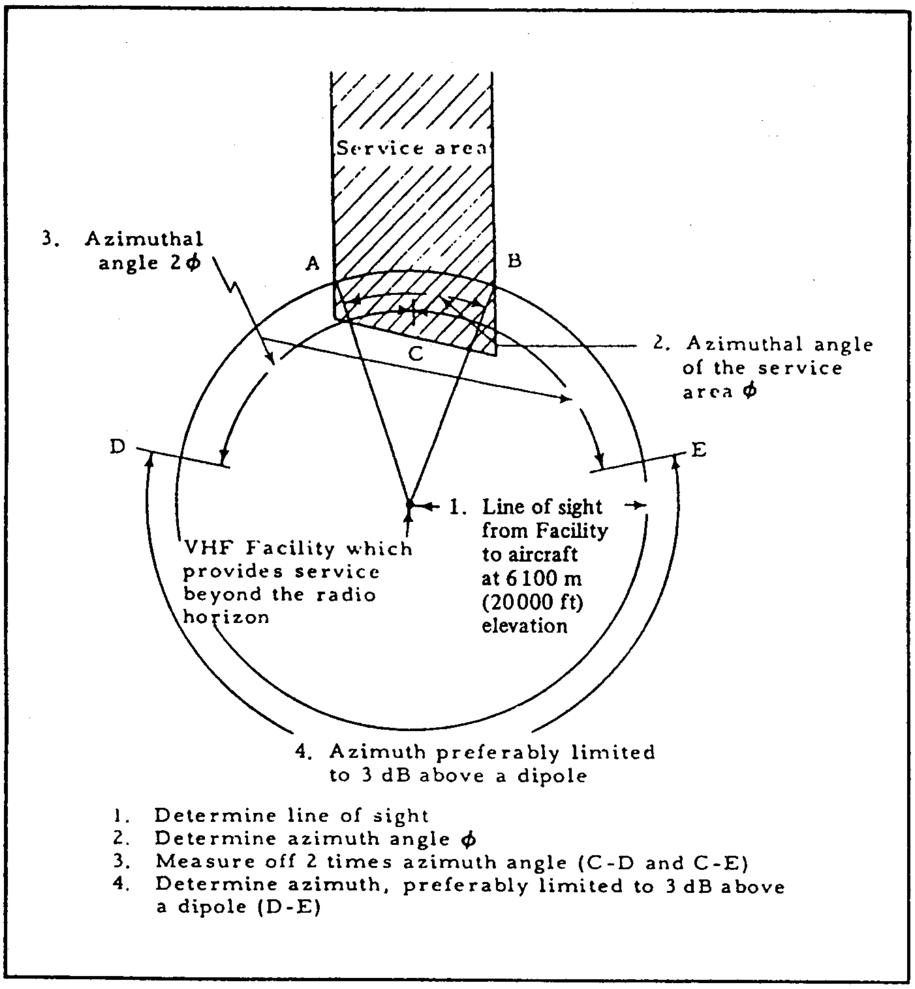


Figure A-2. Limit of azimuth protection for VHF facilities which provide a service beyond the radio horizon

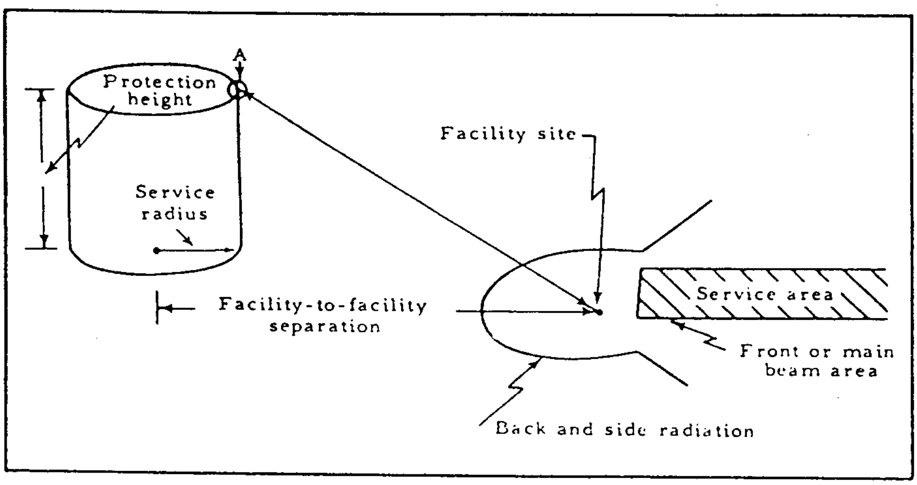


Figure A-3. Air-to-ground (facility from A) and ground-to-air (A from facility) (and therefore all variations are downwards from this figure), no allowance was necessary in respect of airborne transmitter polar diagrams.

5) *Wanted-to-unwanted signal ratio:* 20 dB at the receiver output.

6) *Receiver muting characteristics:* a muting threshold corresponding to a received field strength of 5 microvolts per metre.

2. Criteria to be employed in establishing adjacent channel frequency deployment of VHF facilities that have a service range beyond the radio horizon

For the most economical use of frequencies and to ensure freedom from interference, planning must be based on an accurate knowledge of equipment used. When the equipment characteristics and field strength (or attenuation) curves are on hand for the troposcatter regions, it is relatively easy to determine the required geographical separation. When these are not known, the maximum permitted antenna gain stipulated in Part II, 4.1.6.1 will be assumed. There are several conditions that must be calculated and compared to determine the appropriate separation to be used. The conditions to be compared are:

1) ground facility-to-aircraft;

2) aircraft-to-ground facility;

3) aircraft-to-aircraft;

4) ground facility-to-ground facility.

Case 1.— For the case of protection of aircraft A from a ground facility (see Figure A-3):

A. Determine the signal level S (dB rel. 1 μV/m) received from the desired station at the limit of the service radius at the protection altitude.

B. Assign the desired protection ratio P (dB) required at the aircraft receiver.

C. Let receiver adjacent channel rejection be represented by A (dB). Then the level L (dB rel. 1 μV/m) that can be tolerated at the receiver antenna can be determined by:

$$L = S - P + A$$

D. Distance d (km) from protection point to undesired facility to provide protection established by "C" above, is found by application of L to the appropriate curves.*

E. The facility-to-facility separation D is d (km) plus service radius (km).

**Note 1.— Figures A-7 to A-14 are field strength curves appropriate for the average temperate climate over land or sea, which may be used to determine geographical separation for situations where these field strengths will not normally be exceeded more than 5 per cent of the time. These curves were established by the Institute for Telecommunications Sciences and Aeronomy of the Environmental Science Services Administration of the United States of America.*

Note 2.— For power levels other than 1 kW the necessary corrections under "C" above would have to be made. For example, 5 kW ERP requires a minus 7 dB correction.

Case 2.— Aircraft (A)-to-ground facility (see Figure A-3):

A. Determine signal level Sg at the ground facility receiving antenna for proper system operation.

B. Proceed as in Case 1, where

$$L = Sg - P + A$$

C. Ground facility-to-ground facility separation will also be determined as in Case 1 (D = d + service radius).

Note.— Where ground facility receivers have sensitivities of less than 1 microvolt across 50 ohms, Case 2 is most likely to yield the separation to be used.

Case 3.— Aircraft (A)-to-aircraft (B) (see Figure A-4):

A. Establish service radius and protection altitude for facility to be protected (see aircraft A in Figure A-4).

B. Determine closest point to aircraft A that aircraft B will be transmitting to the ground facility site and the altitude where this will take place.

C. Proceed as in Case 1, using the aircraft (B) contacting ground facilities as the undesired signal.

D. Then $L = S - P + A$

E. The distance d to aircraft B (undesired) obtained from the curves, plus the service radius of the facility to be protected, will determine the separation between aircraft B and the ground facility protected.

F. Facility-to-facility separation may then be determined graphically or by trigonometric means.

Case 4.— Ground facility-to-ground facility (see Figure A-4).

A. Determine signal level that can be tolerated at the receiver antenna at one facility by L = Sg − P + A (see Case 1).

B. Then facility-to-facility separation for these conditions is read directly from the curves (after correcting for transmitter power of other facilities if different from 1 kW).

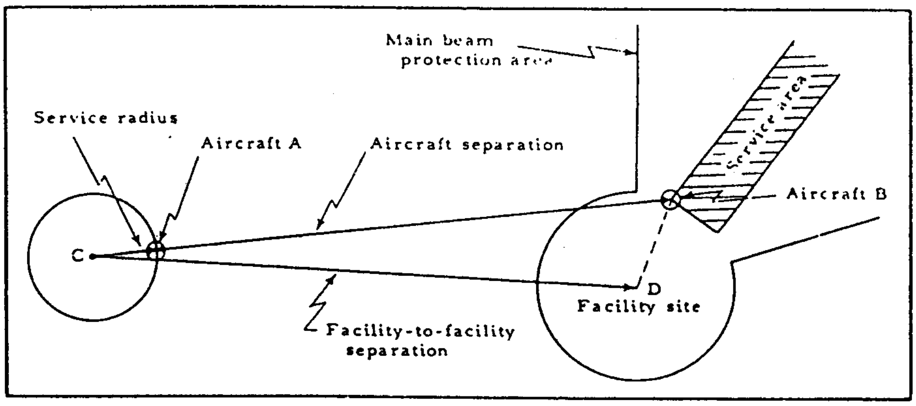


Figure A-4. Facility-to-facility separation based on air-to-air (A from B) and ground-to-ground (C from D)

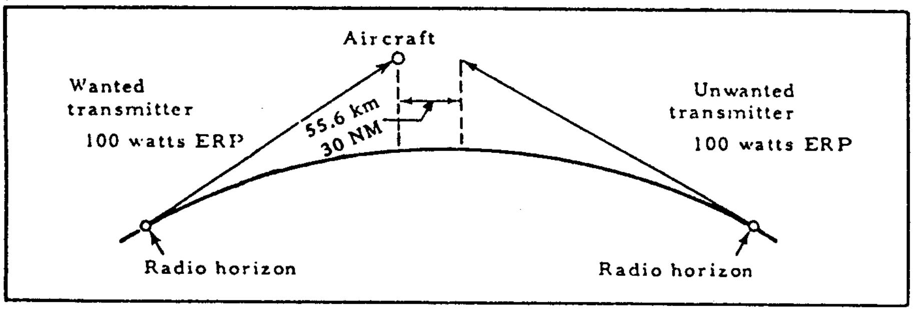


Figure A-5. VOLMET planning (illustrating co-channel protection)

C. Should equipments at the two facilities have different characteristics, repeat procedure in "A" and "B" above for the other combination of equipments.

D. Of the two distances derived, use the greater to compare with other cases (see below).

Note.— In most instances, it will be found that the facility-to-facility consideration will not be the controlling factor in determining geographical separation.

Facility separation will then be the greatest distance derived for Cases 1 to 4.

3. Criteria to be employed in establishing geographical separation between ground stations and between aircraft and ground stations for co-channel operation of VHF facilities that have a service area beyond the radio horizon

Geographical separation of co-channel facilities can be calculated by using the method given in 2 above except that the adjacent channel rejection (A) is omitted from consideration.

4. Criteria employed in establishing co-channel frequency deployment of VHF VOLMET facilities

In the case of VHF VOLMET services, the geographical separation between co-channel stations should be 55.6 km (30 NM) plus twice the distance to the radio horizon from an aircraft at the highest altitude flown by aircraft in the area concerned.

Note.— At 27.9 km (15 NM) beyond the radio horizon, the field strength at 13 500 m (45 000 ft), from a transmitter of 100 W ERP, will be approximately at the receiver muting level of 5 microvolts per metre.

5. Criteria employed in establishing adjacent channel frequency deployment of VHF VOLMET facilities

5.1 For aircraft receivers designed for operation in a 25 kHz channel spacing environment, an effective adjacent channel rejection characteristic of 60 dB or better is assumed. This assumption will result in a geographical separation distance (D) between VHF VOLMET ground transmitters derived as follows (nautical miles may be substituted for kilometres):

$$D = (d_1 + d_2) \text{ km}$$

where

d_1 = distance between aircraft and wanted ground station

= radio horizon + 27.8 km (15 NM)

and

d_2 = distance between aircraft and unwanted ground station

= 24.1 km (13 NM).

5.2 Where it is necessary to take account, on a regional basis, of receivers not specifically designed for 25 kHz channel spacing and used in a 25 kHz channel spacing environment, an effective adjacent channel rejection characteristic of the receiver of the order of 40 dB is assumed. This assumption will result in a minimum geographical separation distance (D) between VHF VOLMET ground transmitters derived as follows:

$$D = (d_1 + d_2) \text{ km}$$

where

d_1 = distance between aircraft and wanted ground station

= radio horizon + 27.8 km (15 NM)

d_2 = distance between aircraft and unwanted ground station

= 240.9 km (130 NM).

5.3 Application of the above criteria in the case of aircraft altitudes of 13 500 m (45 000 ft) and 20 000 m (66 000 ft) results in the following separation distances:

Altitude	*Receiver rejection characteristic*	*d_1 km (NM)*	*d_2 km (NM)*	*D km (NM)*
13 500 m (45 000 ft)	60 dB	491 (265)	24.1 (13)	515 (278)
13 500 m (45 000 ft)	40 dB	491 (265)	241 (130)	732 (395)
20 000 m (66 000 ft)	60 dB	619 (334)	24.1 (13)	643 (347)
20 000 m (66 000 ft)	40 dB	619 (334)	241 (130)	860 (464)

5.4 The above criteria are based on the following additional assumptions:

1) *Effective radiated power:* an ERP of 100 W for the ground stations.

Note.— If an ERP of 20 W is assumed, this would result in separation distances for 13 500 m (45 000 ft) of 472 km (255 NM) for 60 dB receiver adjacent channel rejection and 572 km (309 NM) for 40 dB receiver adjacent channel rejection.

2) *Interfering signal strength:* if the received signal strength is in excess of the free space propagation value, then the maximum value will not exceed the free space value by more than 5 dB over average earth. This condition is satisfied when transmitters of 20 W ERP or more are used in conjunction with a receiver adjacent channel rejection of not less than 35 dB. Thus, the minimum distance for d_2 can be derived from a consideration of receiver muting level, receiver adjacent channel rejection and transmitter ERP.

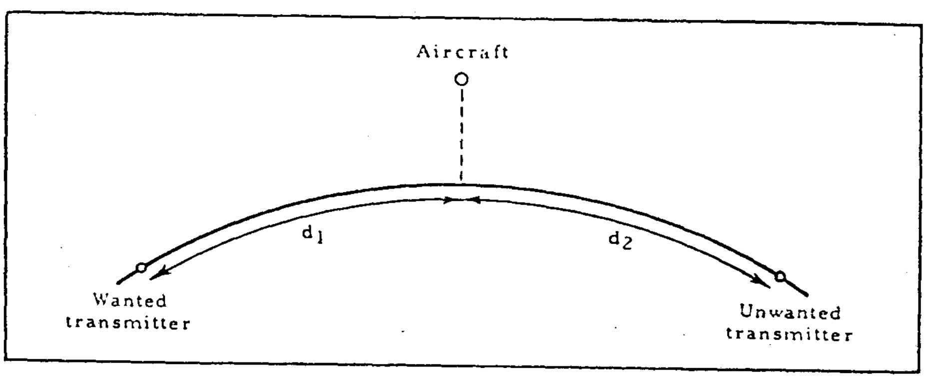


Figure A-6. VOLMET planning (illustrating adjacent channel protection)

Figures A-7 to A-14. Propagation curves for standard atmosphere (301) for frequency of 127 MHz

ESSA/I.T.S.A. — 1966 Propagation Model

These curves labelled "5 per cent time availability" represent only a statistically expected value; *i.e.*, a probability of 0.05 that a particular situation will result in the specified field strength or greater during 5 per cent of the time.

The parameters used to develop these curves include:

1) frequency of 127 MHz;

2) horizontal or vertical polarization;

3) smooth earth with land or sea surface;

4) reflection coefficient of unity magnitude;

5) standard atmosphere with a 301 surface refractivity;

6) continental temperate climate;

7) Nakagami-Rice statistics for within-the-horizon fading;

8) An effective radiated power (ERP) corresponding to 1 kilowatt input power into a lossless half-wave dipole.

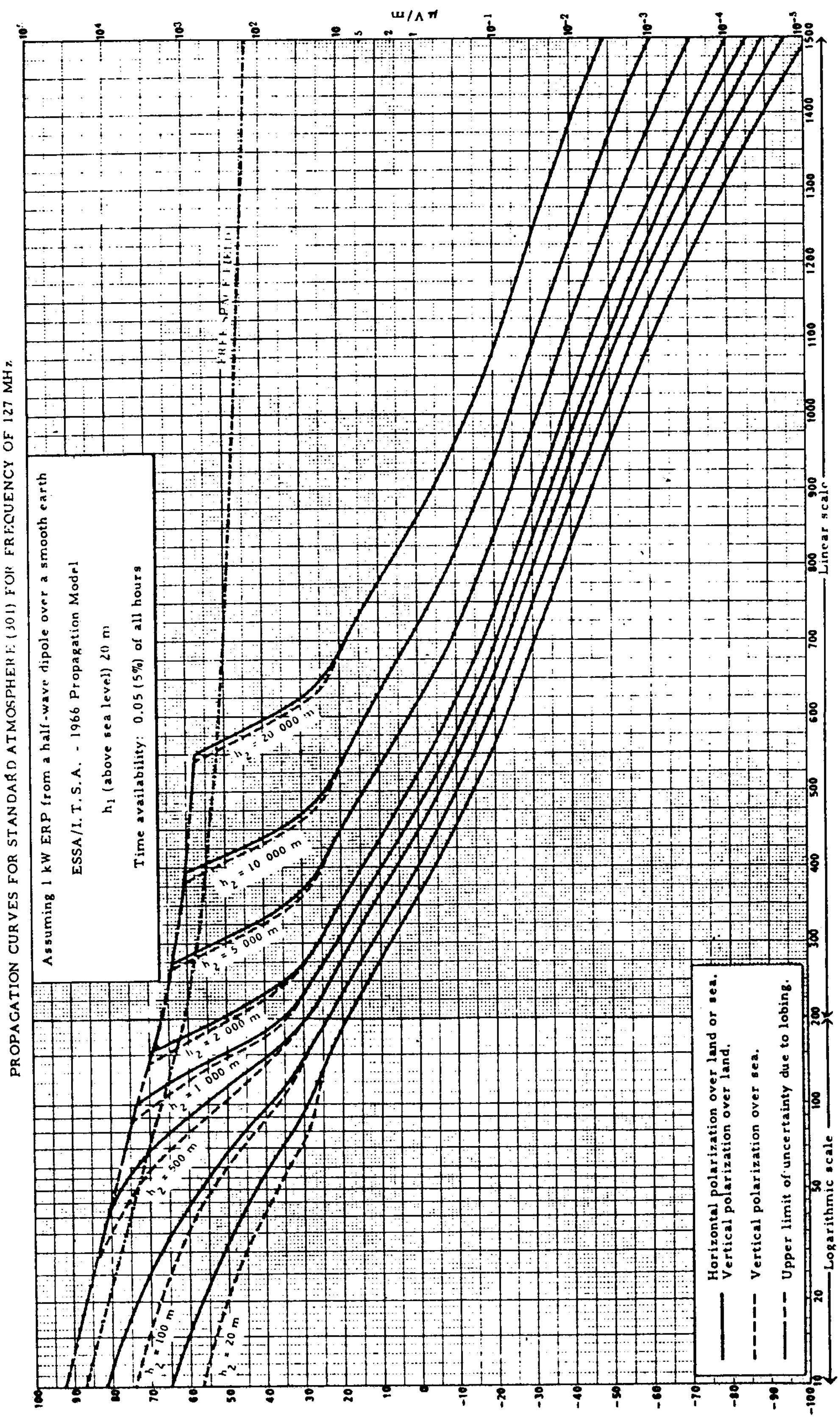


Figure A-7

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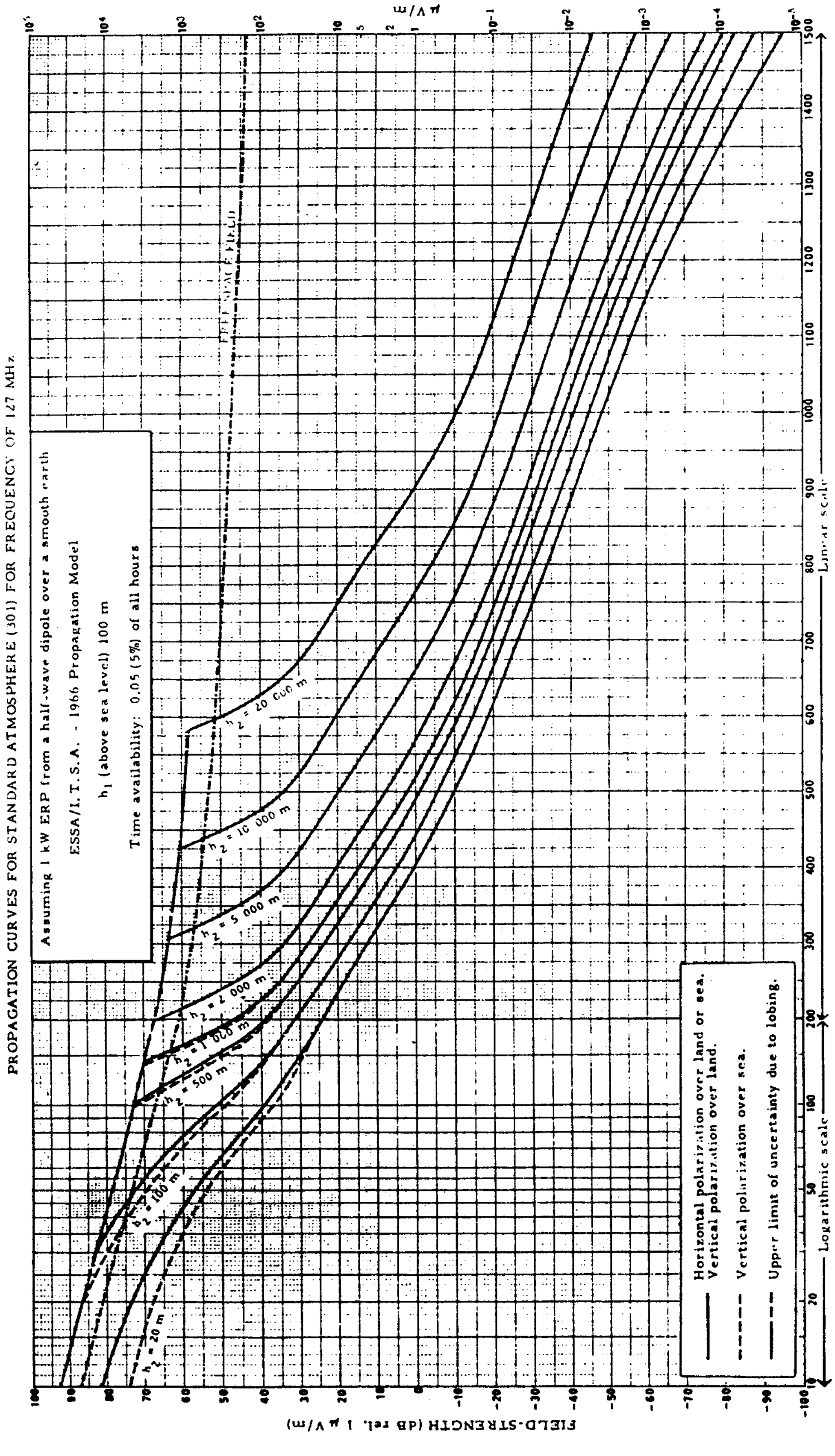

PROPAGATION CURVES FOR STANDARD ATMOSPHERE (301) FOR FREQUENCY OF 127 MHz
Assuming 1 kW ERP from a half-wave dipole over a smooth earth
ESSA/I.T.S.A. - 1966 Propagation Model
h_1 (above sea level) 100 m
Time availability: 0,05 (5%) of all hours
FREE SPACE FIELD
h_2 = 20 000 m
h_2 = 10 000 m
h_2 = 5 000 m
h_2 = 2 000 m
h_2 = 1 000 m
h_2 = 500 m
h_2 = 100 m
h_2 = 20 m
Horizontal polarization over land or sea.
Vertical polarization over land.
Vertical polarization over sea.
Upper limit of uncertainty due to lobing.
DISTANCE IN KILOMETRES
Logarithmic scale
Linear scale
FIELD-STRENGTH (dB rel. 1 μV/m)
μV/m

Figure A-8

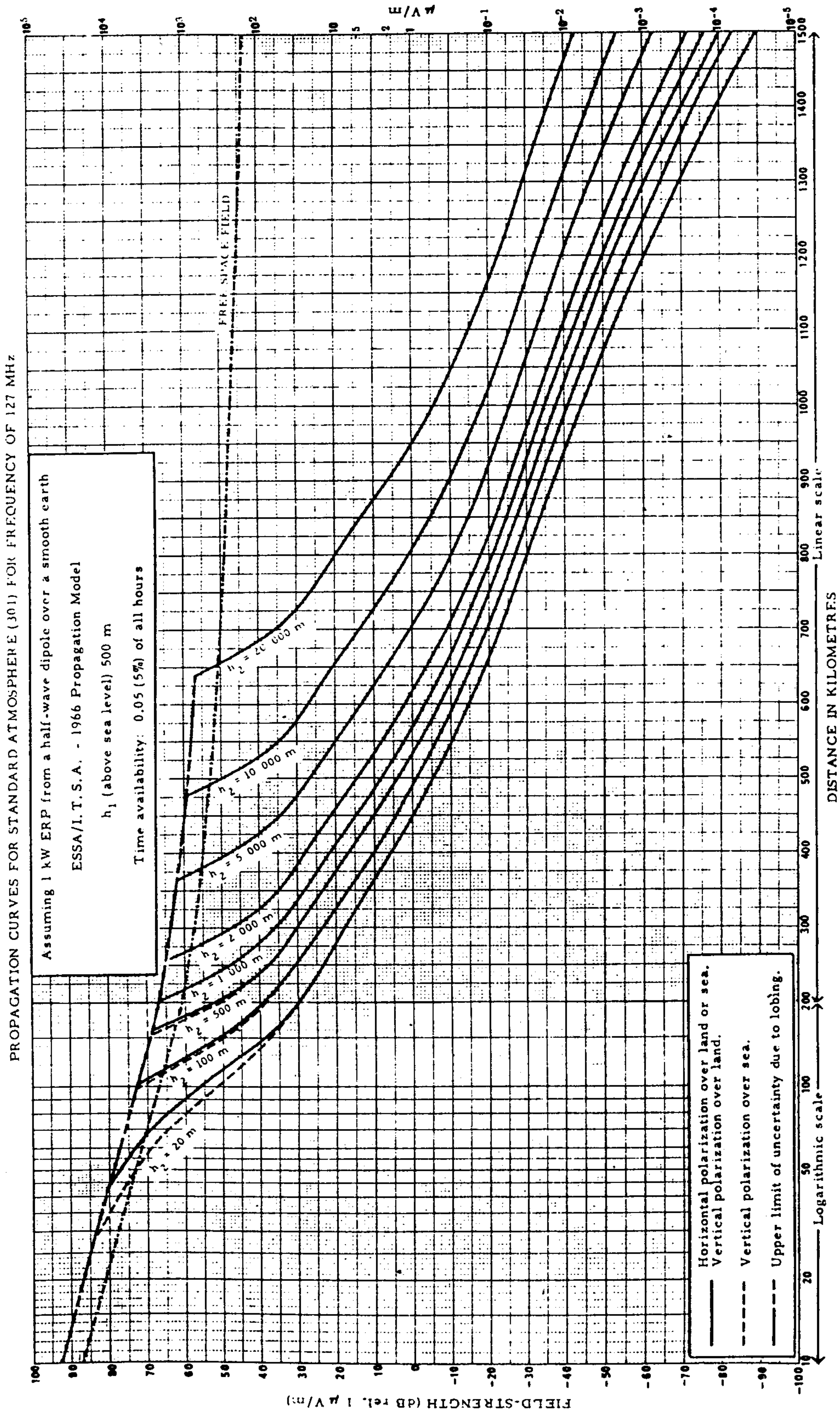


Figure A-9

21/11/85

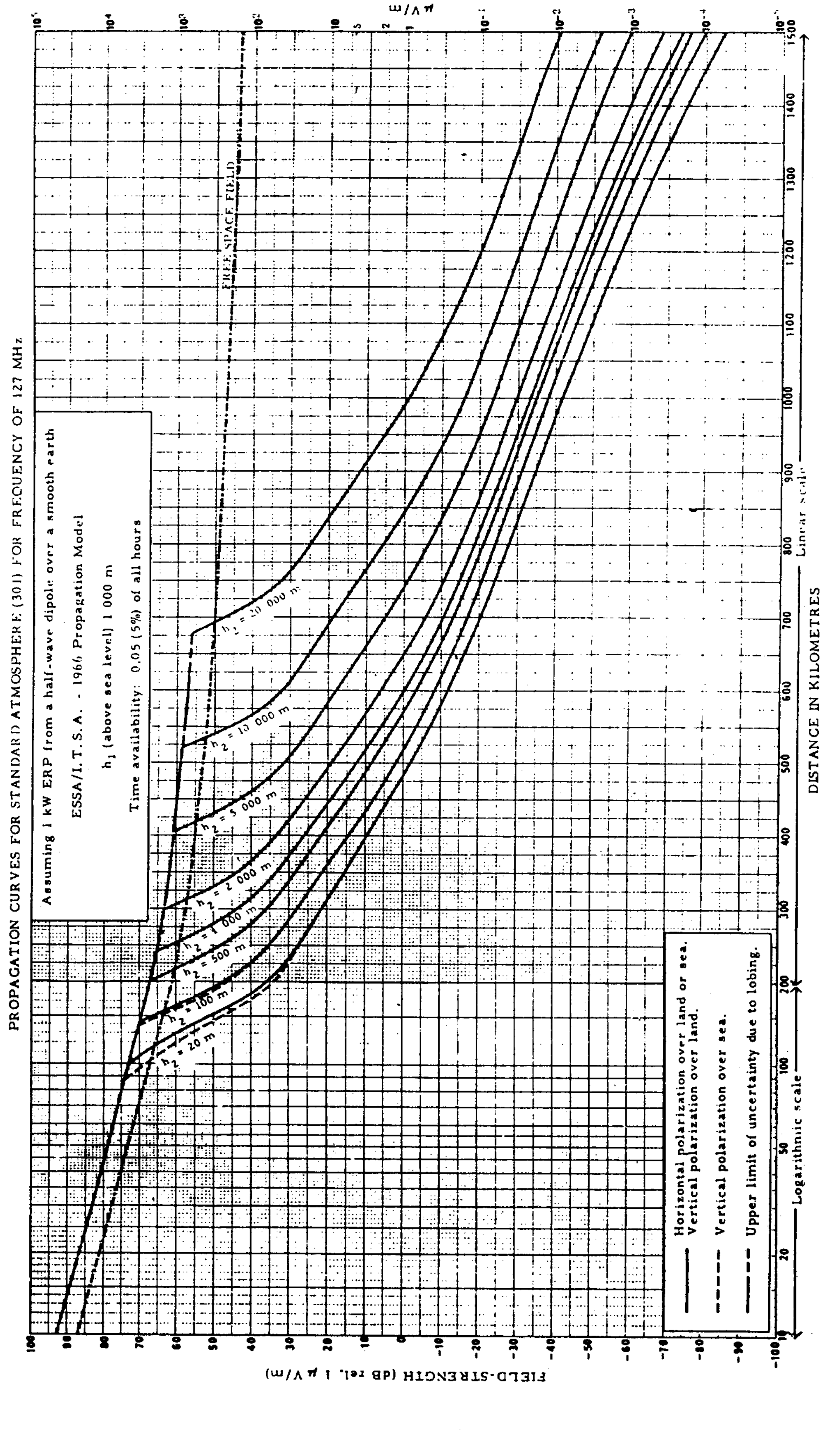

PROPAGATION CURVES FOR STANDARD ATMOSPHERE (301) FOR FREQUENCY OF 127 MHz
Assuming 1 kW ERP from a half-wave dipole over a smooth earth
ESSA/I. T. S. A. - 1966 Propagation Model
h_1 (above sea level) 1 000 m
Time availability: 0.05 (5%) of all hours
FREE SPACE FIELD
h_2 = 20 000 m
h_2 = 10 000 m
h_2 = 5 000 m
h_2 = 2 000 m
h_2 = 1 000 m
h_2 = 500 m
h_2 = 100 m
h_2 = 20 m
Horizontal polarization over land or sea.
Vertical polarization over land.
Vertical polarization over sea.
Upper limit of uncertainty due to lobing.
DISTANCE IN KILOMETRES
Logarithmic scale
Linear scale
FIELD-STRENGTH (dB rel. 1 μV/m)
μV/m

Figure A-10

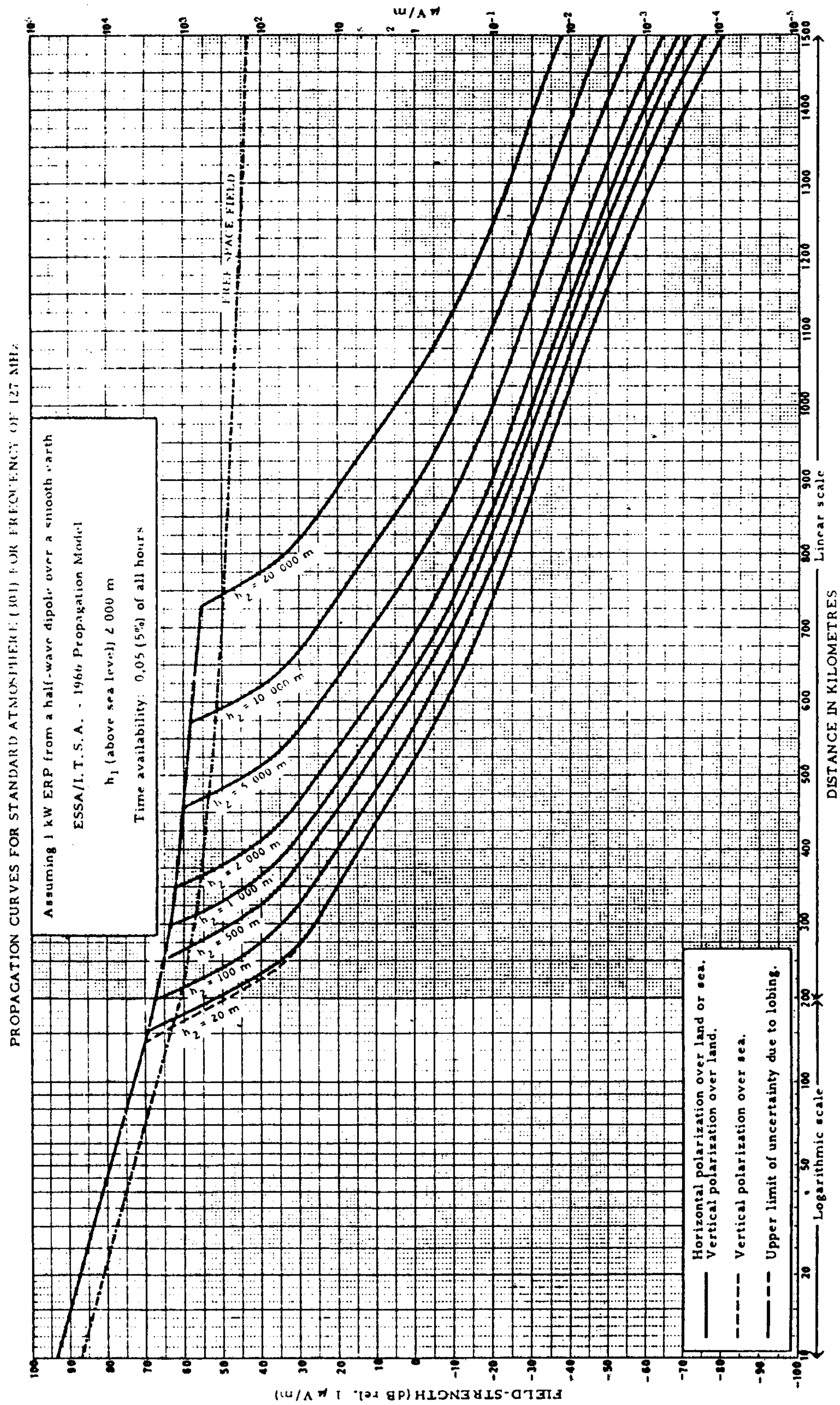


Figure A-11

21/11/85

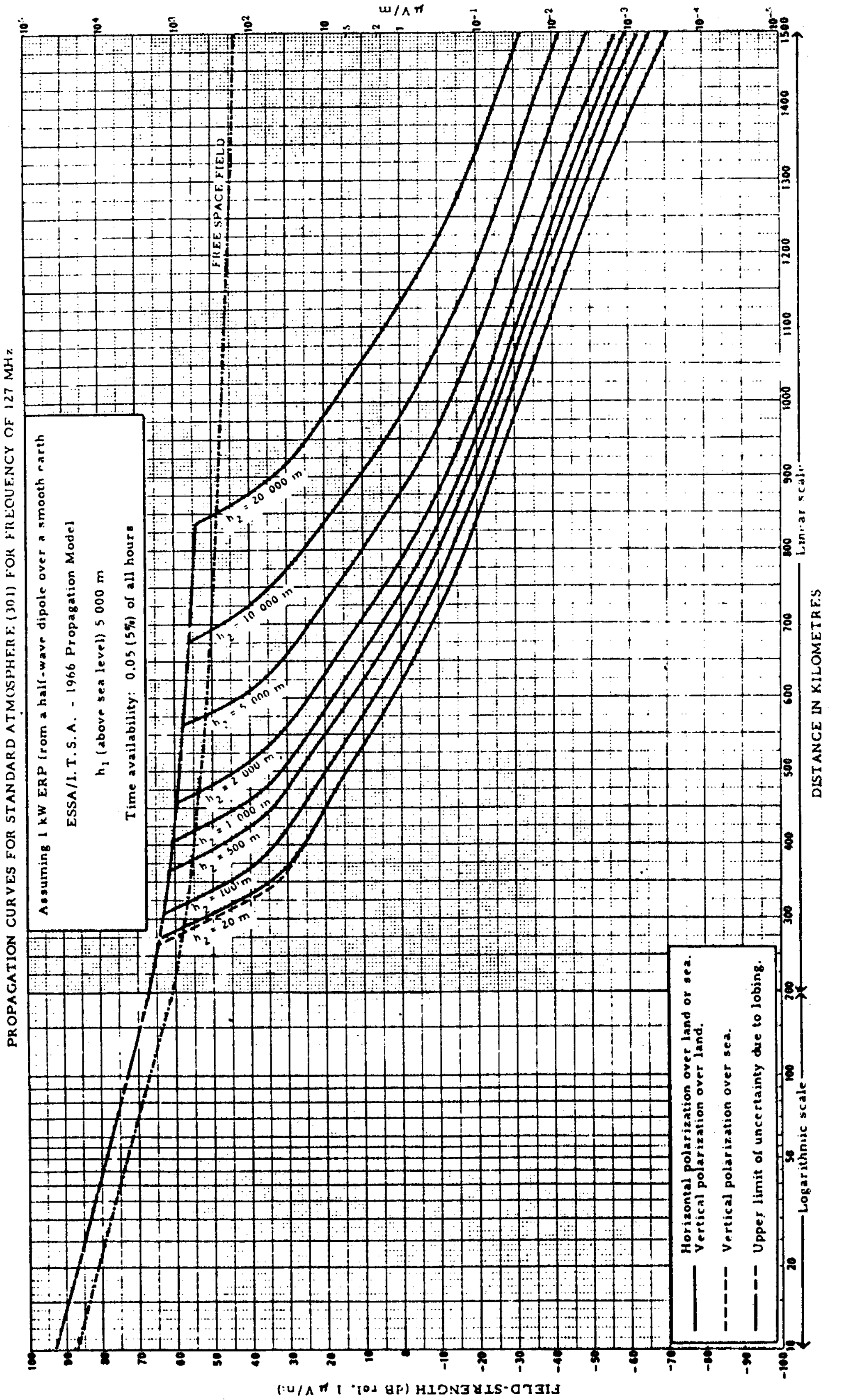

PROPAGATION CURVES FOR STANDARD ATMOSPHERE (301) FOR FREQUENCY OF 127 MHz
Assuming 1 kW ERP (from a half-wave dipole over a smooth earth
ESSA/I.T.S.A. - 1966 Propagation Model
h1 (above sea level) 5 000 m
Time availability: 0.05 (5%) of all hours
FREE SPACE FIELD
h2 = 20 000 m
h2 = 10 000 m
h2 = 5 000 m
h2 = 2 000 m
h2 = 1 000 m
h2 = 500 m
h2 = 100 m
h2 = 20 m
Horizontal polarization over land or sea.
Vertical polarization over land.
Vertical polarization over sea.
Upper limit of uncertainty due to lobing.
DISTANCE IN KILOMETRES
Logarithmic scale
Linear scale
FIELD-STRENGTH (dB rel. 1 μV/m)
μV/m

Figure A-12

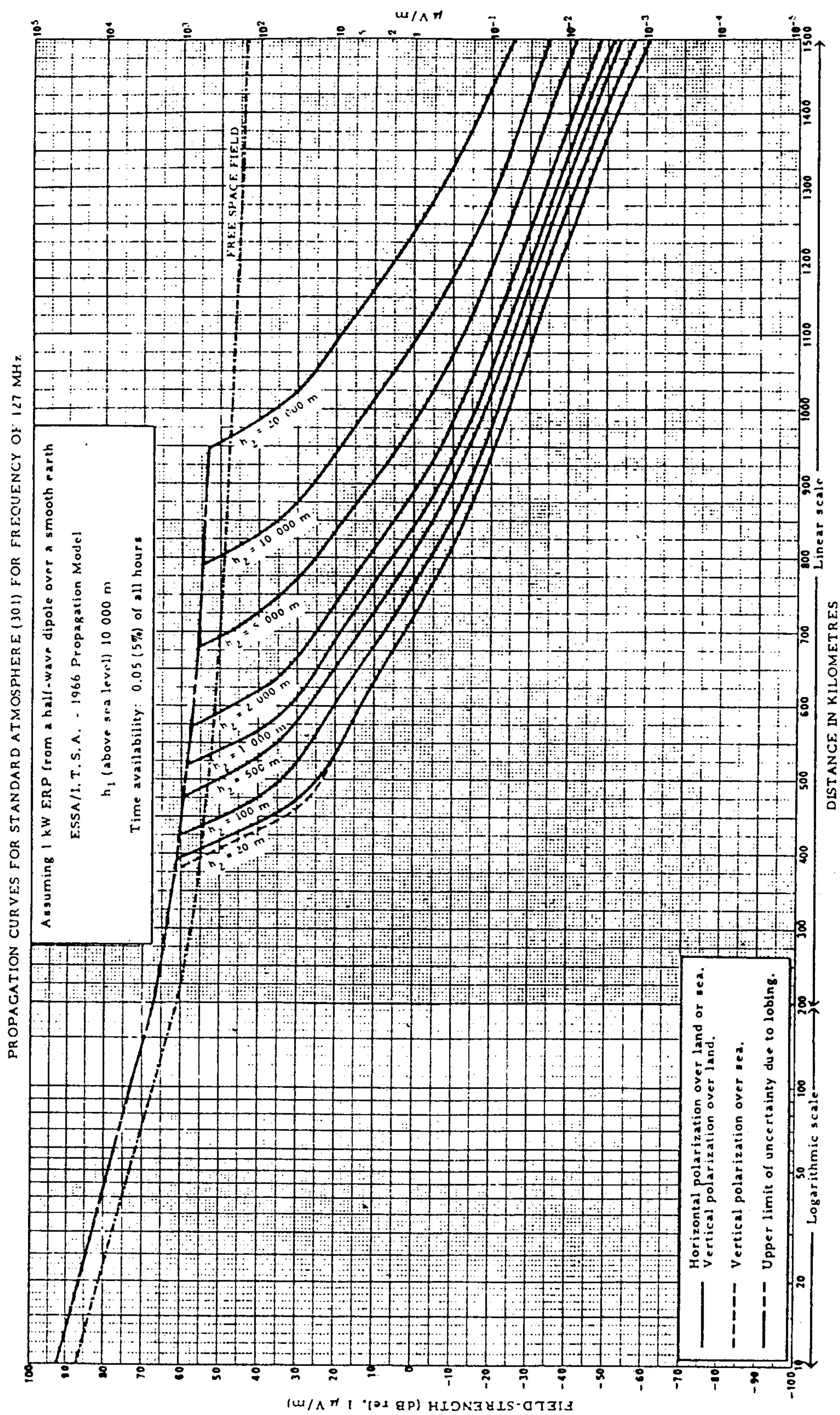

PROPAGATION CURVES FOR STANDARD ATMOSPHERE (301) FOR FREQUENCY OF 127 MHz
Assuming 1 kW ERP from a half-wave dipole over a smooth earth
ESSA/I. T. S. A. - 1966 Propagation Model
h1 (above sea level) 10 000 m
Time availability: 0.05 (5%) of all hours
FREE SPACE FIELD
h2 = 20 000 m
h2 = 10 000 m
h2 = 5 000 m
h2 = 2 000 m
h2 = 1 000 m
h2 = 500 m
h2 = 100 m
h2 = 20 m
Horizontal polarization over land or sea.
Vertical polarization over land.
Vertical polarization over sea.
Upper limit of uncertainty due to lobing.
DISTANCE IN KILOMETRES
Logarithmic scale
Linear scale
FIELD-STRENGTH (dB rel. 1 µV/m)
µV/m

Figure A-13

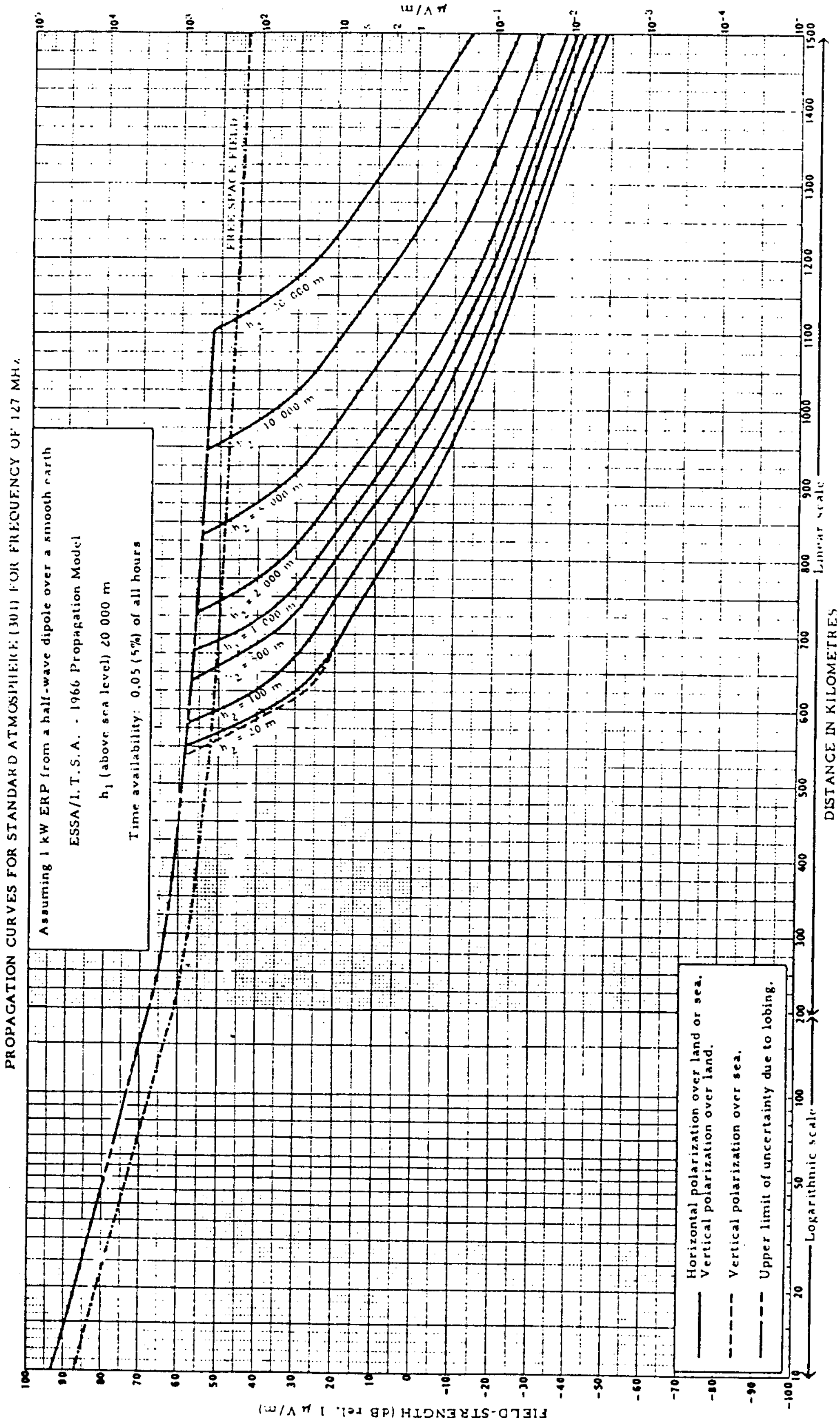

PROPAGATION CURVES FOR STANDARD ATMOSPHERE (301) FOR FREQUENCY OF 127 MHz
Assuming 1 kW ERP from a half-wave dipole over a smooth earth
ESSA/I. T. S. A. - 1966 Propagation Model
h1 (above sea level) 20 000 m
Time availability: 0.05 (5%) of all hours
FREE SPACE FIELD
Horizontal polarization over land or sea.
Vertical polarization over land.
Vertical polarization over sea.
Upper limit of uncertainty due to lobing.
DISTANCE IN KILOMETRES
Linear scale
Logarithmic scale
FIELD-STRENGTH (dB rel. 1 μ V/m)
μ V/m

Figure A-14

ATTACHMENT B TO PART II. — CONSIDERATIONS AFFECTING THE DEPLOYMENT OF LF/MF FREQUENCIES AND THE AVOIDANCE OF HARMFUL INTERFERENCE

1. Particularly in areas of high density of NDBs, it is recognized that efficient planning is essential in order to: a) ensure satisfactory operation of ADF equipments, and b) provide the most efficient usage of the limited frequency spectrum available for the NDB service. It is axiomatic that regional meetings will so plan facilities as to ensure that all facilities will receive the best possible protection from harmful interference. Nevertheless, in certain regions, congestion of facilities has been such that regional meetings have had to plan in terms of a *minimum* protection ratio.

Regional meetings include in their planning consideration of such factors as:

a) the possibility of reducing the number of NDBs required, by co-ordination of system plans;

b) the possibility of reducing the coverage where a lesser grade of service than that obtainable within the rated coverage is acceptable;

c) the characteristics of ADF equipments in use;

d) the atmospheric noise grades, appropriate to the area concerned;

e) ground conductivity;

f) interference protection required at the edge of the rated coverage.

Of the foregoing factors, that which is most susceptible to improvement of a technical kind is c).

2. The 1979 World Administrative Radio Conference adopted regulations concerning the assignment of frequencies for aeronautical radio beacons operating in the LF/MF frequency bands. A minimum protection ratio (wanted/unwanted signal ratio) of 15 dB is to be used as the basis for frequency assignment planning (RR 2854). The following data concerning the attenuation characteristics of ADF equipment was used in the EUM region to aid in the frequency assignment process:

Frequency difference (kHz)	*Attenuation (dB)*
0	0
1	1
2	6
2.4	10
3	20
3.6	30
4.3	40
5	50
6	65
7	80

The above figures (or distance separation criteria derived from them) have also been applied in other regions in determining the minimum protection ratio.

Where a bearing accuracy of plus or minus 5 degrees is required at the edge of cover, a minimum protection of 15 dB by day should be used as the basis for LF/MF channel assignment planning.

3. In view of the fact that in many regions there is a need to improve the planning criteria it is considered that the main source from which improvement can be derived is recognition of higher attenuation figures than those given above. Regional meetings are accordingly advised that, when the congestion is such that the use of the above figures no longer permits efficient planning of the LF/MF frequency spectrum available, the following figures represent from a technical point of view the best that can be accepted in determining distance separation criteria:

Frequency difference (kHz)	*Attenuation (dB)*
0	0
1	6
3	35
5	65
6	80

When using these figures, it should be noted that the RF selectivity of modern ADF equipment is in general better than these figures and that, while the RF selectivity of older ADF equipment is not better than these figures, consideration of the dynamic characteristic of these older equipments shows this to be better. It could therefore be expected that frequency planning based on the new figures would considerably improve the service provided to users of modern equipment, and would not materially reduce the service presently provided to those aircraft using the older equipments.

Nevertheless, in their planning, regional meetings would need to consider this question most carefully.

4. It is further noted that, in certain regions, many NDBs are used with voice channels and that this usage is aligned with the Note at the head of Part I, 3.4.6. It is expected that regional meetings will take this fact into account when establishing criteria for frequency planning.

ATTACHMENT C TO PART II. — GUIDING PRINCIPLES FOR LONG DISTANCE OPERATIONAL CONTROL COMMUNICATIONS

Note.— The numerical sequence of the clauses below does not signify any order of relative importance.

1. Aeronautical Operational Control (AOC) HF Stations should be authorized where no other means for the exercise of long distance operational control are available or where the use of the normal communication services provided for safety and regularity of flights are unsuitable or inadequate.

2. The total number of ground stations on the world-wide radio channels should be kept to a minimum consistent with economic and operational efficiency. Consequently,

a) there should normally be not more than one station per State;

b) where an agreed affinity of interest exists between adjoining States, a single station may be provided by agreement among them to serve the needs of all the aircraft operating agencies requiring a service into those States.

3. Depending on the national policy of the State or States, aeronautical stations could be operated by States on behalf of one or more aircraft operating agencies provided that the agencies' requirements for flexibility and direct communication to their aircraft can be met, or aeronautical stations could be operated by an aircraft operating agency or a communication agency serving the interests of one or more aircraft operating agencies and operating under licence issued by the State or States concerned.

4. The licences should be issued on a regular renewal basis and, pursuant to RR 956 and in accordance with RR 3633, should prohibit "public correspondence", or point-to-point type traffic, or other communications traffic not meeting the definition of operational control communications.

5. VHF (general purpose or AOC channels) and not HF should be used when an aircraft is within the coverage of an appropriate VHF aeronautical station.

Note.— The specific categories of messages that may be handled on Aeronautical Mobile (R) Service channels are prescribed in Annex 10, Volume II, Chapter 5, 5.1.8. The same Chapter defines the standard communications procedures for the Service including the requirements for maintaining watch in 5.2.2. In accordance with RR 2025, Article 24 of the ITU Radio Regulations, licences should define the purpose of the station for aeronautical Operational Control (as defined in Annex 6, Part I) and should specify the general characteristics in accordance with Appendix 27 of the Radio Regulations.

— END —

SUPPLEMENT TO ANNEX 10 — VOLUME I
(FOURTH EDITION)

AERONAUTICAL TELECOMMUNICATIONS

Differences between the national regulations and practices of Contracting States and the corresponding International Standards and Recommended Practices contained in Annex 10, Volume I, as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

OCTOBER 1994

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT

No.	*Date*	*Entered by*
1/10/94	10-7-95	

No.	*Date*	*Entered by*

RECORD OF AMENDMENTS TO ANNEX 10 — VOLUME I (FOURTH EDITION)

No.	*Date of adoption or approval*	*Date applicable*
66	14/3/86	20/11/86
67	16/3/87	22/10/87
68	29/3/90	15/11/90
69	22/3/93	11/11/93

No.	*Date of adoption or approval*	*Date applicable*

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards and Recommended Practices of Annex 10, Volume I, Fourth Edition, or have commented on implementation.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
Argentina	13/10/93	1	1/10/94
Canada	6/10/93	1	1/10/94
Finland	1/10/93	1	1/10/94
France	6/10/93	1	1/10/94
Iran, Islamic Republic of	1/11/93	1	1/10/94
Jordan	11/10/93	1	1/10/94
New Zealand	12/10/93	1	1/10/94
Norway	22/10/93	1	1/10/94
Russian Federation	7/10/93	1	1/10/94
Switzerland	11/10/93	1	1/10/94
United Kingdom	8/11/93	1	1/10/94
United States	3/11/93	1	1/10/94

2. Contracting States which have notified ICAO that no differences exist

State	*Date of notification*	*State*	*Date of notification*
Australia	2/9/93	Myanmar	27/5/93
Austria	12/7/93	Netherlands, Kingdom of the	8/10/93
Barbados	4/6/93	Niger	4/10/93
Brazil	10/11/93	Oman	22/8/93
Chile	9/8/93	Portugal	12/1/94
Croatia	6/10/93	Singapore	22/10/93
Cyprus	19/7/93	Thailand	5/10/93
Denmark	31/8/93	Uganda	11/5/93
Germany	24/9/93	United Kingdom (Hong Kong)	26/7/93
Iceland	8/10/93	Uruguay	28/7/93
Ireland	2/7/93	Zimbabwe	27/5/93
Japan	2/11/93		

3. Contracting States from which no information has been received

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Armenia
Azerbaijan
Bahamas
Bahrain
Bangladesh
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Colombia
Comoros
Congo
Cook Islands
Costa Rica
Côte d'Ivoire
Cuba
Czech Republic
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Ecuador
Egypt
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Fiji
Gabon
Gambia
Georgia
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
India
Indonesia
Iraq
Israel
Italy
Jamaica
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Lithuania
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Micronesia, Federated States of
Monaco
Mongolia
Morocco
Mozambique
Namibia
Nauru
Nepal
Nicaragua
Nigeria
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Qatar
Republic of Korea
Republic of Moldova
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Slovakia
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
Sudan
Suriname
Swaziland
Sweden
Syrian Arab Republic
Tajikistan
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Ukraine
United Arab Emirates
United Republic of Tanzania
Uzbekistan
Vanuatu
Venezuela
Viet Nam
Yemen
Zaire
Zambia

1/10/94

4. Paragraphs with respect to which differences have been notified

Paragraph	*Differences notified by*
PART I	
Definitions	New Zealand
2.5.3.2.3	United States
2.5.4.5	Jamaica
2.5.5.1.1	United States
2.5.5.3	France
	United States
2.7.1	Finland
	Iran, Islamic Republic of
	New Zealand
	Norway
	United Kingdom
3.1.2.1	France
	Iran, Islamic Republic of
	Norway
3.1.3.3	New Zealand
3.1.3.3.1	Finland
	Norway
3.1.3.3.2	Canada
3.1.3.10.1	Norway
3.1.3.11.3.1	France
3.1.5.1.2.1	Iran, Islamic Republic of
3.1.5.1.4	Finland
3.1.5.1.5	Canada
	Norway
3.1.5.3	New Zealand
	Norway
3.1.5.3.2	Canada
3.1.5.7.3.1	France
3.1.7	Canada
3.1.7.1	Norway
3.1.7.3.1	United States
3.1.7.3.2	Canada
3.1.7.4.1	Russian Federation
3.1.7.5.1	Russian Federation
3.1.7.6.2.1	Finland
	New Zealand
	Norway
	United Kingdom
3.1.7.6.3.1	Finland
	Jordan
	New Zealand
	Russian Federation
3.1.7.6.6	United Kingdom
3.2.3.1.1	Russian Federation
3.2.4.3.2	Russian Federation
3.2.4.4	Russian Federation
3.3.2.3	Canada
3.3.6.5	Sweden
3.3.7.1	Canada
3.4.5.4	France
3.4.8	Iran, Islamic Republic of
	Switzerland
	United Kingdom
3.4.8.4	Iran, Islamic Republic of
3.5.2.6.1	Norway
3.5.3.6.3	Sweden
3.5.3.6.4	Iran, Islamic Republic of
3.5.4.7.2	Canada
3.5.4.7.2.1	New Zealand
3.6.1.2.6	Canada
Att. C	France
PART II	
4.1.3	United Kingdom
4.1.3.1.1	France
4.1.3.1.2	Argentina
	France
4.1.3.2.1	Madagascar
4.1.5.1	Canada
4.1.5.2	United States

1/10/94

ARGENTINA

PART II

CHAPTER 4

4.1.3.1.2 b) Partial application.

Acceptance of general application, and especially with respect to the new list of alternate aerodromes drawn up by the last SAM/SAT Meeting, will be effective as of 15 November 1992.

c) Accepted as a Recommendation.

1/10/94

CANADA

PART I

CHAPTER 3

3.1.3.3.2	Retention of existing paragraphs with airborne absolute field strength measurement to be applied on an experimental basis only.
3.1.5.1.5*	This specification is followed for new ILS, but for some existing ones, the height of the reference datum may be as low as 45 ft.
3.1.5.3.2	Retention of existing paragraphs with airborne absolute field strength measurement to be applied on an experimental basis only.
3.1.7	ILS installations and back course localizers do not have VHF marker beacons. NDB and DME installations will provide for the functions marker beacons previously fulfilled.
3.1.7.3.2	Retention of existing paragraphs with airborne absolute field strength measurement to be applied on an experimental basis only.
3.3.2.3	Existing VORs which do not meet the technical requirements for 50 kHz spacing will be upgraded commencing in 1994 as a result of an equipment replacement programme. All new VORs are capable of 50 kHz spacing.
3.3.7.1	Certain VOR/DME used solely for en-route navigation do not provide an indication at a control point. These facilities will be annotated as 'unmonitored' on the navigation charts.
3.5.4.7.2	Certain VOR/DME used solely for en-route navigation do not provide an indication at a control point. These facilities will be annotated as 'unmonitored' on the navigation charts.
3.6.1.2.6	Retention of existing paragraphs with airborne absolute field strength measurement to be applied on an experimental basis only.

PART II

CHAPTER 4

4.1.5.1	In Canada, the shortage of communications channels has resulted in a reduction of separation distance such that the desired-to-undesired signal ratio is as low as 14 dB for some assignments. The 14 dB desired-to-undesired signal ratio has been satisfactorily demonstrated as adequate for reliable communication.

* Recommended Practice

1/10/94

FINLAND

PART I

CHAPTER 2

2.7.1	Non-directional and locator beacons are not the subject of periodic flight checks.

CHAPTER 3

3.1.3.3.1	Some localizers have reduced azimuthal coverage.
3.1.5.1.4	ILS reference datum is less than 15 m (50 ft) at some runways.
3.1.7.6.2.1*	Some middle markers are not located at recommended distance from the threshold.
3.1.7.6.3.1*	Some outer markers are not located at recommended distance from the threshold.

* Recommended Practice

1/10/94

PART I

CHAPTER 2

2.5.5.3 This criterion for carriage appears penalizing for small aircraft capable of speeds greater than 175 kt; the installation required is technically complex and costly. The French Administration is considering not making Mode S equipment mandatory by the dates envisaged in respect of certain aircraft whose gross mass is lower than 5 700 kg, but whose maximum true cruising speed may be greater than 324 km/h (175 kt).

CHAPTER 3

3.1.2.1 Most of the marker beacons installed in France and in the overseas departments and territories do not comprise remote control equipment, since they are designed to operate on a continuous basis.

3.1.3.11.3.1 This Standard is applied with the following interpretation for Category III:

> The period of radiation outside the specified performance limits shall not exceed 2 seconds in the course sector. This period shall not exceed 5 seconds in the coverage sector.

3.1.5.7.3.1 At present, the ILS of the Paris Airports are adjusted so that the total permissible period of radiation outside the limits is the same in Category II for the localizer and the glide path (5 seconds).

3.4.5.4 Most of the MF beacons in France operate in A0/A1 to facilitate frequency allocations for the very large number of facilities, so that the band width occupied by the emission is reduced from 850 Hz to 100 Hz in the case of A2 modulation.

ATTACHMENT C

CHAPTER 2

2.1.1 In France, the three precision approach categories are only defined by DH values:

Category I: DH equal to or higher than 60 m (200 ft);
Category II: DH lower than 60 m (200 ft) and equal to or higher than 30 m (100 ft);
Category III: DH lower than 30 m (100 ft).

No account is taken of a runway visual range criterion.

In Category III, no distinction is made between three types A, B and C and since a DH value is always specified, no Category III C is used.

PART II

CHAPTER 4

4.1.3.1.1 In addition to the uses specified in Annex 10, the French Instructions authorize the use of the frequency 121.5 MHz for direction-finding requirements.

4.1.3.1.2 The frequency 121.5 MHz is implemented at international aerodromes only when it is considered necessary. This implementation is moreover postponed at certain international aerodromes located in the overseas territories as well as at the Tahiti Control Centre.

ISLAMIC REPUBLIC OF IRAN

PART I

CHAPTER 2

2.7.1 Non-directional beacons and locator beacons are not subject to periodic flight checks.

CHAPTER 3

3.1.2.1 Some of the marker beacons installed in the Islamic Republic of Iran are not provided with remote control equipment. They operate on a continuous basis.

3.1.5.1.2.1* The following glide plaths, for economic and operational reasons, will be retained with an angle of:

Mehrabad 29L: 3.3 degrees
Mehrabad 29R: 3.3 degrees

3.4.8 The monitoring of non-directional beacons in the Islamic Republic of Iran does not always follow the exact requirement under 3.4.8.

3.4.8.4* The functioning of en-route NDB is checked at weekly intervals. However, frequent pilot reports are obtained in regard to such NDBs and if necessary a NOTAM is issued regarding their status.

3.5.3.6.4 Those VORs which are collocated with TACAN (DME) are not transmitting synchronized identifications.

* Recommended Practice

1/10/94

JORDAN

PART I

CHAPTER 3

3.1.7.6.3.1* Due to difficulties of procurement of land at the prescribed area, the outer marker is located at 11455 M. from THR.RWY 08L.

* Recommended Practice

1/10/94

NEW ZEALAND

PART I

CHAPTER 1

Definitions	*Airborne collision avoidance system (ACAS).* New Zealand will use the term 'Traffic Alert and Collision Avoidance System (TCAS)'.

CHAPTER 2

2.7.1	Some non-directional locator beacons are not the subject of periodic flight tests (stand-alone NDB only flight tested as required for special or post-accident/incident inspection).

CHAPTER 3

3.1.3.3	Because of siting problems and terrain limitations, some localizers do not meet Category I facility performance criteria for off-course coverage. Details of limitations are published in the AIP.
3.1.5.3	Because of siting problems and terrain limitations, some glide paths do not meet Category I facility performance criteria up to 8 degrees in azimuth on each side of the centre line. Details of limitations are published in the AIP.
3.1.7.6.2.1*	Due to topographical limitations, middle markers are not always at 1 050 plus or minus 150 metres from the landing threshold.
3.1.7.6.3.1*	Due to topographical limitations, outer markers are not always located between 6.5 and 11.1 km from the landing threshold.
3.5.4.7.2.1 a)	Certain remotely sited DMEs do not provide an indication at a control point.

---

* Recommended Practice

1/10/94

NORWAY

PART I

CHAPTER 2

2.7.1	Non-directional and locator beacons in Norway are not subject to periodic flight tests.

CHAPTER 3

3.1.2.1	Some localizers are not associated with glide path or prescribed distance information (OM and/or MM and/or DME).
3.1.3.3.1	Some localizers do not meet Category I coverage criteria due to terrain limitations.
3.1.3.10.1	Some localizers are not located on the extension of the centre line of the runway due to terrain limitations.
3.1.5.1.5*	ILS reference datum is less than 50 ft at a few runways.
3.1.5.3	Some glide paths do not meet Category I coverage criteria due to terrain limitations.
3.1.7.1	Middle markers on localizer backbeam are keyed as Morse letter D with modulation frequency 1 300 Hz.
3.1.7.6.2.1*	Some middle markers and outer markers are not located at standard distances from the threshold.
3.5.2.6.1	One facility is not collocated.

---

* Recommended Practice

1/10/94

RUSSIAN FEDERATION

PART I

CHAPTER 3

3.1.7.4.1 b) The modulation frequency of the middle marker is 3 000 Hz.

c) The modulation frequency of the outer marker is 3 000 Hz.

3.1.7.5.1 a) Inner marker: a continuous unkeyed signal.

b) Inner (middle) marker: a continuous series of alternate dots keyed at the rate of 6 dots per second.

3.1.7.6.3.1* The outer marker beacon should be located 4 000 m ± 200 m from the threshold.

3.2.3.1.1 The PAR should detect the position of an aircraft of 10 m^2 echoing area and larger, which is within a space bounded by a 30 degree azimuth sector and a 10 degree elevation sector to a distance of at least 17 km.

3.2.4.3.2 Distance accuracy of SR-A:

Version 1: 500 m
Version 2: 1 per cent of distance, but not greater than 150 m
Version 3: 1.5 per cent of distance, but not greater than 150 m.

3.2.4.4 The rate of renewal of distance and azimuth information for an aircraft within the coverage of the equipment is once every 6 seconds.

* Recommended Practice

1/10/94

SWITZERLAND

PART I

CHAPTER 3

3.4.8 The monitoring of non-directional beacons in Switzerland does not follow the precise requirements of 3.4.8 for all stations.

PART I

CHAPTER 2

2.7.1 Non-directional and locator beacons in the United Kingdom are not the subject of periodic flight checks.

CHAPTER 3

3.1.7.6.2.1* In the United Kingdom, ILS middle markers are located to enable the Standard of 3.1.7.6.2 to be met, but in a number of cases this location does not comply, in respect of distance from the landing threshold, with the Recommended Practice of 3.1.7.6.2.1.

3.1.7.6.6 DME may be installed as an alternative to VHF marker beacons whether or not the installation of marker beacons is impracticable.

3.4.8 The monitoring of non-directional beacons in the United Kingdom does not always follow the precise requirements of the SARPs under 3.4.8.

Normally, monitoring is provided but its periodicity and scope differ between different installations.

PART II

CHAPTER 4

4.1.3 The United Kingdom allows controlled use of the emergency channel to simulate emergency incidents (but not the state of distress).

---

* Recommended Practice

PART 1

CHAPTER 2

2.5.3.2.3 The United States does not currently require that all Mode S transponders be equipped with pressure altitude encoded in the information pulses in Mode C replies.

2.5.5.1.1 a) The United States does not currently require that all Mode S transponders be equipped with pressure altitude encoded in the information pulses in Mode C replies.

2.5.5.3 a) and b) The United States does not currently require that Mode S transponders installed on aircraft with gross mass in excess of 5 700 kg or a maximum cruising time airspeed capability in excess of 324 km (175 knots) shall operate with antenna diversity as prescribed in Part I, 3.8.2.10.4, if:

a) the aircraft individual certificate of airworthiness is first issued on or after 1 January 1990; or

b) Mode S carriage is required on the basis of Regional Air Navigation agreement in accordance with 2.5.3.3.1 and 2.5.3.3.2.

CHAPTER 3

3.1.7.3.1 c) When necessary to achieve coverage to the edges of the localizer course, the United States authorizes coverage over a greater distance than that specified in 3.1.7.3.1 c), i.e. up to 1 200 m (4 000 ft) along the localizer course centre line.

PART II

CHAPTER 4

4.1.5.2 In the United States the shortage of communications channels, compared with the total operational requirement, has resulted in the geographical separation between facilities working on the same frequency being considerably less (up to 50 per cent reduction) than the Standard defined for such separation.

INTERNATIONAL STANDARDS,
RECOMMENDED PRACTICES AND
PROCEDURES FOR AIR NAVIGATION SERVICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME II

(COMMUNICATION PROCEDURES including those with PANS status)

FIFTH EDITION OF VOLUME II — JULY 1995

This edition incorporates all amendments adopted by the Council prior to 21 March 1995 and supersedes, on 9 November 1995, all previous editions of Annex 10.

For information regarding the applicability of the Standards and Recommended Practices and the Procedures for Air Navigation Services, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-70	incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

FOREWORD

Historical background

Standards and Recommended Practices for Aeronautical Telecommunications were first adopted by the Council on 30 May 1949 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 10 to the Convention. They became effective on 1 March 1950. The Standards and Recommended Practices were based on recommendations of the Communications Division at its Third Session in January 1949.

Up to and including the Seventh Edition, Annex 10 was published in one volume containing four Parts together with associated attachments: Part I — Equipment and Systems, Part II — Radio Frequencies, Part III — Procedures, and Part IV — Codes and Abbreviations.

By Amendment 42, Part IV was deleted from the Annex; the codes and abbreviations contained in that Part were transferred to a new document, Doc 8400.

As a result of the adoption of Amendment 44 on 31 May 1965, the Seventh Edition of Annex 10 was replaced by two volumes: Volume I (First Edition) containing Part I — Equipment and Systems, and Part II — Radio Frequencies, and Volume II (First Edition) containing Communication Procedures.

As a result of the adoption of Amendment 70 on 20 March 1995, Annex 10 was restructured to include five volumes: Volume I — Radio Navigation Aids; Volume II — Communication Procedures; Volume III — Communication Systems; Volume IV — Surveillance Radar and Collision Avoidance Systems; and Volume V — Aeronautical Radio Frequency Spectrum Utilization. By Amendment 70, Volumes III and IV were published in 1995 and Volume V was planned for publication with Amendment 71.

Volume II contains material that has the status of Procedures for Air Navigation Services (PANS). This latter material was included, prior to the publication of the First Edition of Volume II, in *PANS — Radiotelephony Procedures* (Doc 7181), which document is now superseded.

Table A shows the origin of amendments to Annex 10 subsequent to Amendment 43, together with a list of the principal subjects involved, where appropriate, and the dates on which the Annex and the amendments were adopted by Council, when they became effective, and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards, Recommended Practices and Procedures specified in Annex 10 should be notified and take effect in accordance with the provisions of Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been deliberately written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

The Procedures for Air Navigation Services (PANS) contained in Volume II of Annex 10 do not carry the status afforded to Standards adopted by the Council as Annexes to the Convention and, therefore, do not come within the obligation imposed by Article 38 of the Convention to notify differences in the event of non-implementation. However, attention of States is drawn to the provisions of Annex 15 related to the publication in their Aeronautical Information Publications of lists of significant differences between their procedures and the related ICAO Procedures.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper*:

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices*:

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

With respect to the typesetting of the material in Volume II of Annex 10, *Procedures for Air Navigation Services* have been printed in light face italics, the status being indicated by the prefix **PANS**.

Table A. Amendments to Annex 10, Volume II

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
44	Seventh Session of the COM Division	With the creation of Volume II and the inclusion of appropriate provisions which up to that time were included in Doc 7181 — *PANS — Radiotelephony Procedures*, a general rearrangement of the provisions relating to communications procedures was necessary and was effected in the new Volume II.	31 May 1965 1 October 1965 10 March 1966
45	Sixth Meeting of the Panel of Teletypewriter Specialists; Fourth AN Conference	A number of detailed changes in the AFTN procedures; amendment to Chapters 5 and 6, to indicate more precisely the procedures to be used when communications take place directly between a pilot and an air traffic controller; and a rewording of 3.7 — Use of Abbreviations and Codes, to correct an unintentional change in meaning introduced in Amendment 42.	12 December 1966 12 April 1967 24 August 1967
46	Fifth Meeting of the ATC Automation Panel	Provisions for the transmission of ATS messages intended for use in an ATC computer.	7 June 1967 5 October 1967 8 February 1968
47	COM/OPS Divisional Meeting	Introduction of new simplified Aeronautical Mobile Distress Procedures which are better suited to the special requirements of international civil aviation.	11 December 1967 11 April 1968 22 August 1968
48	Seventh Meeting of the Panel of Teletypewriter Specialists	Introduction of changes to message classification and teletypewriter procedures in the light of experience gained in automated operation of the AFTN.	23 January 1969 23 May 1969 18 September 1969
49	First Meeting of the Automated Data Interchange Systems Panel; Sixth AN Conference	Provision concerning the use of the 7-unit code for data interchange at medium signalling rates; introduction of provisions relating to the categories of aeronautical mobile service messages. On the basis of the study of consolidation and presentation of the Regional Supplementary Procedures, it introduces provisions relating to: appropriate diversion routing lists at AFTN communication centres; early transmission of AFTN messages bearing Priority Indicators GG or higher; guarding of 121.5 MHz during long over-water flights; action by aeronautical stations receiving an air-report or a message containing meteorological information transmitted by an aircraft; and the action taken by a station receiving a distress message or an emergency message; and when it is aware that the distress condition is ended.	1 June 1970 1 October 1970 4 February 1971
50	Fifth NAT RAN Meeting; Second Meeting of the Automated Data Interchange Systems Panel; Air Navigation Study on RAN Meeting recommendations of world-wide applicability; Sixth AN Conference	Introduction of the term "Hertz (Hz)" in place of the term "cycles per second (c/s)" as the unit of frequency for electric and radio-technical matters; changes in the provisions relating to short-term and long-term retention of AFTN traffic records and the period of thirty days for the retention of communications logs; expansion of the Introduction to Volume II with material relating to the 7-unit coded character set; introduction of the definitions for "ATS direct speech circuit", "Meteorological operational channel" and "Meteorological operational telecommunication network"; reorganization of the provisions at Chapters 3 and 4 by grouping under Chapter 3 the general provisions for the four parts of the international aeronautical telecommunication service and under Chapter 4 the provisions relating to the aeronautical fixed service, including the aeronautical fixed telecommunication network; provisions concerning the recording of air-reports in AIREP form.	24 March 1972 24 July 1972 7 December 1972
51	Sixth EUM RAN Meeting	Introduction of provisions concerning the use of a predetermined distribution system for AFTN messages.	11 December 1972 11 April 1973 16 August 1973
52*			
53*			
54**	Fourth Meeting of the Automated Data Interchange Systems Panel	Insertion of cross references in Volume I, Part I, Chapter 4, 4.12 and in the Introduction to Volume II, concerning data exchange rates.	17 June 1974 — —
55*			
56*			
57	ASIA/PAC RAN Meeting	Amendments concerning the maintenance of guard on the VHF emergency frequency 121.5 MHz by the crews of aircraft crossing designated areas, and the elimination of ocean station vessels from those aeronautical stations with which radio contact should be attempted in case of air-ground communications failure.	16 June 1976 16 October 1976 6 October 1977

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
58	Sixth Meeting of the Automated Data Interchange Systems Panel	Amendment concerning the material permitted in AFS messages and the procedures for requesting repetition of mutilated messages in the AFTN; also the introduction of a message format for the 7-unit coded character set.	27 June 1977 27 October 1977 23 February 1978
59	COM Divisional Meeting (1976)	Amendment concerning address part of the AFTN messages.	14 December 1977 14 April 1978 10 August 1978
60	Eighth Meeting of the EUR Air Navigation Planning Group; Third Meeting of the EUR/NAM/NAT Regional Planning Group	Designation of VHF 25 kHz channels; short-term retention of AFTN messages.	4 December 1978 4 April 1979 29 November 1979
61	Seventh Meeting of the Automated Data Interchange Systems Panel; COM Divisional Meeting (1978)	Introduction of a new series of marginal serial numbers in use by the International Telecommunication Union (ITU) and clarification of the term "Radio Regulations"; changes to the definition of the Aeronautical Fixed Telecommunication Network (AFTN); introduction of the definition of "operational control communications"; new provisions regarding stripped address procedure; changes in the provisions regarding maximum message length; changes in the provisions regarding flight regularity messages.	10 December 1979 10 April 1980 27 November 1980
62	Eighth Meeting of the Automated Data Interchange Systems Panel	Changes and additions to the provisions related to service messages, multiple lines of address and stripped address procedure; changes and additions to the provisions related to channel-check transmissions and the use of controlled circuit protocols; changes and additions to the provisions related to the detection of mutilated messages; addition of provisions related to the transfer of AFTN messages over code and byte independent circuits and networks.	14 December 1981 14 April 1982 25 November 1982
63	Ninth Meeting of the Automated Data Interchange Systems Panel	Changes to the provisions related to message priority and priority indicators.	13 December 1982 13 April 1983 24 November 1983
64	Air Navigation Commission	Introduction of new and revised radiotelephony procedures for use in the Aeronautical Mobile Service.	30 March 1983 29 July 1983 7 June 1984
65	Recommendations of the ANC relating to the method of referencing date/time; COM/MET Divisional Meeting (1982); Third Meeting of the ATS Data Acquisition, Processing and Transfer Panel; 10th Meeting of the Automated Data Interchange Systems Panel	Co-ordinated universal time (UTC); changes to AFTN message text length, and priorities for movement and control messages; test procedures on AFTN channels; new material on AFTN address stripping in Attachment C.	6 December 1984 6 April 1985 21 November 1985
66*			
67	Eighth Meeting, 104th Session of Council; COM/MET Divisional Meeting (1982); Air Navigation Commission	Changes and editorial rearrangement of AFTN procedures resulting from the new ICAO three-letter designator; changes related to predetermined distribution system for the AFTN; introduction of new procedures concerning transmission of whole hundreds in radiotelephony; introduction of new procedures for use on VHF air-to-air communications channel; editorial rearrangement to present English language radiotelephony phraseology in all language versions of Annex 10, Volume II.	16 March 1987 27 July 1987 22 October 1987
68	Air Navigation Commission	New procedures for the formulation of aircraft radiotelephony call signs; changes to safeguard aircraft against acts of unlawful interference; new procedures related to the maintenance of guard on 121.5 MHz.	29 March 1990 30 July 1990 15 November 1990
69	COM/MET Divisional Meeting (1982); COM/MET/OPS Divisional Meeting (1990)	Changes to AFTN message procedures and addition of material related to the world area forecast system (WAFS) telecommunications requirements; addition of material related to VHF air-ground data link communications and changes to material concerning VHF off-set carrier systems.	22 March 1993 26 July 1993 11 November 1993
70	Air Navigation Commission	New phraseology for the transmission of numbers in radiotelephony. A number of changes in the AFTN procedures related to the acceptance and transmission of messages, categories of messages and removal of obsolete material related to radiotelephony.	20 March 1995 24 July 1995 9 November 1995

* Affected Volume I only.
** Did not affect any Standards or Recommended Practices.

ANNEX 10 — VOLUME II
COMMUNICATION PROCEDURES

Introduction

The object of the international aeronautical telecommunication service is to ensure the telecommunications and radio aids to air navigation necessary for the safety, regularity and efficiency of international air navigation.

Procedures for the International Aeronautical Telecommunication Service are herein set forth for world-wide use. It is recognized that Supplementary Procedures may be required in certain cases in order to meet particular requirements of the ICAO Regions. Any Supplementary Procedure recommended for this purpose must be a requirement peculiar to the region and must not be contained in, nor conflict with, any world-wide Procedure of ICAO.

Where appropriate, specific ITU Radio Regulations have been paraphrased in this document. Users of these Procedures should note that the Radio Regulations Annex of the International Telecommunications Convention is all-embracing in character and, therefore, should be applied in all pertinent cases.

All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union.

The Communication Procedures are to be used in conjunction with the Abbreviations and Codes of Doc 8400 and with such other codes and abbreviations as may be approved by ICAO for use in communications.

Volume II contains a number of provisions relating to the exchange of information which were developed primarily for low modulation rates utilizing the coded character sets of International Alphabets Nos. 2 and 3. Provisions for International Alphabet No. 5 (IA-5) for use at medium and higher signalling rates are contained in Annex 10, Volume I, Part I, 4.11. Guidance material for ground-ground data interchange over data links at medium and higher signalling prates is included in Attachment G to Part I of Volume I.

CHAPTER 1. DEFINITIONS

When the following terms are used in this publication, they have the meaning prescribed in this chapter:

Note.— A list of additional specialized communication terms and their definitions is contained in Attachment A.

1.1 Services

Aeronautical broadcasting service. A broadcasting service intended for the transmission of information relating to air navigation.

Aeronautical fixed service (AFS). A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.

Aeronautical fixed telecommunication network (AFTN). A world-wide system of aeronautical fixed circuits provided, as part of the aeronautical fixed service, for the exchange of messages and/or digital data between aeronautical fixed stations having the same or compatible communications characteristics.

Aeronautical mobile service. A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate; emergency position-indicating radiobeacon stations may also participate in this service on designated distress and emergency frequencies.

Aeronautical mobile (R) service. An aeronautical mobile service reserved for communications relating to safety and regularity of flight, primarily along national or international civil air routes.

Aeronautical mobile-satellite service. A mobile-satellite service in which mobile earth stations are located on board aircraft; survival craft stations and emergency position-indicating radiobeacon stations may also participate in this service.

Aeronautical mobile-satellite (R) service. An aeronautical mobile-satellite service reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes.

Aeronautical radio navigation service. A radio navigation service intended for the benefit and for the safe operation of aircraft.

Note.— The following Radio Regulations are quoted for purposes of reference and/or clarity in understanding of the above definition of the aeronautical radio navigation service:

RR11 Radio navigation: *Radiodetermination used for the purpose of navigation, including obstruction warning.*

RR10 Radiodetermination: *The determination of the position, velocity and/or other characteristics of an object, or the obtaining of information relating to these parameters, by means of the propagation properties of radio waves.*

Aeronautical telecommunication service. A telecommunication service provided for any aeronautical purpose.

International telecommunication service. A telecommunication service between offices or stations of different States, or between mobile stations which are not in the same State, or are subject to different States.

1.2 Stations

Aerodrome control radio station. A station providing radio communication between an aerodrome control tower and aircraft or mobile aeronautical stations.

Aeronautical fixed station. A station in the aeronautical fixed service.

Aeronautical station. A land station in the aeronautical mobile service. In certain instances, an aeronautical station may be located, for example, on board ship or on a platform at sea.

Aeronautical telecommunication station. A station in the aeronautical telecommunication service.

AFTN communication centre. An AFTN station whose primary function is the relay or retransmission of AFTN traffic from (or to) a number of other AFTN stations connected to it.

AFTN destination station. An AFTN station to which messages and/or digital data are addressed for processing for delivery to the addressee.

AFTN origin station. An AFTN station where messages and/or digital data are accepted for transmission over the AFTN.

AFTN station. A station forming part of the aeronautical fixed telecommunication network (AFTN) and operating as such under the authority or control of a State.

Air-ground control radio station. An aeronautical telecommunication station having primary responsibility for handling communications pertaining to the operation and control of aircraft in a given area.

Aircraft station. A mobile station in the aeronautical mobile service, other than a survival craft station, located on board an aircraft.

Communication centre. An aeronautical fixed station which relays or retransmits telecommunication traffic from (or to) a number of other aeronautical fixed stations directly connected to it.

Mobile surface station. A station in the aeronautical telecommunication service, other than an aircraft station, intended to be used while in motion or during halts at unspecified points.

Network station. An aeronautical station forming part of a radiotelephony network.

Radio direction-finding station. A radio station intended to determine only the direction of other stations by means of transmissions from the latter.

Regular station. A station selected from those forming an en-route air-ground radiotelephony network to communicate with or to intercept communications from aircraft in normal conditions.

Tributary station. An aeronautical fixed station that may receive or transmit messages and/or digital data but which does not relay except for the purpose of serving similar stations connected through it to a communication centre.

1.3 Communication methods

Air-ground communication. Two-way communication between aircraft and stations or locations on the surface of the earth.

Air-to-ground communication. One-way communication from aircraft to stations or locations on the surface of the earth.

Blind transmission. A transmission from one station to another station in circumstances where two-way communication cannot be established but where it is believed that the called station is able to receive the transmission.

Broadcast. A transmission of information relating to air navigation that is not addressed to a specific station or stations.

Duplex. A method in which telecommunication between two stations can take place in both directions simultaneously.

Ground-to-air communication. One-way communication from stations or locations on the surface of the earth to aircraft.

Interpilot air-to-air communication. Two-way communication on a designated air-to-air channel to enable aircraft engaged in flights over remote and oceanic areas out of range of VHF ground stations to exchange necessary operational information and to facilitate the resolution of operational problems.

Non-network communications. Radiotelephony communications conducted by a station of the aeronautical mobile service, other than those conducted as part of a radiotelephony network.

Radiotelephony network. A group of radiotelephony aeronautical stations which operate on and guard frequencies from the same family and which support each other in a defined manner to ensure maximum dependability of air-ground communications and dissemination of air-ground traffic.

Readback. A procedure whereby the receiving station repeats a received message or an appropriate part thereof back to the transmitting station so as to obtain confirmation of correct reception.

Simplex. A method in which telecommunication between two stations takes place in one direction at a time.

Telecommunication. Any transmission, emission, or reception of signs, signals, writing, images and sounds or intelligence of any nature by wire, radio, optical or other electromagnetic systems.

1.4 Direction finding

Homing. The procedure of using the direction-finding equipment of one radio station with the emission of another radio station, where at least one of the stations is mobile, and whereby the mobile station proceeds continuously towards the other station.

Radio bearing. The angle between the apparent direction of a definite source of emission of electro-magnetic waves and a reference direction, as determined at a radio direction-finding station. A *true* radio bearing is one for which the reference direction is that of true North. A *magnetic* radio bearing is one for which the reference direction is that of magnetic North.

Radio direction finding. Radiodetermination using the reception of radio waves for the purpose of determining the direction of a station or object.

Radio direction-finding station. A radiodetermination station using radio direction finding.

Note.— The aeronautical application of radio direction finding is in the aeronautical radio navigation service.

1.5 Teletypewriter systems

Automatic relay installation. A teletypewriter installation where automatic equipment is used to transfer messages from incoming to outgoing circuits.

Note.— This term covers both fully automatic and semi-automatic installations.

Fully automatic relay installation. A teletypewriter installation where interpretation of the relaying responsibility in respect of an incoming message and the resultant setting-up of the connections required to effect the appropriate retransmissions is carried out automatically, as well as all other normal operations of relay, thus obviating the need for operator intervention, except for supervisory purposes.

Message field. An assigned area of a message containing specified elements of data.

Semi-automatic relay installation. A teletypewriter installation where interpretation of the relaying responsibility in respect of an incoming message and the resultant setting-up of the connections required to effect the appropriate retransmissions require the intervention of an operator but where all other normal operations of relay are carried out automatically.

Teletypewriter tape. A tape on which signals are recorded in the 5-unit Start-Stop code by completely severed perforations (Chad Type) or by partially severed perforations (Chadless Type) for transmission over teletypewriter circuits.

"Torn-tape" relay installation. A teletypewriter installation where messages are received and relayed in teletypewriter tape form and where all operations of relay are performed as the result of operator intervention.

1.6 Agencies

Aeronautical telecommunication agency. An agency responsible for operating a station or stations in the aeronautical telecommunication service.

Aircraft operating agency. The person, organization or enterprise engaged in, or offering to engage in, an aircraft operation.

1.7 Frequencies

Primary frequency. The radiotelephony frequency assigned to an aircraft as a first choice for air-ground communication in a radiotelephony network.

Secondary frequency. The radiotelephony frequency assigned to an aircraft as a second choice for air-ground communication in a radiotelephony network.

1.8 Miscellaneous

Aeronautical fixed circuit. A circuit forming part of the aeronautical fixed service (AFS).

Aeronautical fixed telecommunication network circuit. A circuit forming part of the aeronautical fixed telecommunication network (AFTN).

Aeronautical telecommunication log. A record of the activities of an aeronautical telecommunication station.

Air-report. A report from an aircraft in flight prepared in conformity with requirements for position, and operational and/or meteorological reporting.

Note.— Details of the AIREP form are given in PANS-RAC (Doc 4444).

Altitude. The vertical distance of a level, point or an object considered as a point, measured from mean sea level.

ATS direct speech circuit. An aeronautical fixed service (AFS) telephone circuit, for direct exchange of information between air traffic services (ATS) units.

Automatic telecommunication log. A record of the activities of an aeronautical telecommunication station recorded by electrical or mechanical means.

Flight level. A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hPa, and is separated from other such surfaces by specific pressure intervals.

Frequency channel. A continuous portion of the frequency spectrum appropriate for a transmission utilizing a specified class of emission.

Note.— The classification of emissions and information relevant to the portion of the frequency spectrum appropriate for a given type of transmission (bandwidths) is specified in the ITU Radio Regulations, Article 4, RR 264 to RR 273 inclusive.

Height:

1) The vertical distance of a level, point or an object considered as a point, measured from a specified datum.

Note.— The datum may be specified in the text or in an explanatory note in the publication concerned.

2) The vertical dimension of an object.

Note.— The term "height" *may also be used in a figurative sense for a dimension other than vertical, e.g. the height of a letter or a figure on a runway.*

Location indicator. A four-letter code group formulated in accordance with rules prescribed by ICAO and assigned to the location of an aeronautical fixed station.

Meteorological operational channel. A channel of the aeronautical fixed service (AFS), for the exchange of aeronautical meteorological information.

Meteorological operational telecommunication network. An integrated system of meteorological operational channels, as part of the aeronautical fixed service (AFS), for the exchange of aeronautical meteorological information between the aeronautical fixed stations within the network.

Note.— "Integrated" is to be interpreted as a mode of operation necessary to ensure that the information can be transmitted and received by the stations within the network in accordance with pre-established schedules.

NOTAM. A notice containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

— *Class I distribution.* Distribution by means of telecommunication.

— *Class II distribution.* Distribution by means other than telecommunication.

Operational control communications. Communications required for the exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of the safety of the aircraft and the regularity and efficiency of a flight.

Note.— Such communications are normally required for the exchange of messages between aircraft and aircraft operating agencies.

Route segment. A route or portion of route usually flown without an intermediate stop.

Routing Directory. A list in a communication centre indicating for each addressee the outgoing circuit to be used.

SNOWTAM. A special series NOTAM notifying the presence or removal of hazardous conditions due to snow, ice, slush or standing water associated with snow, slush and ice on the movement area by means of a specific pro forma.

VHF air-ground data link. Two-way data communication in the 118-137 MHz VHF band between aircraft and aeronautical stations.

CHAPTER 2. ADMINISTRATIVE PROVISIONS RELATING TO THE INTERNATIONAL AERONAUTICAL TELECOMMUNICATION SERVICE

2.1 Division of service

The international aeronautical telecommunication service shall be divided into four parts:

1) aeronautical fixed service;

2) aeronautical mobile service;

3) aeronautical radio navigation service;

4) aeronautical broadcasting service.

2.2 Telecommunications — charges

Recommendation.— *The exchange of communications necessary for ensuring safety of air navigation and the regularity of air traffic between aeronautical fixed stations of different States and between aeronautical stations and aircraft stations should be handled without specific message charge unless otherwise provided.*

2.3 Hours of service

2.3.1 The Competent Authority shall give notification of the normal hours of service of stations and offices of the international aeronautical telecommunication service under its control to the aeronautical telecommunication agencies designated to receive this information by other Administrations concerned.

2.3.2 Whenever necessary and practicable, the Competent Authority shall give notification of any change in the normal hours of service, before such a change is effected, to the aeronautical telecommunication agencies designated to receive this information by other Administrations concerned. Such changes shall also, whenever necessary, be promulgated in NOTAM.

2.3.3 If a station of the international aeronautical telecommunication service, or an aircraft operating agency, requests a change in the hours of service of another station, such change shall be requested as soon as possible after the need for change is known. The station or aircraft operating agency requesting the change shall be informed of the result of its request as soon as possible.

2.4 Supervision

2.4.1 Each State shall designate the authority responsible for ensuring that the international aeronautical telecommunication service is conducted in accordance with the Procedures in this Annex.

2.4.2 **Recommendation.—** *Occasional infringements of the Procedures contained herein, when not serious, should be dealt with by direct communication between the parties immediately interested either by correspondence or by personal contact.*

2.4.3 When a station commits serious or repeated infringements, representations relating to them shall be made to the authority designated in 2.4.1 of the State to which the station belongs by the authority which detects them.

2.4.4 **Recommendation.—** *The authorities designated in 2.4.1 should exchange information regarding the performance of systems of communication, radio navigation, operation and maintenance, unusual transmission phenomena, etc.*

2.5 Superfluous transmissions

Each State shall ensure that there is no wilful transmission of unnecessary or anonymous signals, messages or data by any station within that State.

2.6 Interference

Before authorizing tests and experiments in any station, each Administration, in order to avoid harmful interference, shall prescribe the taking of all possible precautions, such as the choice of frequency and of time, and the reduction or, if possible, the suppression of radiation. Any harmful interference resulting from tests and experiments shall be eliminated as soon as possible.

CHAPTER 3. GENERAL PROCEDURES FOR THE INTERNATIONAL AERONAUTICAL TELECOMMUNICATION SERVICE

3.1 General

The Procedures outlined in this chapter are general in character and shall be applied where appropriate to the other chapters contained in this Volume.

Note.— Detailed Procedures, with special application to the service concerned, are contained in Chapters 4, 5, 6 and 7.

3.2 Extensions of service and closing down of stations

3.2.1 Stations of the international aeronautical telecommunication service shall extend their normal hours of service as required to provide for traffic necessary for flight operation.

3.2.2 Before closing down, a station shall notify its intention to all other stations with which it is in direct communication, confirm that an extension of service is not required and advise the time of re-opening if other than its normal hours of service.

3.2.3 When it is working regularly in a network on a common circuit, a station shall notify its intention of closing down either to the control station, if any, or to all stations in the network. It shall continue watch for two minutes and may then close down if it has received no call during this period.

3.2.4 Stations with other than continuous hours of operation, engaged in, or expected to become engaged in distress, urgency, unlawful interference, or interception traffic, shall extend their normal hours of service to provide the required support to those communications.

3.3 Acceptance, transmission and delivery of messages

3.3.1 Only those messages coming within the categories specified in 4.4.1.1 shall be accepted for transmission by the aeronautical telecommunication service.

3.3.1.1 The responsibility for determining the acceptability of a message shall rest with the station where the message is filed for transmission.

3.3.1.2 Once a message is deemed acceptable, it shall be transmitted, relayed and (or) delivered in accordance with the priority classification and without discrimination or undue delay.

3.3.1.3 **Recommendation.—** *The authority in control of any station through which a message is relayed, should make representations at a later date to the authority in control of the accepting station regarding any message which is considered unacceptable.*

3.3.2 Only messages for stations forming part of the aeronautical telecommunication service shall be accepted for transmission, except where special arrangements have been made with the telecommunication authority concerned.

3.3.2.1 Acceptance as a single message of a message intended for two or more addresses, whether at the same station or at different stations, shall be permitted subject, however, to the provisions prescribed in 4.4.3.1.2.3.

3.3.3 Messages handled for aircraft operating agencies shall be accepted only when handed in to the telecommunication station in the form prescribed herein and by an authorized representative of that agency, or when received from that agency over an authorized circuit.

3.3.4 For each station of the aeronautical telecommunication service from which messages are delivered to one or more aircraft operating agencies, a single office for each aircraft operating agency shall be designated by agreement between the aeronautical telecommunication agency and the aircraft operating agency concerned.

3.3.5 Stations of the international aeronautical telecommunication service shall be responsible for delivery of messages to addressee(s) located within the boundaries of the aerodrome(s) served by that station and beyond those boundaries only to such addressee(s) as may be agreed by special arrangements with the Administrations concerned.

3.3.6 Messages shall be delivered in the form of a written record, or other permanent means as prescribed by authorities.

3.3.6.1 **Recommendation.—** *In cases where telephone or loudspeaker systems are used without recording facilities for the delivery of messages, a written copy should be provided, as confirmation of delivery, as soon as possible.*

3.3.7 Messages originated in the aeronautical mobile service by an aircraft in flight and which require transmission over the aeronautical fixed telecommunication network to effect delivery, shall be reprocessed by the aeronautical telecommunication station into the message format prescribed in 4.4.2 prior to transmission on the AFTN.

3.3.7.1 Messages originated in the aeronautical mobile service by an aircraft in flight and which require transmission over the aeronautical fixed service, other than on AFTN circuits, shall also be reprocessed by the aeronautical telecommunication station into the format prescribed in 4.4.2 except where, subject to the provisions of 3.3.5, prior and other arrangements have been made between the aeronautical telecommunication agency and the aircraft operating agency concerned for predetermined distribution of messages from aircraft.

3.3.7.2 Messages (including air-reports) without specific address containing meteorological information received from an aircraft in flight shall be forwarded without delay to the meteorological office associated with the point of reception.

3.3.7.3 Messages (including air-reports) without specific address containing air traffic services information from aircraft in flight shall be forwarded without delay to the air traffic services unit associated with the communication station receiving the message.

3.3.7.4 **PANS.**— *When recording the text of air-reports in AIREP form, the data conventions approved by ICAO for this purpose shall be used wherever possible.*

Note.— Provisions relating to the composition, including data conventions, of air-reports and to the order and form in which the elements of such reports are transmitted by the aircraft stations and recorded and retransmitted by the aeronautical stations, are contained in the PANS-RAC (Doc 4444).

3.3.7.5 **PANS.**— *When air-reports in AIREP form are to be retransmitted by telegraphy (including teletypewriting), the text transmitted shall be as recorded in compliance with 3.3.7.4.*

3.4 Time system

3.4.1 Universal Co-ordinated Time (UTC) shall be used by all stations in the aeronautical telecommunication service. Midnight shall be designated as 2400 for the end of the day and 0000 for the beginning of the day.

3.4.2 A date-time group shall consist of six figures, the first two figures representing the date of the month and the last four figures the hours and minutes in UTC.

3.5 Record of communications

3.5.1 General

3.5.1.1 A telecommunication log, written or automatic, shall be maintained in each station of the aeronautical telecommunication service except that an aircraft station, when using radiotelephony in direct communication with an aeronautical station, need not maintain a telecommunication log.

Note.— The telecommunication log will serve as a protection, should the operator's watch activities be investigated. It may be required as legal evidence.

3.5.1.1.1 **Recommendation.**— *Aeronautical stations should record messages at the time of their receipt, except that, if during an emergency the continued manual recording would result in delays in communication, the recording of messages may be temporarily interrupted and completed at the earliest opportunity.*

Note.— In the case of radiotelephony operation it would be desirable if voice recording were provided for use during interruption in manual recording.

3.5.1.1.2 **Recommendation.**— *When a record is maintained in an aircraft station, either in a radiotelephone log or elsewhere, concerning distress communications, harmful interference, or interruption to communications, such a record should be associated with information concerning the time and the position, and altitude of the aircraft.*

3.5.1.2 In written logs, entries shall be made only by operators on duty except that other persons having knowledge of facts pertinent to the entries may certify in the log the accuracy of operators' entries.

3.5.1.3 All entries shall be complete, clear, correct and intelligible. Superfluous marks or notations shall not be made in the log.

3.5.1.4 In written logs, any necessary correction in the log shall be made only by the person making the initial entry. The correction shall be accomplished by drawing or typing a single line through the incorrect entry, initialling same, recording the time and date of correction. The correct entry shall be made on the next line after the last entry.

3.5.1.5 Telecommunication logs, written or automatic, shall be retained for a period of at least thirty days. When logs are pertinent to inquiries or investigations they shall be retained for longer periods until it is evident that they will be no longer required.

3.5.1.6 The following information shall be entered in written logs:

a) the name of the agency operating the station;

b) the identification of the station;

c) the date;

d) the time of opening and closing the station;

e) the signature of each operator, with the time the operator assumes and relinquishes a watch;

f) the frequencies being guarded and type of watch (continuous or scheduled) being maintained on each frequency;

g) except at intermediate mechanical relay stations where the provisions of this paragraph need not be complied with, a record of each communication, test transmission, or attempted communication showing text of communication, time communication completed, station(s) communicated with, and frequency used. The text of the communication may be omitted from the log when copies of the messages handled are available and form part of the log;

h) all distress communications and action thereon;

i) a brief description of communication conditions and difficulties, including harmful interference. Such entries should include, whenever practicable, the time at which interference was experienced, the character, radio frequency and identification of the interfering signal;

j) a brief descripion of interruption to communications due to equipment failure or other troubles, giving the duration of the interruption and action taken;

k) such additional information as may be considered by the operator to be of value as a part of the record of the station's operations.

3.6 Establishment of radiocommunication

3.6.1 All stations shall answer calls directed to them by other stations in the aeronautical telecommunication service and shall exchange communications on request.

3.6.2 All stations shall radiate the minimum power necessary to ensure a satisfactory service.

3.7 Use of abbreviations and codes

3.7.1 Abbreviations and codes shall be used in the international aeronautical telecommunication service whenever they are appropriate and their use will shorten or otherwise facilitate communication.

3.7.1.1 Where abbreviations and codes other than those approved by ICAO are contained in the text of messages, the originator shall, if so required by the aeronautical telecommunication station accepting the message for transmission, make available to that station a decode for the abbreviations and codes used.

Note.— The use of ICAO approved abbreviations and codes wherever appropriate — for example, those contained in ICAO Abbreviations and Codes *(Doc 8400) — obviates the need for application of the provisions of 3.7.1.1.*

3.8 Cancellation of messages

3.8.1 Messages shall be cancelled by a telecommunication station only when cancellation is authorized by the message originator.

CHAPTER 4. AERONAUTICAL FIXED SERVICE (AFS)

4.1 General

4.1.1 The aeronautical fixed service comprises all types and systems of point-to-point communications in the international aeronautical telecommunication service.

4.1.2 Material permitted in AFS messages

Note.— The provisions contained in 4.1.2 do not apply to the exchange of telephone communications on ATS direct speech circuits.

4.1.2.1 The following characters are allowed in messages:

Letters: ABCDEFGHIJKLMNOPQRSTUVWXYZ

Figures: 1 2 3 4 5 6 7 8 9 0

Other signs:

-	(hyphen)
?	(question mark)
:	(colon)
(	(open bracket)
)	(close bracket)
.	(full stop, period, or decimal point)
,	(comma)
'	(apostrophe)
=	(double hyphen or equal sign)
/	(oblique)
+	(plus sign)

Characters other than those listed above shall not be used in messages unless absolutely necessary for understanding of the text. When used, they shall be spelled out in full.

4.1.2.2 For the exchange of messages over the teletypewriter circuits the following signals of the International Telegraph Alphabet No. 2 (ITA-2) shall be permitted:

signals nos. 1 to 3	— in letter and in figure case;
signal no. 4	— in letter case only;
signal no. 5	— in letter and in figure case;
signals nos. 6 to 8	— in letter case only;
signal no. 9	— in letter and in figure case;
signal no. 10	— in letter case only;
signals nos. 11 to 31	— in letter and figure case.

Note 1.— "Letter case" and "figure case" are to be understood as the shift condition in which the equipment associated with the channel was positioned prior to the reception of the signal.

Note 2.— When using any of the above signals, account is to be taken of, amongst others, the provisions of 4.4.5.3.

Note 3.— The foregoing provisions of 4.1.2.2 are not intended to prevent the use of:

a) figure case of signals nos. 6, 7 and 8 after bilateral agreements between States having telecommunication stations directly connected to each other;

b) figure case of signal no. 10 as the priority alarm (see 4.4.4.3);

c) figure case of signal no. 4 for operational purposes only and not as part of a message.

4.1.2.2.1 For the exchange of messages over the teletypewriter circuits the following characters of International Alphabet No. 5 (IA-5) shall be permitted:

- — characters 0/1 to 0/3, 0/7 — in the priority alarm (see 4.4.16.2.2.5), 0/10, 0/11 — in the ending sequence (see 4.4.16.3.12.1), 0/13;
- — characters 2/0, 2/7 to 2/9, 2/11 to 2/15;
- — characters 3/0 to 3/10, 3/13, 3/15;
- — characters 4/1 to 4/15;
- — characters 5/0 to 5/10;
- — character 7/15.

Note.— The foregoing provisions of 4.1.2.2.1 are not intended to prevent the use of the full IA-5 after agreement between the Administrations concerned.

4.1.2.3 Roman numerals shall not be employed. If the originator of a message wishes the addressee to be informed that roman figures are intended, the arabic figure or figures shall be written and preceded by the word ROMAN.

4.1.2.4 Messages using the ITA-2 code shall not contain:

1) any uninterrupted sequence of signals nos. 26, 3, 26 and 3 (letter case and figure case) in this order, other than the one in the heading as prescribed in 4.4.2.1.1;

2) any uninterrupted sequence of four times signal no. 14 (letter case and figure case) other than the one in the ending as prescribed in 4.4.6.1.

4.1.2.4.1 Messages using IA-5 shall not contain:

1) character 0/1 (SOH) other than the one in the heading as prescribed in 4.4.16.1.1 a);

2) character 0/2 (STX) other than the one in the origin line as prescribed in 4.4.16.2.2.7;

3) character 0/3 (ETX) other than the one in the ending as prescribed in 4.4.16.3.12.1;

4) any uninterrupted sequence of characters 5/10, 4/3, 5/10, 4/3 in this order (ZCZC);

5) any uninterrupted sequence of characters 2/11, 3/10, 2/11, 3/10 in this order (+:+:);

6) any uninterrupted sequence of four times character 4/14 (NNNN);

7) any uninterrupted sequence of four times character 2/12 (,,,,).

4.1.2.5 The text of messages shall be drafted in plain language or in abbreviations and codes, as prescribed in 3.7. The originator shall avoid the use of plain language when reduction in the length of the text by appropriate abbreviations and codes is practicable. Words and phrases which are not essential, such as expressions of politeness, shall not be used.

4.1.2.5.1 If the originator of a message wishes alignment functions [<≡] to be transmitted at specific places in the text part of such message (see 4.4.5.3 and 4.4.16.3.6), the sequence [<≡] shall be written on each of those places.

4.2 ATS direct speech circuits

Note.— Provisions relating to ATS direct speech communications are contained in Chapter 6 of Annex 11.

4.3 Meteorological operational channels and meteorological operational telecommunication networks

4.3.1 Meteorological operational channel procedures and meteorological operational communication network procedures shall be compatible with aeronautical fixed telecommunications network (AFTN) procedures.

Note.— "Compatible" is to be interpreted as a mode of operation ensuring that the information exchanged over the meteorological operational channels also can be exchanged over the aeronautical fixed telecommunication network without harmful effect on the operation of the aeronautical fixed telecommunication network and vice versa.

4.4 Aeronautical fixed telecommunication network (AFTN)

4.4.1 General

4.4.1.1 *Categories of messages.* Subject to the provisions of 3.3, the following categories of message shall be handled by the aeronautical fixed telecommunication network:

a) distress messages;

b) urgency messages;

c) flight safety messages;

d) meteorological messages;

e) flight regularity messages;

f) aeronautical information services (AIS) messages;

g) aeronautical administrative messages;

h) service messages.

4.4.1.1.1 *Distress messages (priority indicator SS).* This message category shall comprise those messages sent by mobile stations reporting that they are threatened by grave and imminent danger and all other messages relative to the immediate assistance required by the mobile station in distress.

4.4.1.1.2 *Urgency messages (priority indicator DD).* This category shall comprise messages concerning the safety of a ship, aircraft or other vehicles, or of some person on board or within sight.

4.4.1.1.3 Flight safety messages (priority indicator FF) shall comprise:

a) movement and control messages as defined in PANS-RAC (Doc 4444), Part VIII;

b) messages originated by an aircraft operating agency of immediate concern to aircraft in flight or preparing to depart;

c) meteorological messages restricted to SIGMET information, special air-reports and amended forecasts.

4.4.1.1.4 Meteorological messages (priority indicator GG) shall comprise:

a) messages concerning forecasts, e.g. terminal aerodrome forecasts (TAFs), area and route forecasts;

b) messages concerning observations and reports, e.g. METAR, SPECI.

4.4.1.1.5 Flight regularity messages (priority indicator GG) shall comprise:

a) aircraft load messages required for weight and balance computation;

b) messages concerning changes in aircraft operating schedules;

c) messages concerning aircraft servicing;

d) messages concerning changes in collective requirements for passengers, crew and cargo covered by deviation from normal operating schedules;

e) messages concerning non-routine landings;

f) messages concerning pre-flight arrangements for air navigation services and operational servicing for non-scheduled aircraft operations, e.g. overflight clearance requests;

g) messages originated by aircraft operating agencies reporting an aircraft arrival or departure;

h) messages concerning parts and materials urgently required for the operation of aircraft.

4.4.1.1.6 Aeronautical information services (AIS) messages (priority indicator GG) shall comprise:

a) messages concerning NOTAMs;

b) messages concerning SNOWTAMs.

4.4.1.1.7 Aeronautical administrative messages (priority indicator KK) shall comprise:

a) messages regarding the operation or maintenance of facilities provided for the safety or regularity of aircraft operations;

b) messages concerning the functioning of aeronautical telecommunication services;

c) messages exchanged between civil aviation authorities relating to aeronautical services.

4.4.1.1.8 Messages requesting information shall take the same priority indicator as the category of message being requested except where a higher priority is warranted for flight safety.

4.4.1.1.9 *Service messages (priority indicator as appropriate).* This category shall comprise messages originated by aeronautical fixed stations to obtain information or verification concerning other messages which appear to have been transmitted incorrectly by the aeronautical fixed service, confirming channel-sequence numbers, etc.

4.4.1.1.9.1 Service messages shall be prepared in the format prescribed in 4.4.2 or 4.4.16. In applying the provisions of 4.4.3.1.2 or 4.4.16.2.1.3 to service messages addressed to an aeronautical fixed station identified only by a location indicator, this indicator shall be immediately followed by the ICAO three-letter designator YFY, followed by an appropriate 8th letter.

4.4.1.1.9.2 Service messages shall be assigned the appropriate priority indicator.

4.4.1.1.9.2.1 **Recommendation.—** *When service messages refer to messages previously transmitted, the priority indicator assigned should be that used for the message(s) to which they refer.*

4.4.1.1.9.3 Service messages correcting errors in transmission shall be addressed to all the addressees that will have received the incorrect transmission.

4.4.1.1.9.4 A reply to a service message shall be addressed to the station which originated the initial service message.

4.4.1.1.9.5 **Recommendation.—** *The text of all service messages should be as concise as possible.*

4.4.1.1.9.6 A service message, other than one acknowledging receipt of SS messages, shall be further identified by the use of the abbreviation SVC as the first item in the text.

4.4.1.1.9.7 When a service message refers to a message previously handled, reference to the previous message shall be made by use of the appropriate transmission identification (see 4.4.2.1.1 b) and 4.4.16.1.1 b)) or the filing time and originator indicator groups (see 4.4.4 and 4.4.16.2.2) identifying the reference message.

4.4.1.2 *Order of priority*

4.4.1.2.1 The order of priority for the transmission of messages in the aeronautical fixed telecommunication network shall be as follows:

Transmission priority	*Priority indicator*
1	SS
2	DD FF
3	GG KK

4.4.1.2.2 **Recommendation.—** *Messages having the same priority indicator should be transmitted in the order in which they are received for transmission.*

4.4.1.3 *Routing of messages*

4.4.1.3.1 All communications shall be routed by the most expeditious route available to effect delivery to the addressee.

4.4.1.3.2 Predetermined diversion routing arrangements shall be made, when necessary, to expedite the movement of communication traffic. Each communication centre shall have the appropriate diversion routing lists, agreed to by the Administration(s) operating the communication centres affected and shall use them when necessary.

4.4.1.3.2.1 **Recommendation.—** *Diversion routing should be initiated:*

1) in a fully automatic communication centre:

a) immediately after detection of the circuit outage, when the traffic is to be diverted via a fully automatic communication centre;

b) within a 10-minute period after detection of the circuit outage, when the traffic is to be diverted via a non-fully automatic communication centre;

2) in a non-fully automatic communication centre within a 10-minute period after detection of the circuit outage.

Service message notification of the diversion requirement should be provided where no bilateral or multilateral pre-arranged agreements exist.

4.4.1.3.3 As soon as it is apparent that it will be impossible to dispose of traffic over the aeronautical fixed service within a reasonable period, and when the traffic is held at the station where it was filed, the originator shall be consulted regarding further action to be taken, unless:

a) otherwise agreed between the station concerned and the originator; or

b) arrangements exist whereby delayed traffic is automatically diverted to commercial telecommunication services without reference to the originator.

Note.— The expression "reasonable period" means a period of time such that it seems probable that the traffic will not be delivered to the addressee within any fixed transit period applicable to the category of traffic concerned, or, alternatively, any predetermined period agreed between originators and the telecommunication station concerned.

4.4.1.4 *Supervision of message traffic*

4.4.1.4.1 *Continuity of message traffic.* The receiving station shall check the transmission identification of incoming transmissions to ensure the correct sequence of channel-sequence numbers of all messages received over that channel.

4.4.1.4.1.1 When the receiving station detects that one or more channel-sequence numbers are missing, it shall send a complete service message (see 4.4.1.1.9) to the previous station rejecting receipt of any message that may have been transmitted with such missing number(s). The text of this service message shall comprise the signal QTA, the procedure signal MIS followed by one or more missing transmission identification (see 4.4.2.1.1.3 and 4.4.16.1.1.4) and the end-of-text signal (see 4.4.5.6 and 4.4.16.3.12).

Note.— The following examples illustrate application of the above-mentioned procedure. In example 2) the hyphen (-) separator is understood to mean "through" in plain language.

1) when one channel-sequence number is missing:

SVC→QTA→MIS→ABC↑123↓<≡

2) when several channel-sequence numbers are missing:

SVC→QTA→MIS→ABC↑123-126↓<≡

4.4.1.4.1.1.1 When the provisions of 4.4.1.4.1.1 are applied, the station notified of the missing message(s) condition by the service message shall reassume its responsibility for transmission of the message (or messages) that it had previously transmitted with the transmission identification concerned, and shall retransmit that message (or those messages) with a new (correct in sequence) transmission identification. The receiving station shall synchronize such that the next expected channel-sequence number is the last received channel-sequence number plus one.

4.4.1.4.1.2 **Recommendation.—** *When the receiving station detects that a message has a channel sequence number less than that expected, it should advise the previous station using a service message with a text comprising:*

1) the abbreviation SVC;

2) the procedure signal LR followed by the transmission identification of the received message;

3) the procedure signal EXP followed by the transmission identification expected;

4) the end-of-text signal.

Note.— The following example illustrates application of the above-mentioned procedure:

SVC→LR→ABC↑123→↓EXP→ABC↑135↓<≡

4.4.1.4.1.2.1 **Recommendation.—** *When the provisions of 4.4.1.4.1.2 are applied, the station receiving the out-of-*

sequence message should synchronize such that the next expected channel-sequence number is the last received channel-sequence number plus one. The previous station should check its outgoing channel-sequence numbers and, if necessary, correct the sequence.

4.4.1.4.2 *Misrouted messages*

Note.— A message is considered to have been misrouted when it contains no relaying instructions, expressed or implied, on which the receiving station can take action.

4.4.1.4.2.1 When the receiving station detects that a message has been misrouted to it, it shall either:

1) send a service message (see 4.4.1.1.9) to the previous station rejecting receipt of the misrouted message; or

2) itself assume responsibility for transmission of the message to all addressee indicators.

Note.— The procedure of 1) is preferable at stations using "torn-tape" relay methods or a semi-automatic relay technique with continuous tape. The procedure of 2) may be preferred at stations using fully automatic relay methods or a semi-automatic relay technique without continuous tape.

4.4.1.4.2.2 When the provisions of 4.4.1.4.2.1, 1) are applied, the text of the service message shall comprise the abbreviation SVC, the signal QTA, the procedure signal MSR followed by the transmission identification (see 4.4.2.1.1.3 and 4.4.16.1.1.4) of the misrouted message and the end-of-text signal (see 4.4.5.6 and 4.4.16.3.12).

Note.— The following example illustrates application of the above-mentioned procedure:

SVC→QTA→MSR→ABC↑123↓<≡

4.4.1.4.2.3 When, as a result of the provisions of 4.4.1.4.2.2, a sending station is notified of the misrouted message condition by service message, it shall reassume its responsibility for the message and shall retransmit as necessary on the correct outgoing channel or channels.

4.4.1.4.3 When a circuit becomes interrupted and alternative facilities exist, the last channel-sequence numbers sent and received shall be exchanged between the stations concerned. Such exchanges shall take the form of complete service messages (see 4.4.1.1.9) with the text comprising the abbreviation SVC, the procedure signals LR and LS followed by the transmission identifications of the relevant messages and the end-of-text signal (see 4.4.5.6 and 4.4.16.3.12).

Note.— The following example illustrates application of the above-mentioned procedure:

SVC→LR→ABC↑123↓→LS→BAC↑321↓<≡

4.4.1.5 *Failure of communications*

4.4.1.5.1 Should communication on any fixed service circuit fail, the station concerned shall attempt to re-establish contact as soon as possible.

4.4.1.5.2 **Recommendation.—** *If contact cannot be re-established within a reasonable period on the normal fixed service circuit, an appropriate alternative circuit should be used. If possible, attempts should be made to establish communication on any authorized fixed service circuit available.*

4.4.1.5.2.1 If these attempts fail, use of any available air- ground frequency shall be permitted only as an exceptional and temporary measure when no interference to aircraft in flight is ensured.

4.4.1.5.2.2 Where a radio circuit fails due to signal fade-out or adverse propagation conditions, a receiving watch shall be maintained on the regular fixed service frequency normally in use. In order to re-establish contact on this frequency as soon as possible there shall be transmitted:

a) the procedure signal DE;

b) the identification of the transmitting station transmitted three times;

c) the alignment function [<≡];

d) the letters RY repeated without separation for three lines of page copy;

e) the alignment function [<≡];

f) end-of-message signal (NNNN).

The foregoing sequence shall be repeated as required.

4.4.1.5.2.3 A station experiencing a circuit or equipment failure shall promptly notify other stations with which it is in direct communication if the failure will affect traffic routing by those stations. Restoration to normal shall also be notified to the same stations.

4.4.1.5.3 Where diverted traffic will not be accepted automatically or where a predetermined diversion routing has not been agreed, a temporary diversion routing shall be established by the exchange of service messages. The text of such service messages shall comprise:

1) the abbreviation SVC;

2) the procedure signal QSP;

3) if required, the procedure signal RQ, NO or CNL to request, refuse or cancel a diversion;

4) identification of the routing areas, States, territories, locations, or stations for which the diversion applies;

5) the end-of-text signal.

Note.— The following examples illustrate application of the above-mentioned procedures:

a) to request a diversion:

SVC→QSP→RQ→C→K→BG→BI↓<≡

b) to accept a diversion:

SVC→QSP→C→K→BG→BI↓<≡

c) to refuse a diversion:

SVC→QSP→NO→C→K→BG→BI↓<≡

d) to cancel a diversion:

SVC→QSP→CNL→C→K→BG→BI↓<≡

4.4.1.6 *Long-term retention of AFTN traffic records*

4.4.1.6.1 Copies of all messages, in their entirety, transmitted by an AFTN origin station shall be retained for a period of at least 30 days.

Note.— The AFTN origin station, although responsible for ensuring that AFTN traffic is recorded, is not necessarily the unit where the records are made and retained. By local agreement the State concerned may permit the originators to perform those functions.

4.4.1.6.2 AFTN destination stations shall retain, for a period of at least 30 days, a record containing the information necessary to identify all messages received and the action taken thereon.

Note.— The provision for identification of messages mentioned in 4.4.1.6.2 may be obtained by recording the heading, address and origin parts of messages.

4.4.1.6.3 **Recommendation.—** *AFTN communication centres should retain, for a period of at least 30 days, a record containing the information necessary to identify all messages relayed or retransmitted and the action taken thereon.*

Note 1.— The provision for identification of messages mentioned in 4.4.1.6.3 may be obtained by recording the heading, address and origin parts of messages.

Note 2.— Provisions relating to short-term retention of AFTN traffic records in AFTN communication centres are contained in 4.4.1.7.

4.4.1.7 *Short-term retention of AFTN traffic records*

4.4.1.7.1 Except as provided in 4.4.1.7.2, AFTN communication centres shall retain, for a period of at least one hour, a copy of all messages, in their entirety, retransmitted or relayed by that communication centre.

4.4.1.7.2 In cases where acknowledgement is made between AFTN communication centres, a relay centre shall be considered as having no further responsibility for retransmission or repetition of a message for which it has received positive acknowledgement, and it may be deleted from its records.

Note.— Provisions relating to long-term retention of AFTN traffic records in AFTN communication centres are contained in 4.4.1.6.

4.4.1.8 *Test procedures on AFTN channels*

4.4.1.8.1 **Recommendation.—** *Test messages transmitted on AFTN channels for the purpose of testing and repairing lines should consist of the following:*

1) the start-of-message signal;

2) the procedure signal QJH;

3) the originator indicator;

*4) three page-copy lines of the sequence of characters RY in ITA-2 or U(5/5) *(2/10) in IA-5; and*

5) the end-of-message signal.

4.4.2 Message format — International Telegraph Alphabet No. 2 (ITA-2)

All messages, other than those prescribed in 4.4.1.8 and 4.4.9.3, shall comprise the components specified in 4.4.2.1 to 4.4.6.1 inclusive.

Note 1.— An illustration of the ITA-2 message format is given in Figure 4-1.

Note 2.— In the subsequent Standards relative to message format the following symbols have been used in making reference to the functions assigned to certain signals in the International Telegraph Alphabet No. 2 (see Volume I, Part I, 4.2.1):

Message part		*Component of the message part*	*Element of the component*	*Teletypewriter signal*
HEADING (see 4.4.2.1)		Start-of-Message Signal	—	**ZCZC**
		Transmission Identification	a) One SPACE b) Transmitting-terminal letter c) Receiving-terminal letter d) Channel-Identification letter e) One FIGURE SHIFT f) Channel-sequence number (3 digits) (*Example:* **NRA062**)	→···↑···
		(*If necessary*) Additional Service Indication	a) One SPACE b) No more than 10 characters (*Example:* **270930**)	
		Spacing Signal	Five SPACES One LETTER SHIFT	→→→→→↓
ADDRESS (see 4.4.3)	THE PERMANENT PART OF A MESSAGE	Alignment Function	One CARRIAGE RETURN, one LINE FEED	<≡
		Priority Indicator	The relevant 2-letter group	··
		Addressee Indicator(s)	One SPACE An 8-letter group given in sequence for each address (*Example:* → **EGLLZRZX**→**EDLLYKYX**→**EGLLACAM**)	
		Alignment Function(s)	One CARRIAGE RETURN, one LINE FEED	<≡
ORIGIN (see 4.4.4)		Filing Time	One FIGURE SHIFT The 6-digit date-time group specifying when the message was filed for transmission One LETTER SHIFT	↑ ······ ↓
		Originator Indicator	One SPACE The 8-letter group identifying the message originator	→······
		Priority Alarm (*used only in teletypewriter operation for Distress Messages, Distress Traffic and Urgency Messages*)	One FIGURE SHIFT Five Signal No. 10 of Telegraph Alphabet No. 2 One LETTER SHIFT	↑ Attention Signal(s) ↓
		Alignment Function	One CARRIAGE RETURN, one LINE FEED	<≡
TEXT (*see* 4.4.5)		Beginning of the Text	Specific identification of Addressee(s) (if necessary) *with* each followed by one CARRIAGE RETURN, one LINE FEED (*if necessary*) The English word FROM (*if necessary*) (see 4.4.5.2.3) Specific identification of Originator (*if necessary*) The English word STOP followed by one CARRIAGE RETURN, one LINE FEED (*if necessary*)(*see* 4.4.5.2.3); *and/or* Originator's reference (*if used*)	
		Message Text	Message Text with one CARRIAGE RETURN, one LINE FEED at the end of each printed line of the Text except for the last one (see 4.4.5.3)	
		Confirmation (*if necessary*)	a) One CARRIAGE RETURN, one LINE FEED b) The abbreviation CFM followed by the portion of the Text being confirmed	
		Correction (*if necessary*)	a) One CARRIAGE RETURN, one LINE FEED b) The abbreviation COR followed by the correction of an error made in the preceding Text	
		End-of-Text Signal	a) One LETTER SHIFT b) One CARRIAGE RETURN, one LINE FEED	↓<≡
ENDING (see 4.4.6)		Page-Feed Sequence	Seven LINE FEEDS	═══════
		End-of-Message Signal	Four of the letter case of N (Signal No. 14)	NNNN
		Message-Separation Signal (*used only on message traffic transmitted to a "torn-tape" station*)	Twelve LETTER SHIFTS	↓↓↓↓↓↓↓↓↓↓↓↓
		Tape Feed (see 4.4.7)	Additional LETTER SHIFTS will appear at this point in instances where prior arrangements have been made for tape-feed transmissions to be employed on an incoming circuit (see 4.4.7).	

Legend: ↑ FIGURE SHIFT (*Signal No. 30*) ≡ LINE FEED (*Signal No. 28*) ↓ LETTER SHIFT (*Signal No. 29*)
→ SPACE (*Signal No. 31*) < CARRIAGE RETURN (*Signal No. 27*)

Figure 4-1. Message format ITA-2

(the above illustrates the teletypewriter message format prescribed in 4.4.2 to 4.4.9.1 inclusive)

9/11/95

Symbol	*Signification*
<	CARRIAGE RETURN *(signal no. 27)*
≡	LINE FEED *(signal no. 28)*
↓	LETTER SHIFT *(signal no. 29)*
↑	FIGURE SHIFT *(signal no. 30)*
→	SPACE *(signal no. 31)*

4.4.2.1 *Heading*

4.4.2.1.1 The heading shall comprise:

a) start-of-message signal, the characters ZCZC;

b) transmission identification comprising:

1) circuit identification;

2) channel-sequence number.

c) additional service information (if necessary) comprising:

1) one SPACE;

2) no more than ten characters.

d) spacing signal.

4.4.2.1.1.1 The circuit identification shall consist of three letters selected and assigned by the transmitting station; the first letter identifying the transmitting, the second letter the receiving end of the circuit and the third letter to identify the channel; where there is only one channel between the transmitting and receiving stations, channel letter A shall be assigned; where more than one channel between stations is provided, the channels shall be identified as A, B, C, etc. in respective order.

4.4.2.1.1.2 Three-digit channel-sequence numbers from 001 to 000 (representing 1 000) shall be assigned sequentially by telecommunication stations to all messages transmitted directly from one station to another. A separate series of these numbers shall be assigned for each channel and a new series shall be started daily at 0000 hours.

4.4.2.1.1.2.1 **Recommendation.**— *The use of the 4-digit channel-sequence number, to preclude duplication of the same numbers during the 24-hour period, is permitted subject to agreement between the authorities responsible for the operation of the circuit.*

4.4.2.1.1.3 The transmission identification shall be sent over the circuit in the following sequence:

1) *Morse:*

a) transmitting-terminal letter;

b) receiving-terminal letter;

c) channel-identification letter;

d) channel-sequence number (3 digits).

2) *teletypewriter:*

a) SPACE [→];

b) transmitting-terminal letter;

c) receiving-terminal letter;

d) channel-identification letter;

e) FIGURE SHIFT [↑];

f) channel-sequence number (3 digits).

4.4.2.1.2 In teletypewriter operation, the spacing signal, consisting of 5 SPACES [→→→→→) followed by 1 LETTER SHIFT [↓], shall be transmitted immediately following the transmission identification prescribed in 4.4.2.1.1.3, 2).

Note.— The examples appearing below illustrate the application of the transmission identification Standard (see *4.4.2.1.1 b) and 4.4.2.1.1.3):*

Tape	*Page-copy*
→GLB↑039→→→→→↓	GLB039

(This indicates the 39th message of the day transmitted on Channel B of the circuit from Station G to Station L.)

4.4.2.1.3 Optional service information shall be permitted to be inserted following the transmission identification subject to agreement between the authorities responsible for the operation of the circuit. Such additional service information shall be preceded by a SPACE followed by not more than ten characters and shall not contain any alignment functions.

4.4.2.1.4 **Recommendation.**— *To avoid any misinterpretation of the diversion indicator especially when considering the possibility of a partly mutilated heading, the sequence of two consecutive signals no. 22 (in the letter case or in the figure case) should not appear in any other component of the heading.*

4.4.3 Address

4.4.3.1 The address shall comprise:

a) alignment function [<≡];

b) priority indicator;

c) addressee indicator(s);

d) alignment function [<≡].

4.4.3.1.1 The priority indicator shall consist of the appropriate two-letter group assigned by the originator in accordance with the following:

Message category	*Priority indicator*
distress messages (*see* 4.4.1.1.1)	SS
urgency messages (*see* 4.4.1.1.2)	DD
flight safety messages (*see* 4.4.1.1.3)	FF
meteorological messages (*see* 4.4.1.1.4)	GG
flight regularity messages (*see* 4.4.1.1.5)	GG
aeronautical information services messages (*see* 4.4.1.1.6)	GG
aeronautical administrative messages (*see* 4.4.1.1.7)	KK
service messages (*see* 4.4.1.1.9)	*(as appropriate)*

4.4.3.1.2 An addressee indicator, which shall be immediately preceded by a SPACE, except when it is the first address indicator of the second or third line of address shall comprise:

a) the four-letter location indicator of the place of destination;

b) the three-letter designator identifying the organization/function (aeronautical authority, service or aircraft operating agency) addressed;

c) an additional letter, which shall represent a department, division or process within the organization/function addressed. The letter X shall be used to complete the address when explicit identification is not required.

Note 1.— The four-letter location indicators are listed in Doc 7910 — Location Indicators.

Note 2.— The three-letter designators are listed in Doc 8585 — Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services.

4.4.3.1.2.1 Where a message is to be addressed to an organization that has not been allocated an ICAO three-letter designator of the type prescribed in 4.4.3.1.2, the location indicator of the place of destination shall be followed by the ICAO three-letter designator YYY (or the ICAO three-letter designator YXY in the case of a military service or organization). The name of the addressee organization shall then be included in the first item of the text of the message. The eighth position letter following the ICAO three-letter designator YYY or YXY shall be the filler letter X.

4.4.3.1.2.2 Where a message is to be addressed to an aircraft in flight and, therefore, requires handling over the AFTN for part of its routing before retransmission over the aeronautical mobile service, the location indicator of the aeronautical station which is to relay the message to the aircraft shall be followed by the ICAO three-letter designator ZZZ. The identification of the aircraft shall then be included in the first item of the text of the message. The eighth position letter following the ICAO three-letter designator ZZZ shall be the filler letter X.

Note.— The following examples illustrate application of the Standards in 4.4.3.1.2.1 and 4.4.3.1.2.2:

1) addressee indicators (possible types):

LGATZTZX	*aerodrome control tower (ZTZ) at LGAT*
LGATYMYF	*section (F) of the Meteorological Office (YMY) at LGAT*
LGATKLMN	*department (N) of the aircraft operating agency KLM (KLM) at LGAT*
LGATYYYX	*the aircraft operating agency whose name appears in the beginning of the message text and whose office location is served by LGAT*
LGATZZZX	*the aeronautical station (LGAT) is required to relay this message in the aeronautical mobile service to the aircraft whose identification appears in the beginning of the message text.*

2) YYY ICAO three-letter designator:

Example of a message addressed to (say) "Penguin Airlines" at NCRG by the PHNL office of the same aircraft operating agency. The Heading and Ending of the message are not shown in this example of teletypewriter page-copy form.

(Address)	*GG NCRGYYYX*
(Origin)	*311521 PHNLYYYX*
(Text)	*AIR PENGUIN FLIGHT 801 CANCELLED*

3) *ZZZ ICAO three-letter designator:*

Example of a message addressed to aircraft GABCD via aeronautical station NZAA from Area Control Centre at NZZC. The Heading and Ending of the message are not shown in this example of teletypewriter page-copy form.

(Address)	*FF NZAAZZZX*
(Origin)	*031451 NZZCZQZX*
(Text)	*GABCD CLR DES 5000FT HK NDB*

4.4.3.1.2.3 The complete address shall be restricted to three lines of page-printing copy and, except as provided in 4.4.15, a separate addressee indicator shall be used for each addressee whether at the same or at different locations.

4.4.3.1.2.3.1 Where messages are offered in page-copy form for transmission and contain more addressee indicators than can be accommodated on three lines of a page-copy, such message shall be converted, before transmission, into two or more messages, each of which shall conform with the provisions of 4.4.3.1.2.3. During such conversion, the addressee indicators shall, in so far as practicable, be positioned in the sequence which will ensure that the minimum number of retransmissions will be required at subsequent communication centres.

4.4.3.1.2.3.2 On teletypewriter circuits, the completion of each line of addressee indicator groups in the address of a message shall be immediately followed by the alignment function [<≡].

4.4.4 Origin

The origin shall comprise:

a) filing time;

b) originator indicator;

c) priority alarm (when necessary);

d) optional heading field;

e) alignment function [<≡].

4.4.4.1 The filing time shall comprise the 6-digit date-time group indicating the date and time of filing the message for transmission (*see* 3.4.2); in teletypewriter operation, the filing time shall be followed by one LETTER SHIFT [↓].

4.4.4.2 An originator indicator, which shall be immediately preceded by a SPACE, shall comprise:

a) the four-letter location indicator of the place at which the message is originated;

b) the three-letter designator identifying the organization/function (aeronautical authority, service or aircraft operating agency) which originated the message;

c) an additional letter which shall represent a department, division or process within the organization/function of the originator. The letter X shall be used to complete the address when explicit identification is not required.

4.4.4.2.1 Where a message is originated by an organization that has not been allocated an ICAO three-letter designator of the type prescribed in 4.4.4.2 b), the location indicator of the place at which the message is originated shall be followed immediately by the ICAO three-letter designator YYY followed by the filler letter X (or the ICAO three-letter designator YXY followed by the filler letter X in the case of a military service or organization). The name of the organization (or military service) shall then be included in the first item in the text of the message.

4.4.4.2.2 Where a message originated by an aircraft in flight requires handling on the AFTN for part of its routing before delivery, the originator indicator shall comprise the location indicator of the aeronautical station responsible for transferring the message to the AFTN, followed immediately by the ICAO three-letter designator ZZZ followed by the filler letter X. The identification of the aircraft shall then be included in the first item in the text of the message.

Note.— The following illustrates the application of 4.4.4.2.2 procedure as it would appear with a message from aircraft KLM153 addressed to the Area Control Centre at CZEG, the message being handled via aeronautical station CYCB. The heading and ending of the message are not shown in this example of teletypewriter page-copy form:

(Address)	*FF CZEGZRZX*
(Origin)	*031821 CYCBZZZX*
(Text)	*KLM153 [remainder of text as received from aircraft]*

4.4.4.3 The priority alarm shall be used only for distress messages, distress traffic and urgency messages. When used, it shall consist of the following, in the order stated:

a) FIGURE SHIFT [↑];

b) FIVE transmissions of signal no. 10 (figure case);

c) LETTER SHIFT [↓].

Note 1.— The figure case of signal no. 10 of the International Telegraph Alphabet No. 2 generally corresponds to the figure case of J of teletypewriter equipment in use on aeronautical fixed service circuits.

Note 2.— Use of the priority alarm will actuate a bell (attention) signal at the receiving teletypewriter station, other than at those fully automatic stations which may provide a similar alarm on receipt of priority indicator SS, thereby alerting supervisory personnel at relay centres and operators at tributary stations, so that immediate attentlon may be given to the message.

4.4.4.4 The inclusion of optional data in the origin line shall be permitted provided a total of 69 characters is not exceeded and subject to agreement between the authorities concerned.

4.4.4.5 The origin line shall be concluded by an alignment function [<≡].

4.4.5 Text

4.4.5.1 The text of messages shall be drafted in accordance with 4.1.2.

4.4.5.2 When an originator's reference is used, it shall appear at the beginning of the text, except as provided in 4.4.5.2.1 and 4.4.5.2.2.

4.4.5.2.1 When the ICAO three-letter designators YXY, YYY or ZZZ comprise the second element of the addressee indicator (*see* 4.4.3.1.2.1 and 4.4.3.1.2.2) and it, therefore, becomes necessary to identify in the text the specific addressee of the message, such identification group will precede the originator's reference (if used) and become the first item of the text.

4.4.5.2.2 When the ICAO three-letter designators YXY, YYY or ZZZ comprise the second element of the originator indicator (*see* 4.4.4.2.1 and 4.4.4.2.2) and it thus becomes necessary to identify in the text the name of the organization (or military service), or the aircraft, which originated the message, such identification shall be inserted in the first item of the text of the message.

4.4.5.2.3 When applying the provisions of 4.4.5.2.1 and 4.4.5.2.2 to messages where the ICAO three-letter designator(s) YXY, YYY or ZZZ is (are) used to refer to two or more different organizations (or military services), the sequence of further identification in the text shall correspond to the complete sequence used in the address and origin of the message. In such instance, each addressee identification shall be followed immediately by an alignment function. The name of the (YXY, YYY or ZZZ) organization originating the message shall then be preceded with "FROM". "STOP" followed by an alignment function shall then be included in the text at the end of these identifications to precede the remainder of the text wording.

4.4.5.3 An alignment function [<≡] shall be transmitted at the end of each printed line of the text except for the last (*see* 4.4.5.6).

4.4.5.4 Except as provided in 4.4.14.1.1 b), when it is desired to confirm a portion of the text of a message in teletypewriter operation, such confirmation shall be separated from the last text group by an alignment function [<≡], and shall be indicated by the abbreviation CFM followed by the portion being confirmed.

4.4.5.5 Except as provided in 4.4.14.1.1 b), when it is discovered that an error has been made in the text, the correction shall be separated from the last text group or confirmation, if any, by an alignment function [<≡] in the case of teletypewriter circuits. This shall be followed by the abbreviation COR and the correction.

4.4.5.5.1 Stations shall make all indicated corrections on the page-copy prior to local delivery.

4.4.5.6 At the end of the text the following end-of-text signal shall be transmitted:

1 LETTER SHIFT [↓], alignment function [<≡].

4.4.5.7 The text of the messages entered by the AFTN origin station shall not exceed 1 800 characters in length.

Note 1.— Where it is desired that a communication with a text exceeding 1 800 characters be transmitted over the aeronautical fixed telecommunication network, 4.4.5.7 requires that such a communication be entered by the AFTN origin station in the form of separate messages, each text of which does not exceed 1 800 characters. Guidance material for forming separate messages from a single long message is given in Attachment D to Volume II.

Note 2.— The character count includes all printing and non-printing characters in the message from, but not including, the alignment function preceding the beginning of the text to, but not including, the end-of-text signal.

4.4.6 Ending

4.4.6.1 The ending shall comprise:

a) the page-feed sequence consisting of 7 LINE FEEDS [≡≡≡≡≡≡≡];

Note.— This, together with the 1 LINE FEED of the preceding alignment function will provide sufficient separation between messages when appearing in page-copy form.

b) the end-of-message signal, consisting of the letter N (letter case of signal no. 14), appearing FOUR times in undivided sequence.

Note.— This component, transmitted intact from the moment of the first transmission of the message until ultimate delivery, is required so that connections set up for cross-office transmission, at a semi-automatic or fully automatic relay installation, can be cleared for following message traffic.

And in addition, on message traffic transmitted to "torn-tape" relay stations only:

c) the message-separation signal, consisting of a LETTER SHIFT [↓] transmitted 12 times in uninterrupted sequence.

Note 1.— Nothing but letter shifts are to be transmitted in message traffic between the end-of-message signal of one message and the start-of-message signal of the next.

Note 2.— The following illustrates the procedures specified in 4.4.2 to 4.4.6.1 inclusive for a message in page-copy form:

(Heading)	**ZCZC LPA183*
(Address)	*GG LGGGZRZX LGATKLMW*
(Origin)	*201838 EGLLKLMW*
(Text)	*As required*
(Ending)	*(Page feed)*
	*NNNN***

**Note 2A.— If this message had been one of a series and there had been no manual paper-feed action between messages by the operator attending the receiving page teletypewriter, the "NNNN" of the preceding message would have appeared here.*

***Note 2B.— In the circumstances described in Note 2A, the heading of the next message received would be printed on page-copy at this position.*

Note 2C.— In actual station practice, messages would be separated on page-copy by tearing through the page-feed sequence. The end-of-message signal would then appear to have become a component part of the next message. This apparent misplacement is, however, unlikely to give rise to any misunderstanding on the part of communicators or addressees since, in practice, the end-of-message signal has no significance on page-copy.

4.4.6.2 AFTN messages entered by the AFTN origin station shall not exceed 2 100 characters in length.

Note.— The character count includes all printing and non-printing characters in the message from and including the start-of-message signal (ZCZC) to and including the end-of-message signal (NNNN).

4.4.7 Tape feed

4.4.7.1 **Recommendation.—** *In "torn-tape" installations, and in "semi-automatic" installations using continuous tape technique, when signals additional to those prescribed in 4.4.6.1 are required to ensure that the tape is adequately advanced from the reperforator at the receiving stations, when the ending of one message is not followed immediately by the start-of-message signal of another message, local arrangements should be made at the receiving station to avoid the need for transmission of these signals by the transmitting station.*

Note.— In "torn-tape" stations, a facility is normally necessary whereby the tape can be fed from the receiving reperforator to an extent that permits the receiving operator to tear through the message-separation signal at the correct point, on occasions when the operator is ready to tear the tape but there has been no following message to cause this tape-feed to take place. In semi-automatic stations using continuous-tape techniques, a similar process may be necessary in similar circumstances to advance the tape to an extent that permits the end-of-message signal to reach the transmitter.

4.4.7.1.1 When the provisions of 4.4.7.1 cannot be applied, arrangements shall be made with the transmitting station for the latter to send, at the end of a single message, or following the last message of a series, an agreed number of LETTER SHIFTS [↓] in addition to the components prescribed in 4.4.6.

4.4.8 Stripped address

4.4.8.1 When applying the provisions of 4.4.3 or 4.4.16.2.1, an AFTN communication centre shall omit from the address all the addressee indicators not required for:

a) onward transmission by the AFTN communication centre to which the message is transmitted;

b) local delivery to the addressee(s) by the AFTN destination station;

c) onward transmission or local delivery by the aggregate of stations on a multi-point circuit.

Note.— Guidance material relative to address stripping procedures on non-CIDIN links is contained in Attachment C.

4.4.9 Teletypewriter operating procedure — general

4.4.9.1 *End-of-line functions*

4.4.9.1.1 A single line of page-copy shall not contain more than a total of 69 characters and/or spaces.

4.4.9.1.2 One CARRIAGE RETURN [<] and one LINE FEED IMPULSES [≡] shall be transmitted between each printed page-line of the text of a message.

4.4.9.2 *Duration of transmissions.* For simplex circuits, the transmission of a series of messages in a single transmission shall not continue for longer than approximately five minutes. Action shall be taken to deliver or relay each message correctly received without waiting for the end of the series.

4.4.9.3 *Channel-check transmissions.* Except as provided in 4.4.9.3.3 and 4.4.9.3.5 the following periodic transmissions shall be sent on teletypewriter circuits:

1) heading (*see* 4.4.2.1.1);

2) alignment function [<≡];

3) the procedure signal CH;

4) alignment function [<≡];

5) end-of-message signal [NNNN];

6) message-separation signal [↓↓↓↓↓↓↓↓↓↓↓↓] (if required).

The receiving station shall then check the transmission identification of this incoming transmission to ensure its correct sequence in respect of all messages received over that incoming channel.

Note.— Application of this procedure provides some measure of assurance that channel continuity is maintained.

4.4.9.3.1 **Recommendation.—** *Where a circuit is unoccupied, the transmission specified in 4.4.9.3 should be sent at H + 00, H + 20, H + 40.*

4.4.9.3.2 If a periodic channel check transmission is not received within a tolerance agreed for that channel, a station shall send a service message to the station from which the transmission was expected. The text of this service message shall comprise:

1) the abbreviation SVC;

2) the procedure signal MIS;

3) the procedure signal CH;

4) (optionally) the time at which the transmission was expected;

5) the procedure signal LR;

6) the transmission identification of the last message received;

7) the end-of-text signal.

Note.— The following example illustrates application of the above-mentioned procedure:

SVC→MIS→CH→[↑1220↓→]LR→ABC↑123↓<≡

4.4.9.3.3 When a teletypewriter channel is equipped with a system of controlled circuit protocol, and following agreement between the Administrations responsible, the transmission specified in 4.4.9.3 shall not be made.

Note.— Guidance material on systems of continuous check of channel condition and ITA-2 controlled circuit protocols are contained in Volume I, Attachment D to Part I.

4.4.9.3.4 *Channel-check transmissions and station radio identifications.* In order to satisfy the requirements of ITU regarding periodic transmission of the station radio identification, those AFTN stations using radioteletypewriter channels may combine the station radio identification transmission with the channel-check transmission specified in 4.4.9.3. In this case the combined transmission shall be sent as follows:

1) heading (*see* 4.4.2.1.1);

2) alignment function [<≡];

3) the procedure signal CH;

4) alignment function [<≡];

5) the procedure signal DE followed by one SPACE [→] and the assigned ITU radio call sign;

6) alignment function [<≡];

7) end-of-message signal [NNNN];

8) message-separation signal [↓↓↓↓↓↓↓↓↓↓↓↓] (if required).

Note.— Application of this format will permit this special transmission to be handled by fully automatic switching centres without the intervention of supervisory personnel.

4.4.9.3.4.1 **Recommendation.—** *When multichannel radioteletypewriter circuits are used (e.g. MET and AFTN) the* *station radio call sign transmission should be sent on only one channel of the circuit. The channel chosen should be the one which is the most convenient for this purpose with the identification transmission being sent in conformance with the format used on that channel. When an AFTN channel is chosen the identification transmission should be combined with the channel-check transmission.*

4.4.9.3.5 When a teletypewriter circuit is associated with Automatic Error Corrrection (ARQ) equipment, and following agreement between the Administrations responsible, the transmissions specified in 4.4.9.3 need not be made: however stations employing radioteletypewriter channels on the AFTN for which the station radio identification is required, shall comply with the provisions of 4.4.9.3.4.

Note.— The foregoing is not to be interpreted as implying any ICAO requirement necessitating the installation of Automatic Error Correction (ARQ) equipment on international aeronautical fixed circuits.

4.4.10 Normal teletypewriter transmission procedures

4.4.10.1 Messages shall be transmitted in accordance with predetermined responsibility for onward relay as agreed between the Administrations responsible for the operation of directly connected stations (*see also* 4.4.1.3 and 4.4.1.5.2.3).

4.4.10.1.1 Arising from the responsibility agreements established under the provisions of 4.4.10.1, each station of the AFTN shall employ and, subject to the provisions of 4.4.10.1.1.1, adhere to a Routing Directory which consists of the Routing List.

4.4.10.1.1.1 When an incoming message contains only identical location indicators in the lines-following-the-heading the receiving station shall accept responsibility for further relay. If possible such relay shall be effected on the normal outgoing circuit to the place of destination of the message; if it is not possible to use the normal circuit, an appropriate alternative outgoing circuit shall be used. When neither of these facilities is in operation, the message shall not be retransmitted over the circuit from which it was received, without prior service message (*see* 4.4.1.1.9) notification of this action being given to the station that had made the previous transmission.

4.4.10.1.2 *Form of transmission — teletypewriter operation.* All transmissions shall comprise in the following order (*see* Figure 4-2).

4.4.10.1.2.1 *Starting pulse.* When the receiving station uses equipment fitted with a time-switch to stop the teletypewriter machine motor when the channel is idle, a 20-30 millisecond SPACING IMPULSE shall be transmitted when the channel has been at rest for 30 seconds or more and at least 1.5 seconds shall be permitted to elapse before the transmission of the heading.

Note 1.— This is equivalent to the transmission of a LETTER SHIFT [↓], followed by a pause (i.e. a continuous MARKING IMPULSE) of at least 1.37 seconds.

Note 2.— Application of this procedure will allow the receiving equipment to reach synchronization before transmission of the heading is commenced.

4.4.10.1.3 *Message format.* All messages shall be prepared in accordance with the provisions of 4.4.2 (ITA-2 format) or 4.4.16 (IA-5 format).

4.4.10.1.4 *Reprocessing procedures*

4.4.10.1.4.1 A message requiring retransmission shall have its previous heading deleted by the station which received such message for relay. The retransmission shall commence with the new heading using the transmission identification for the outgoing channel.

4.4.10.1.4.1.1 When applying the provisions of 4.4.10.1.4.1, transmission of the address part of the message shall commence at some point during the 5 SPACES, 1 LETTER SHIFT [→→→→→↓] immediately preceding the first alignment function [<≡].

4.4.10.1.4.1.2 At tributary and "torn-tape" relay stations not equipped with automatic numbering machine devices and hence where it is necessary for a small number of additional teletypewriter characters to be perforated on a tape before the start-of-message signal to preclude risk of mutilation of the latter signal during retransmission, such additional characters, as required, shall consist of LETTER SHIFTS [↓]. Subsequent transmission on the outgoing channel shall then commence at a point as close as practicable to the start-of-message signal.

STARTING PULSE *(if necessary)*	HEADING	ADDRESS	ORIGIN	TEXT	ENDING

Figure 4-2. Form of transmission — teletypewriter operation (see 4.4.10.1.2)

4.4.10.1.4.1.3 At stations where the heading of a message is originated by automatic equipment at the point of and time of transmission on the outgoing channel, but where preparation of the other parts of a message is by the perforation of a tape and where, therefore, it is necessary for a small number of additional teletypewriter characters to be perforated before the alignment function [<≡] at the commencement of the address so as to preclude risk of mutilation of this alignment function, such additional characters, as required, shall consist of LETTER SHIFTS [↓] or SPACES [→]. Subsequent transmission on the outgoing channel shall then commence at a point as close as practicable to the first alignment function [<≡] of the message.

4.4.10.1.4.2 At a "torn-tape" station the incoming tapes shall be torn at a position in the message-separation signal component (*see* 4.4.6.1 and 4.4.7.1) so that the preceding end-of-message signal remains intact.

4.4.10.1.4.2.1 Following application of the provisions of 4.4.10.1.4.2 the shortened (i.e. less than 12 LETTER SHIFTS [↓]) message-separation signal remaining on the message tape shall be deleted, if necessary by electronic methods, before retransmission to an automatic relay installation. If the retransmission is to another "torn-tape" station then:

1) the shortened message-separation signal shall be reformed to a complete [↓↓↓↓↓↓↓↓↓↓↓↓] signal by transmission of the necessary number of additional LETTER SHIFTS [↓]; or
2) the shortened message-separation signal remaining on the tape shall be removed and a new and complete message-separation signal shall be added to the message in the process of retransmission in accordance with the provisions of 4.4.6.1 c).

4.4.10.1.5 When possible in "torn-tape" or semi-automatic installations, a correct tape shall be obtained prior to onward relay; when tape is illegible or mutilated the station shall not relay the message unless good judgement indicates that this is not likely to result in malfunctioning of equipment at subsequent relay stations.

4.4.10.1.6 *Acknowledgement of receipt of messages.* In teletypewriter operation and except as provided in 4.4.10.1.6.1, a receiving station shall not transmit acknowledgement of receipt of incoming messages. In lieu thereof the provisions of 4.4.1.4.1 shall be applied.

4.4.10.1.6.1 The receipt of distress messages (priority SS — *see* 4.4.1.1.1) shall be individually acknowledged by the AFTN destination station sending a service message (*see* 4.4.1.1.9) to the AFTN origin station. Such acknowledgement of receipt shall take the format of a complete message addressed to the AFTN origin station, shall be assigned priority indicator SS and the associated priority alarm (*see* 4.4.4.3) and shall have a text comprising:

1) the procedure signal R;
2) the origin (*see* 4.4.4), without priority alarm, of the message being acknowledged;
3) the end-of-text signal [↓<≡].

Note.— The following example illustrates the application of 4.4.10.1.6.1 procedure:

Heading (see *4.4.2.1.1*)
<≡SS→LECBYFYX<≡
↑121322↓→ EGLLYFYX *(Priority Alarm)* <≡
R→↑121319↓→LECBZRZX↓<≡
Ending (see *4.4.6*)

4.4.10.1.7 In cases where an addressee of a multi-address message requests a repetition of the message from the origin station, the origin station shall address the repeat of the message only to the addressee requesting the repeat. Under these conditions the procedure signal DUPE shall not be included.

4.4.11 Action on mutilated messages detected in teletypewriter relay stations

4.4.11.1 If, before retransmission is commenced, a relay station detects that a message has been mutilated at some point ahead of the end-of-message signal, and it has reason to believe that this mutilation had occurred before the message had been received by the previous station, it shall send a service message (*see* 4.4.1.1.9) to the originator as identified by the originator indicator in the origin of the mutilated message, requesting repetition of the incorrectly received message.

Note 1.— The following example illustrates a typical text of a service message in which the foregoing procedure has been applied in respect of a mutilated message having as its origin "141335 CYULACAX":

SVC→QTA→RPT→↑141335↓→CYULACAX↓<≡

Note 2.— This circumstance of detection of a mutilation may only be possible at "torn-tape" relay stations.

4.4.11.2 When the provisions of 4.4.11.1 are applied, the originator as identified by the originator indicator in the origin of the mutilated message shall reassume responsibility for the mutilated message, and shall comply with the provisions of 4.4.11.3.

4.4.11.3 Following application of the provisions of 4.4.11.2, the following reprocessing shall be accomplished before the unmutilated version of the message is transmitted for the second time towards the same addressee or addressees:

1) *insert* a new heading;

2) *remove* the ending of the message (*see* 4.4.6.1);

3) *insert* in lieu thereof the procedure signal DUPE, preceded by at least 1 LETTER SHIFT [↓] and followed by 1 CARRIAGE RETURN, 8 LINE FEEDS, end-of-message signal and, if necessary (*see* 4.4.6 and 4.4.7), the LETTER SHIFTS [↓] of the message-separation signal and tape feed.

Note.— The example appearing in Figure 4-3 illustrates the application of this procedure.

4.4.11.4 If, before retransmission is commenced, a relay station detects that one or more messages have been mutilated at some point ahead of the end-of-message signal, and it has reason to believe that this mutilation had occurred during or subsequent to its transmission from the previous station, it shall send a service message (*see* 4.4.1.1.9) to the previous station rejecting the mutilated transmission and requesting a repetition of the incorrectly received message (or messages).

Note 1.— The following examples illustrate application of the above-mentioned procedure. In example 2) the hyphen (-) separator is understood to mean "through" in plain language.

1) in respect of a single mutilated message:

SVC→QTA→RPT→ABC↑123↓<≡

2) in respect of several mutilated messages:

SVC→QTA→RPT→ABC↑123-126↓<≡

Note 2.— This circumstance of detection of a mutilation may only be possible at "torn-tape" relay stations.

4.4.11.5 When the provisions of 4.4.11.4 are applied, the station receiving the service message shall reassume responsibility for the referenced message. It shall then retransmit the unmutilated copy of the referenced message with a new (i.e. correct in sequence) transmission identification (*see* 4.4.2.1.1 b)). If that station is not in possession of an unmutilated copy of the original message, it shall take the action prescribed in 4.4.11.1.

4.4.11.6 If, before retransmission is commenced, a relay station detects that a received message has a recognizable but mutilated end-of-message signal, it shall, where necessary, repair this mutilation before retransmission.

Note.— This circumstance of detection of a mutilation may only be possible at "torn-tape" relay stations and the action prescribed will be essential where messages are being transmitted to a semi-automatic or fully automatic station.

4.4.11.7 If, during retransmission of a message, a relay station detects that the message has been mutilated at some point ahead of the end-of-message signal and is able to take action before a correct end-of-message signal has been transmitted, it shall:

1) cancel the transmission by inserting into the channel the sequence ↓<≡QTA→QTA↓<≡ followed by a complete ending (*see* 4.4.6):

2) reassume responsibility for the message;

3) comply with the provisions of 4.4.11.1 or 4.4.11.4 as appropriate.

Note.— This circumstance of detection of a mutilation may only be possible at "torn-tape" relay stations or at semi-automatic stations using continuous-tape.

4.4.11.8 If, after a message has been transmitted *in toto*, a station detects that the text or the origin of the message was mutilated or incomplete, it shall transmit to all addressees concerned a service message with the following text, if an unmutilated copy of the message is available in the station:

SVC CORRECTION *(the origin of the incorrect message)* STOP *(followed by the correct text).*

Note.— This circumstance of detection of a mutilation or incomplete message may only be possible at "torn-tape" relay stations or at semi-automatic stations using continuous-tape.

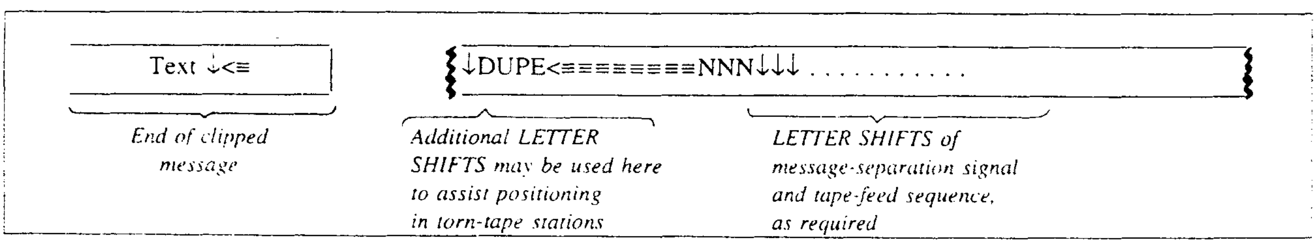


Figure 4-3. Example of application of 4.4.11.3 procedure

4.4.11.9 If, after transmission of the text of a message, a relay station detects that the message has an obviously mutilated end-of-message signal, it shall insert a proper end-of-message signal into the channel.

Note.— This circumstance of detection of a mutilation may only be possible at "torn-tape" relay stations or at semi-automatic stations using continuous-tape.

4.4.11.10 If, after transmission of the text material of a message, a relay station can detect that there is no complete end-of-message signal, but has no practicable means of discovering whether the irregularity has affected only the end-of-message signal or whether it may have also caused part of the original text to have been lost, it shall insert into the channel the following:

1) ↓<≡CHECK≡TEXT≡
NEW→ENDING→ADDED→

2) its own station identification;

3) ↓<≡

4) a proper ending as prescribed in 4.4.6.1.

Note 1.— On tape copy, this insertion will appear as follows:

↓<≡CHECK≡TEXT≡
NEW→ENDING→ADDED→LOWWYFYX↑↓<≡
≡≡≡≡≡≡≡NNNN↓↓↓ . . .

Note 2.— On page copy, this insertion will appear as follows:

CHECK
TEXT
NEW ENDING ADDED LOWWYFYX
NNNN

Note 3.— The staggered presentation on copy is prescribed to ensure that the attention of the addressee is drawn immediately to the insertion.

Note 4.— The FIGURE SHIFT [↑] is included to ensure proper functioning where First Line Monitoring Equipment is used, where the presence of the FIGURE SHIFT in the origin is used to cause disconnection of this equipment and where the missing part of the message includes this FIGURE SHIFT.

Note 5.— This circumstance of detection of a mutilation may only be relevant to fully automatic stations or stations using semi-automatic methods without continuous-tape.

4.4.11.11 **Recommendation.—** *Relay stations applying the procedural provisions of 4.4.11.9 or 4.4.11.10 should, if practicable, ensure that the appropriate material therein prescribed is inserted prior to the transmission of a complete start-of-message signal associated with any following message.*

4.4.11.12 If a relay station detects that a message was received with a completely mutilated address line, it shall send a service message to the previous station rejecting the mutilated transmission.

4.4.11.12.1 The text of this service message shall comprise:

1) the abbreviation SVC;

2) the procedure signal QTA;

3) the procedure signal ADS;

4) the transmission identification of the message rejected;

5) the indication CORRUPT;

6) the end-of-text signal.

Note.— The following example illustrates application of the above-mentioned procedure:

SVC→QTA→ADS→ABC↑123↓→CORRUPT↓<≡

4.4.11.12.2 The station receiving such a service message shall reassume responsibility for the referenced message, and shall retransmit the message with a corrected address line, and a new transmission identification.

4.4.11.13 If a relay station detects a received message with an invalid (i.e. length other than 8 letters) or unknown addressee indicator, it shall relay the message to those valid addresses for which it has relay responsibility using the shortened address procedure (*see* 4.4.8).

4.4.11.13.1 In addition, except as in 4.4.11.13.3, the station shall send a service message to the previous station requesting correction of the error. The text of this service message shall comprise:

1) the abbreviation SVC;

2) the procedure signal ADS;

3) the transmission identification of the message in error;

4) an alignment function;

5) the line-following-the-heading of the message as received;

6) an alignment function;

7) either:

a) for an invalid addressee indicator: the indication CHECK;

b) for an unknown addressee indicator: the indication UNKNOWN;

8) the invalid or unknown addressee indicator(s);

9) the end-of-text signal.

Note.— The following examples illustrate the application of the procedure of 4.4.11.13.1:

a) for an invalid addressee indicator:

SVC→ADS→ABC↑123↓<≡
GG→EGLLACAX→EGPKYTYX→CYAAYFYX→
CYQXAFX<≡CHECK→CYQXAFX↓<≡

b) for an unknown addressee indicator:

SVC→ADS→ABC↑123↓<≡
GG→EGLLACAX→EGEHYTYX→CYAAYFYX→
CYQXACAX<≡UNKNOWN→EGEHYTYX↓<≡

4.4.11.13.2 A station receiving a service message as prescribed in 4.4.11.13.1 shall, if a correct addressee indicator is available, repeat the message to that addressee only using the shortened address procedure (*see* 4.4.8) or, if a correct addressee indicator is not available, act as prescribed in 4.4.11.13.1.

4.4.11.13.3 Where the procedure of 4.4.11.13 is applied in the case of an unknown addressee indicator, and if the origin of the message is without fault, the station shall send a service message to the originator. The text of this service message shall comprise:

1) the abbreviation SVC;

2) the procedure signal ADS;

3) the origin of the message in error;

4) an alignment function;

5) the line-following-the-heading of the message as received;

6) an alignment function;

7) the indication UNKNOWN;

8) the unknown addressee indicator(s);

9) the end-of-text signal.

Note.— The following example illustrates application of the above-mentioned procedure:

SVC→ADS→↑141335↓→CYULACAX<≡
GG→EGLLACAX→EGEHYTYX→CYAAYFYX→
CYQXACAX<≡UNKNOWN→EGEHYTYX↓<≡

4.4.11.13.4 A station receiving such a service message shall obtain a correct addressee indicator and shall repeat the message to the addressee using the shortened address procedure (*see* 4.4.8).

4.4.11.14 When the first relay station detects that a message was received with a mutilated origin line or without any origin, it shall:

a) stop processing the message;

b) send a service message to the station from which the message was received.

4.4.11.14.1 The text of this service message shall comprise:

1) the abbreviation SVC;

2) the procedure signal QTA;

3) the procedure signal OGN;

4) the transmission identification of the message rejected;

5) the indication CORRUPT;

6) the end-of-text signal.

Note.— The following example illustrates application of the above-mentioned procedure:

SVC→QTA→OGN→ABC↑123↓→CORRUPT↓<≡

4.4.11.14.2 The station receiving a service message as prescribed in 4.4.11.14.1 shall reassume responsibility for the referenced message and shall retransmit the message with a correct origin line and a new transmission identification.

Note.— When applying the provisions of 4.4.11.14, the minimum requirements for processing the origin of AFTN messages are:

1) the date-time group consisting of six numeric characters;

2) the originator indicator consisting of eight alpha characters.

4.4.12 Correction of errors during tape preparation

4.4.12.1 Messages for which tapes are prepared at the origin station shall not be allowed to flow into the AFTN with known uncorrected errors.

4.4.12.2 Errors made ahead of the text of a message shall be corrected by discarding the incorrect tape and preparing a new one.

4.4.12.3 Where possible, errors made in the text of a message shall be corrected by back-spacing the tape and eliminating the error by operation of the LETTERS [↓] key over the undesired portion.

4.4.12.4 Where the action of 4.4.12.3 is not possible, correction to the text shall, except in the case of ATS messages specified in 4.4.14.1.1 a), be made immediately after the error by making the error sign (→E→E→E→), transmitting the last correct word or group and then continuing with the tape preparation.

4.4.12.5 Where neither the action of 4.4.12.3 nor the action of 4.4.12.4 is possible because the error in the text is not noticed until later in the preparation process (but before the end-of-message signal has been added) the station shall comply with the provisions of 4.4.5.5.

4.4.12.6 The ending must be typed without error.

4.4.13 Correction of errors during message origination in cases where the message is flowing into the AFTN during preparation

4.4.13.1 Messages flowing into the AFTN during preparation shall not be terminated with an end-of-message signal if they contain known uncorrected errors.

4.4.13.2 Where an error is made, in this circumstance, in any part of the message which precedes the text, the unfinished message shall be cancelled by sending the sequence ↓<≡QTA→QTA↓<≡ followed by a complete ending (*see* 4.4.6).

4.4.13.3 Errors made in the text and noticed immediately shall, except in the case of ATS messages specified in 4.4.14.1.1 a), be corrected by making the error sign (→E→E→E→), transmitting the last correct word or group and then continuing with the message.

4.4.13.4 In cases where errors are made in the text and not noticed until later in the origination process, the station shall comply with the provisions of 4.4.5.5.

4.4.13.5 In cases where it becomes obvious, during the origination of the text, that the message should be cancelled, the station shall take the action described in 4.4.13.2.

4.4.14 Transmission of ATS messages intended for use in an ATC computer

4.4.14.1 *General*

4.4.14.1.1 In messages containing ATS data intended for use in an ATC computer:

a) in the message fields identified in PANS-RAC (Doc 4444), Appendix 3, as Fields Type 1 to 4, 6 to 17, and 22 to 25 the ATS data shall be transmitted free of errors, except that it may contain redundant LETTER SHIFTS [↓] providing these are separated from following figures case characters by a FIGURE SHIFT [↑];

   Note.— This provision permits, in cases only where these messages are prepared in perforated paper tape form before transmission, the blocking out of incorrect characters in the fields identified by back-spacing and replacement by LETTER SHIFT. The procedures at 4.4.12.4 and 4.4.13.3 are not permissible in these fields.

b) in the message fields identified in PANS-RAC (Doc 4444), Appendix 3, as Fields Type 5, and 18 to 21, the confirmation and correction techniques of 4.4.5.4 and 4.4.5.5, if used, shall be performed prior to transmission of the end-of-ATS-data signal.

   Note.— The end-of-ATS-data signal is specified in PANS-RAC (Doc 4444) as a close bracket ")" (figure case of signal no. 12).

4.4.14.2 *Transmission by direct or omnibus non-AFTN channels using low modulation rate 5-unit code*

4.4.14.2.1 **Recommendation.—** *The procedures in 4.4.14.2.2 and 4.4.14.2.3 should apply except where there is a bilateral or multilateral arrangement to deviate.*

4.4.14.2.2 **Recommendation.—** *Transmissions should be preceded by a starting pulse in accordance with the terms of 4.4.10.1.2.1.*

4.4.14.2.3 **Recommendation.—** *The message should comprise:*

a) the start-of-message signal (ZCZC);

b) on omnibus channels carrying manually-prepared messages only, 1 SPACE [→] followed by the location indicators of the sending and addressed units;

Note.— In messages exchanged between computers, provision has been made in PANS-RAC (Doc 4444), Appendix 3, for data describing the sending and addressed units/computers to be included within the ATS data.

c) an alignment function [<≡], so that the beginning of the ATS data appears at the beginning of a new line whenever the message appears on page-copy.

4.4.15 Predetermined distribution system for AFTN messages

4.4.15.1 When it has been agreed between the Administrations concerned to make use of a predetermined distribution system for AFTN messages, the system described below shall be used.

4.4.15.2 The Predetermined Distribution Addressee Indicator (PDAI) shall be constructed as follows:

a) The first and second letters:

The first two letters of the Location Indicator of the communications centre of the State which has agreed to implement the system and which receives messages over a circuit for which it has a predetermined routing responsibility;

b) The third and fourth letters:

The letters ZZ, indicating a requirement for special distribution;

c) The fifth, sixth and seventh letters:

1) The fifth, sixth and seventh letters taken from the series A to Z and denoting the national and/or international distribution list(s) to be used by the receiving AFTN centre;

2) "N" and "S", as the fifth letter, are reserved for NOTAM and SNOWTAM respectively (*see* Appendix 4 to Annex 15);

d) The eighth letter:

Either the filler letter "X" or a letter taken from the series A to Z to further define the national and/or international distribution list(s) to be used by the receiving AFTN centre.

Note 1.— To avoid conflict with the AFTN start-of-message signal, combinations with ZC or CZ will not be used.

Note 2.— To avoid conflict with the AFTN end-of-message signal, combinations with NN will not be used.

4.4.15.3 **PANS.—** *Predetermined Distribution Addressee Indicators (PDAIs) should be used whenever possible on AFTN messages between States which have agreed to make use of the predetermined distribution system.*

4.4.15.4 AFTN messages carrying Predetermined Distribution Addressee Indicators allocated by the State receiving the message shall be routed to the addressees listed on the associated list of Addressee Indicators described in 4.4.15.5.

4.4.15.5 States shall send their list of selected Predetermined Distribution Addressee Indicators together with the associated lists of Addressee Indicators to:

a) the States from which they will receive AFTN messages for predetermined distribution, to assure correct routing; and

b) the States which will originate AFTN messages for predetermined distribution to facilitate the treatment of requests for retransmission and to assist originators in using the Predetermined Distribution Addressee Indicators correctly.

4.4.15.5.1 The list of Addressee Indicators associated with a Predetermined Distribution Addressee Indicator shall include either:

a) Addressee Indicators for national distribution; or

b) Addressee Indicators for international distribution; or

c) Predetermined Distribution Addressee Indicators for international distribution; or

d) any combination of a), b), and c).

4.4.16 Message format — International Alphabet No. 5 (IA-5)

When it has been agreed between the Administrations concerned to use International Alphabet No. 5 (IA-5) the format described in 4.4.16 through 4.4.16.3 shall be used. It shall be the responsibility of Administrations using IA-5 to accommodate adjacent AFTN stations employing ITA-2 code in the format described in 4.4.2.

All messages, other than those prescribed in 4.4.1.8 and 4.4.9.3 shall comprise the components specified in 4.4.16.1 to 4.4.16.6 inclusive.

Note 1.— An illustration of the IA-5 message format is given in Figure 4-4.

*Note 2.— In the subsequent standards relative to message format the following symbols have been used in making reference to the functions assigned to certain signals in IA-5. (*See *Volume I, Part I, 4.12.1 and Tables 4-2 and 4-3.)*

Symbol	*Signification*
<	CARRIAGE RETURN (character position 0/13)
≡	LINE FEED (character position 0/10)
→	SPACE (character position 2/0).

4.4.16.1 *Heading*

4.4.16.1.1 The heading shall comprise:

a) start-of-heading (SOH) character 0/1;

b) transmission identification comprising:

1) circuit or link identification;

2) channel-sequence number;

c) additional service information (if necessary) comprising:

1) one SPACE;

2) no more than 10 characters.

4.4.16.1.1.1 On point-to-point circuits or links the identification shall consist of three letters selected and assigned by the transmitting station; the first letter identifying the transmitting, the second letter the receiving end of the circuit, and the third letter to identify the channel. Where only one channel exists the letter A shall be assigned. Where more than one channel between stations is provided, the channels shall be identified as A, B, C, etc., in respective order. On multipoint channels the identification shall consist of three letters selected and assigned by the circuit control or master station.

4.4.16.1.1.2 Except as provided in 4.4.16.1.1.3 three-digit channel-sequence numbers from 001 to 000 (representing 1 000) shall be assigned sequentially by telecommunication stations to all messages transmitted directly from one station to another. A separate series of these numbers shall be assigned for each channel and a new series shall be started daily at 0000 hours.

4.4.16.1.1.3 **Recommendation.—** *The expansion of the channel-sequence number to preclude duplication of the same numbers during the 24-hour period should be permitted subject to agreement between the Authorities responsible for the operation of the circuit.*

4.4.16.1.1.4 The transmission identification shall be sent over the circuit in the following sequence:

a) transmitting-terminal letter;

b) receiving-terminal letter;

c) channel-identification letter;

d) channel-sequence number.

4.4.16.1.1.5 Additional service information shall be permitted to be inserted following the transmission identification subject to agreement between the Authorities responsible for the operation of the circuit. Such additional service information shall be preceded by a SPACE (→) followed by not more than 10 characters inserted into the heading of message immediately following the last digit of the channel-sequence number and shall not contain any alignment functions. When no such additional service information is added the information in 4.4.16.1.1.4 shall be followed immediately by that of 4.4.16.2.

4.4.16.2 *Address*

4.4.16.2.1 The address shall comprise:

a) alignment function (<≡);

b) priority indicator;

c) addressee indicator(s);

d) alignment function (<≡).

4.4.16.2.1.1 The priority indicator shall consist of the appropriate two-letter group assigned by the originator in accordance with the following:

Priority indicator	*Message category*
SS	distress messages
DD	urgency messages (*see* 4.4.1.1.2)
FF	flight safety messages (*see* 4.4.1.1.3)
GG	meteorological messages (*see* 4.4.1.1.4)
GG	flight regularity messages (*see* 4.4.1.1.5)
GG	aeronautical information services messages (*see* 4.4.1.1.6)
KK	aeronautical administrative messages (*see* 4.4.1.1.7)
as appropriate	service messages (*see* 4.4.1.1.9)

Message part		*Component of the message part*	*Elements of the component*	*Teletypewriter character*
THE HEADING	HEADING LINE (see 4.4.16.1.1)	Start-of-Heading Character	One Character (0/1)	SOH
		Transmission Identification	a) Transmitting-terminal letter b) Receiving-terminal letter c) Channel-identification letter d) Channel-sequence number (*Example:* NRA062)	......
		(*If necessary*) Additional Service Indication	a) One SPACE b) No more than the remainder of the line (*Example:* 270930)	→
	ADDRESS (see 4.4.16.2.1)	Alignment Function	One CARRIAGE RETURN, one LINE FEED	<≡
		Priority Indicator	The relevant 2-letter group	..
		Addressee Indicator(s)	One SPACE, An 8-letter group — given in sequence for each addressee (*Example:*→EGLLZRZX→EGLLYKYX→EGLLACAD)	
		Alignment Function(s)	One CARRIAGE RETURN, one LINE FEED	<≡
	ORIGIN (see 4.4.16.2.2)	Filing Time	6-digit date-time group specifying when the message was filed for transmission	......
		Originator Indicator	a) One SPACE b) 8-letter group identifying the message originator	→......
		Priority Alarm (*used only in teletypewriter operation for Distress Traffic and Urgency Messages*)	Five characters (0/7)(BEL)	
		Optional Heading Information	Additional data not to exceed the remainder of the line. See 4.4.16.2.2.6.	
		Alignment Function	One CARRIAGE RETURN, one LINE FEED	<≡
		Start-of-Text Character	One character (0/2)	STX
TEXT (see 4.4.16.3)		Beginning of the Text	Specific identification of Addressee(s) (*if necessary*) *with* each followed by one CARRIAGE RETURN, one LINE FEED (*if necessary*) The English word FROM (*if necessary*)(see 4.4.16.3.5) Specific identification of Originator (*if necessary*) The English word STOP followed by one CARRIAGE RETURN, one LINE FEED (*if necessary*) (see 4.4.16.3.5) *and/or* Originator's reference (*if used*)	
		Message Text	Message Text with one CARRIAGE RETURN, one LINE FEED at the end of each printed line of the Text except for the last one (see 4.4.16.3.6)	
		Confirmation (*if necessary*)	a) One CARRIAGE RETURN, one LINE FEED b) The abbreviation CFM followed by the portion of the Text being confirmed.	
		Correction (*if necessary*)	a) One CARRIAGE RETURN, one LINE FEED b) The abbreviation COR followed by the correction of an error made in the preceding Text	
ENDING (see 4.4.16.3.12.1)		Alignment Function	One CARRIAGE RETURN, one LINE FEED	<≡
		Page-feed Sequence	One character (0/11)	VT
		End-of-Text character	One character (0/3)	ETX

Figure 4-4. Message format International Alphabet No. 5 (IA-5)
(the above illustrates the teletypewriter message format described in 4.4.16)

4.4.16.2.1.2 The order of priority shall be the same as specified in 4.4.1.2.

4.4.16.2.1.3 An addressee indicator, which shall be immediately preceded by a SPACE, except when it is the first address indicator of the second or third line of addresses, shall comprise:

a) the four-letter location indicator of the place of destination;

b) the three-letter designator identifying the organization/function (aeronautical authority, service or aircraft operating agency) addressed;

c) an additional letter, which shall represent a department, division or process within the organization/function addressed. The letter X shall be used to complete the address when explicit identification is not required.

4.4.16.2.1.3.1 Where a message is to be addressed to an organization that has not been allocated an ICAO three-letter designator of the type prescribed in 4.4.16.2.1.3 the location indicator of the place of destination shall be followed by the ICAO three-letter designator YYY (or the ICAO three-letter designator YXY in the case of a military service or organization). The name of the addressee organization shall then be included in the first item in the text of the message. The eighth position letter following the ICAO three-letter designator YYY or YXY shall be the filler letter X.

4.4.16.2.1.3.2 Where a message is to be addressed to an aircraft in flight and, therefore, requires handling over the AFTN for part of its routing before retransmission over the Aeronautical Mobile Service, the location indicator of the aeronautical station which is to relay the message to the aircraft shall be followed by the ICAO three-letter designator ZZZ. The identification of the aircraft shall then be included in the first item of the text of the message. The eighth position letter following the ICAO three-letter designator ZZZ shall be the filler letter X.

4.4.16.2.1.4 The complete address shall be restricted to three lines of page-printing copy, and, except as provided in 4.4.17, a separate addressee indicator shall be used for each addressee whether at the same or different locations.

4.4.16.2.1.5 The completion of the addressee indicator group(s) in the address of a message shall be immediately followed by the alignment function.

4.4.16.2.1.6 Where messages are offered in page-copy form for transmission and contain more addressee indicators than can be accommodated on three lines of a page copy, such messages shall be converted, before transmission, into two or more messages, each of which shall conform with the provisions of 4.4.16.2.1.5. During such conversion, the addressee indicators shall, in so far as practicable, be positioned in the sequence which will ensure that the minimum number of retransmissions will be required at subsequent communication centres.

4.4.16.2.2 *Origin*

The origin shall comprise:

a) filing time;

b) originator indicator;

c) priority alarm (when necessary);

d) optional heading information;

e) alignment function (<≡);

f) start-of-text character, character 0/2 (STX).

4.4.16.2.2.1 The filing time shall comprise the 6-digit date-time group indicating the date and time of filing the message for transmission (*see* 3.4.2).

4.4.16.2.2.2 The originator indicator, which shall be immediately preceded by a SPACE, shall comprise:

a) the four-letter location indicator of the place at which the message is originated;

b) the three-letter designator identifying the organization/function (aeronautical authority, service or aircraft operating agency) which originated the message;

c) an additional letter which shall represent a department, division or process within the organization/function of the originator. The letter X shall be used to complete the address when explicit identification is not required.

4.4.16.2.2.3 Where a message is originated by an organization that has not been allocated an ICAO three-letter designator of the type prescribed in 4.4.16.2.2.2 the location indicator of the place at which the message is originated shall be followed immediately by the ICAO three-letter designator YYY followed by the filler letter X (or the ICAO three-letter designator YXY followed by the filler letter X in the case of a military service or organization). The name of the organization (or military service) shall then be included in the first item in the text of the message.

4.4.16.2.2.4 Where a message originated by an aircraft in flight requires handling on the AFTN for part of its routing before delivery, the originator indicator shall comprise the location indicator of the aeronautical station responsible for transferring the message to the AFTN, followed immediately by the ICAO three-letter designator ZZZ followed by the filler letter X. The identification of the aircraft shall then be included in the first item in the text of the message.

4.4.16.2.2.5 The priority alarm shall be used only for distress messages, distress traffic and urgency messages. When used it shall consist of five successive BEL (0/7) characters.

Note.— Use of the priority alarm will actuate a bell (attention) signal at the receiving teletypewriter station, other than at those fully automatic stations which may provide a similar alarm on receipt of priority indicator SS, thereby alerting supervisory personnel at relay centres and operators at tributary stations, so that immediate attention may be given to the message.

4.4.16.2.2.6 The inclusion of optional data in the origin line shall be permitted provided a total of 69 characters is not exceeded and subject to agreement between the Administrations concerned.

4.4.16.2.2.7 The origin line shall be concluded by an alignment function (<≡) and the start-of-text (STX) (0/2) character.

4.4.16.3 *Text*

4.4.16.3.1 The text of messages shall be drafted in accordance with 4.1.2 and shall consist of all data between STX and ETX.

Note.— When message texts do not require conversion to the ITA-2 code and format and do not conflict with ICAO message types or formats in PANS-RAC (Doc 4444), Administrations may make full use of the characters available in International Alphabet No. 5 (IA-5).

4.4.16.3.2 When an originator's reference is used, it shall appear at the beginning of the text, except as provided in 4.4.16.3.3 and 4.4.16.3.4.

4.4.16.3.3 When the ICAO three-letter designators YXY, YYY or ZZZ comprise the second element of the addressee indicator (*see* 4.4.16.2.1.3.1 and 4.4.16.2.1.3.2) and it, therefore, becomes necessary to identify in the text the specific addressee of the message, such identification group shall precede the originator's reference (if used) and become the first item of the text.

4.4.16.3.4 When the ICAO three-letter designators YXY, YYY or ZZZ comprise the second element of the originator indicator (*see* 4.4.16.2.2.3 and 4.4.16.2.2.4) and it thus becomes necessary to identify in the text the name of the organization (or military service) or the aircraft which originated the message, such identification shall be inserted in the first item of the text of the message.

4.4.16.3.5 When applying the provisions of 4.4.16.3.3 and 4.4.16.3.4 to messages where the ICAO three-letter designator(s) YXY, YYY, ZZZ refer to two or more different organizations (or military services), the sequence of further identification in the text shall correspond to the complete sequence used in the address and originator indicator of the message. In such instance, each addressee identification shall be followed immediately by an alignment function. The name of the (YXY, YYY or ZZZ) organization originating the message shall then be preceded with "FROM". "STOP" followed by an alignment function shall then be included in the text at the end of this identification and preceding the remainder of text.

4.4.16.3.6 An alignment function shall be transmitted at the end of each printed line of the text. Except as provided in 4.4.14.1.1 b) when it is desired to confirm a portion of the text of a message in teletypewriter operation, such confirmation shall be separated from the last text group by an alignment function (<≡), and shall be indicated by the abbreviation CFM followed by the portion being confirmed.

4.4.16.3.7 Where messages are prepared off-line, e.g. by preparation of a paper tape, errors in the text shall be corrected by backspacing and replacing the character in error by character DEL (7/15).

4.4.16.3.8 Except when the provisions of 4.4.14.1.1 a) apply, corrections to textual errors made in on-line operations shall be corrected by inserting →E→E→E→ following the error, then retyping the last correct word (or group).

4.4.16.3.9 Except as provided in 4.4.14.1.1 b) when it is not discovered until later in the origination process that an error has been made in the text, the correction shall be separated from the last text group, or confirmation, if any, by an alignment function (<≡). This shall be followed by the abbreviation COR and the correction.

4.4.16.3.10 Stations shall make all indicated corrections on the page-copy prior to local delivery or a transfer to a manually operated circuit.

4.4.16.3.11 The text of messages entered by the AFTN origin station shall not exceed 1 800 characters in length. AFTN messages exceeding 1 800 characters shall be entered by the AFTN origin station in the form of separate messages. Guidance material for forming separate messages from a single long message is given in Attachment D to Volume II. When messages or data are transmitted only on medium or high speed circuits the text may be increased to a length that exceeds 1 800 characters as long as performance characteristics of the network or link are not diminished and subject to agreement between the Administrations concerned.

Note.— The character count includes all printing and non-printing characters in the text from, but not including, the *start-of-text signal to, but not including, the first alignment function of the ending.*

4.4.16.3.12 *Ending*

4.4.16.3.12.1 The ending of a message shall comprise the following in the order stated:

a) an alignment (<≡) function following the last line of text;

b) page-feed character, character 0/11 (VT);

c) end of text character 0/3 (ETX).

4.4.16.3.12.1.1 **Recommendation.**— *Station terminal equipment (page printers) on the International Alphabet Number 5 (IA-5) shall be provided with a capability to generate sufficient line feed functions for local station use upon the reception of a VERTICAL TAB character (0/11).*

4.4.16.3.12.1.2 **Recommendation.**— *When the message does not transit ITA-2 portions of the AFTN, or where Administrations have made provisions to add automatically the second carriage return before transmission to an ITA-2 circuit, one carriage return in the alignment function and end-of-line function should be permitted subject to agreement between the Administrations concerned.*

4.4.16.3.12.1.3 Messages entered by the AFTN origin station shall not exceed 2 100 characters in length.

Note.— The character count includes all printing and non-printing characters in the message from and including the start-of-heading character (SOH) to and including the end-of-text character.

4.4.16.4 Except as provided in 4.4.16.5 to 4.4.16.6 and 4.4.17, the procedures of 4.4.8 and 4.4.9 to 4.4.14 shall be used for messages using IA-5 code.

4.4.16.5 *Channel-check transmissions.* In the case where continuous control of channel condition is not provided the following periodic transmissions shall be sent on teletypewriter circuits:

1) heading line (*see* 4.4.16.1.1);

2) alignment function S
T ;
X

3) the procedure signal CH;

4) alignment function E
T
X

The receiving station shall then check the transmission identification of this incoming transmission to ensure its correct sequence in respect of all messages received over that incoming channel.

Note.— Application of this procedure provides some measure of assurance that channel continuity is maintained; however, a continuously controlled channel is much more preferable in that data integrity can also be improved.

4.4.16.5.1 **Recommendation.**— *Where a circuit is unoccupied and uncontrolled the transmission identified in 4.4.16.5 should be sent at H + 00, H + 20, H + 40.*

4.4.16.6 The receipt of distress messages, distress traffic and urgency messages (priority indicator SS, *see* 4.4.1.1.1 and 4.4.1.1.2) shall be individually acknowledged by the AFTN destination station by sending a service message (*see* 4.4.1.1.9) to the AFTN origin station. Such acknowledgement of receipt shall take the format of a complete message addressed to the AFTN origin station, shall be assigned priority indicator SS and the associated priority alarm (*see* 4.4.16.2.2.5), and shall have a text comprising:

1) the procedure signal R;

2) the origin line (*see* 4.4.16.2.2) without priority alarm, of the message being acknowledged;

3) the ending (*see* 4.4.16.3.12.1).

Note.— The following example illustrates the application of the 4.4.16.6 procedures:

Heading (*see* 4.4.16.1.1)

<≡ SS → LECBYFYX <≡

121322 → EGLLYFYX (priority alarm) <≡

S
TR → 121319 → LECBZRZX <≡
X

Ending (*see* 4.4.16.3.12.1).

4.4.17 Action taken on mutilated messages in IA-5 detected in computerized AFTN relay stations

4.4.17.1 On channels employing continuous control the mutilation detection and subsequent recovery shall be a function of the link control procedures and shall not require the subsequent sending of service or CHECK TEXT NEW ENDING ADDED messages.

4.4.17.2 On channels not employing continuous control the relay station shall employ the following procedures:

4.4.17.2.1 If, during the reception of a message a relay station detects that the message has been mutilated at some point ahead of the end-of-text character, it shall:

1) cancel the onward routing responsibility for the message;

2) send a service message to the transmitting station requesting a retransmission.

Note.— The following example illustrates a typical text of a service message in which the foregoing procedure has been applied in respect of a mutilated message:

SVC→QTA→RPT→ABC 123 (ending — *see* 4.4.16.3.12.1)

4.4.17.2.2 When the provisions of 4.4.17.2.1 are applied, the station receiving the service message shall reassume responsibility for the referenced message with a new (i.e. correct in sequence) transmission identification (*see* 4.4.16.2.1). If that station is not in possession of an unmutilated copy of the original message, it shall send a message to the originator as identified by the originator indicator in the origin of the mutilated message, requesting repetition of the incorrectly received message.

Note.— The following example illustrates a typical text of a service message in which the foregoing procedure has been applied in respect of a mutilated message having as its origin "141335 CYULACAX":

SVC→QTA→RPT→141335→CYULACAX
(ending — *see* 4.4.16.3.12.1)

4.4.17.3 If, after transmission of the text material of a message, a relay station can detect that there is no complete end-of-text character, but has no practical means of discovering whether the irregularity has affected only the end-of-text character, or whether it has also caused part of the original text to have been lost, it shall insert into the channel the following:

1) <≡CHECK≡TEXT≡
NEW→ENDING→ADDED

2) its own station identification;

3) (ending — *see* 4.4.16.3.12.1).

4.4.18 Transfer of AFTN messages over code and byte independent circuits and networks

When AFTN messages are transferred across code and byte independent circuits and networks of the AFS, the following shall apply.

4.4.18.1 Except as provided in 4.4.18.3 the heading line of the message shall be omitted. The message shall start with an alignment function followed by the address.

4.4.18.2 The message shall end with a complete ending.

4.4.18.3 **Recommendation.**— *For the purposes of technical supervision, entry centres should be permitted to insert additional data preceding the first alignment function and/or following the ending of the message. Such data may be disregarded by the receiving station.*

4.4.18.3.1 When the provisions of 4.4.18.3 are applied, the data added shall not include either carriage return or line feed characters or any of the combinations listed in 4.1.2.4.

CHAPTER 5. AERONAUTICAL MOBILE SERVICE

5.1 General

Note 1.— While the provisions of Chapter 5 are based primarily on the use of R/T, the provisions of 5.1 would apply to any mode of communications in the aeronautical mobile service.

Note 2.— For the purposes of these provisions, the communication procedures applicable to the aeronautical mobile service, as appropriate, also apply to the aeronautical mobile satellite service.

5.1.1 In all communications the highest standard of discipline shall be observed at all times.

5.1.1.1 In all situations for which standard radiotelephony phraseology is specified it shall be used.

5.1.1.2 The transmission of messages, other than those specified in 5.1.8, on aeronautical mobile frequencies when the aeronautical fixed services are able to serve the intended purpose, shall be avoided.

5.1.2 Where it is necessary for an aircraft station to send signals for testing or adjustment which are liable to interfere with the working of a neighbouring aeronautical station, the consent of the station shall be obtained before such signals are sent. Such transmissions shall be kept to a minimum.

5.1.3 When it is necessary for a station in the aeronautical mobile service to make test signals, either for the adjustment of a transmitter before making a call or for the adjustment of a receiver, such signals shall not continue for more than 10 seconds and shall be composed of spoken numerals (ONE, TWO, THREE, etc.) in radiotelephony, followed by the radio call sign of the station transmitting the test signals. Such transmissions shall be kept to a minimum.

5.1.4 Except as otherwise provided, the responsibility of establishing communication shall rest with the station having traffic to transmit.

Note.— In certain cases when SELCAL is used the procedures respecting the establishment of communications are contained in 5.2.4.

5.1.5 **Recommendation.**— *After a call has been made to the aeronautical station, a period of at least 10 seconds should elapse before a second call is made. This should eliminate unnecessary transmissions while the aeronautical station is getting ready to reply to the initial call.*

5.1.6 When an aeronautical station is called simultaneously by several aircraft stations, the aeronautical station shall decide the order in which aircraft shall communicate.

5.1.7 In communications between aircraft stations, the duration of communication shall be controlled by the aircraft station which is receiving, subject to the intervention of an aeronautical station. If such communications take place on an ATS frequency, prior permission of the aeronautical station shall be obtained. Such request for permission is not required for brief exchanges.

5.1.8 Categories of messages

The categories of messages handled by the aeronautical mobile service and the order of priority in the establishment of communications and the transmission of messages shall be in accordance with the following table.

Message category and order of priority	*Radiotelephony signal*
a) Distress calls, distress messages and distress traffic	MAYDAY
b) Urgency messages, including messages preceded by the medical transports signal	PAN, PAN *or* PAN, PAN MEDICAL
c) Communications relating to direction finding	—
d) Flight safety messages	—
e) Meteorological messages	—
f) Flight regularity messages	—

Note 1.— Messages concerning acts of unlawful interference constitute a case of exceptional circumstances which may preclude the use of recognized communication procedures used to determine message category and priority.

Note 2.— A NOTAM may qualify for any of the categories or priorities c) to f) inclusive. The decision as to which priority will depend on the contents of the NOTAM and its importance to the aircraft concerned.

5.1.8.1 *Distress messages and distress traffic* shall be handled in accordance with the provisions of 5.3.

5.1.8.2 *Urgency messages and urgency traffic*, including messages preceded by the medical transports signal, shall be handled in accordance with the provisions of 5.3.

Note.— The term "medical transports" is defined in the 1949 Geneva Conventions and Additional Protocols and refers to 'any means of transportation by land, water, or air, whether military or civilian, permanent or temporary, assigned exclusively to medical transportation and under the control of a competent authority of a Party to the conflict'.

5.1.8.3 *Communications relating to direction finding* shall be handled in accordance with Chapter 6.

5.1.8.4 *Flight safety messages* shall comprise the following:

1) movement and control messages [*see* PANS-RAC (Doc 4444)];
2) messages originated by an aircraft operating agency or by an aircraft, of immediate concern to an aircraft in flight;
3) meteorological advice of immediate concern to an aircraft in flight or about to depart (individually communicated or for broadcast);
4) other messages concerning aircraft in flight or about to depart.

5.1.8.5 *Meteorological messages* shall comprise meteorological information to or from aircraft, other than those in 5.1.8.4 3).

5.1.8.6 *Flight regularity messages* shall comprise the following:

1) messages regarding the operation or maintenance of facilities essential for the safety or regularity of aircraft operation;
2) messages concerning the servicing of aircraft;
3) instructions to aircraft operating agency representatives concerning changes in requirements for passengers and crew caused by unavoidable deviations from normal operating schedules. Individual requirements of passengers or crew shall not be admissible in this type of message;
4) messages concerning non-routine landings to be made by the aircraft;
5) messages concerning aircraft parts and materials urgently required;
6) messages concerning changes in aircraft operating schedules.

5.1.8.6.1 Air traffic services units using direct pilot-controller communication channels shall only be required to handle flight regularity messages provided this can be achieved without interference with their primary role and no other channels are available for the handling of such messages.

Note.— The messages at 5.1.8.4, 2) and 5.1.8.6, 1) to 6) above typify some of the operational control communications defined in Chapter 1.

5.1.8.7 **Recommendation.—** *Messages having the same priority should, in general, be transmitted in the order in which they are received for transmission.*

5.1.8.8 Interpilot air-to-air communication shall comprise messages related to any matter affecting safety and regularity of flight. The category and priority of these messages shall be determined on the basis of their content in accordance with 5.1.8.

5.1.9 Cancellation of messages

5.1.9.1 *Incomplete transmissions.* If a message has not been completely transmitted when instructions to cancel are received, the station transmitting the message shall instruct the receiving station to disregard the incomplete transmission. This shall be effected in radiotelephony by use of an appropriate phrase.

5.1.9.2 *Complete transmissions*

Recommendation.— *When a completed message transmission is being held pending correction and the receiving station is to be informed to take no forwarding action, or when delivery or onward relay cannot be accomplished, transmission should be cancelled. This should be effected in radiotelephony by the use of an appropriate phrase.*

5.1.9.3 The station cancelling a transmission shall be responsible for any further action required.

5.2 Radiotelephony procedures

Note.— When Selective Calling (SELCAL) equipment is used certain of the following procedures are superseded by those contained in 5.2.4.

5.2.1 General

5.2.1.1 *Language to be used*

5.2.1.1.1 **Recommendation.—** *In general, the air-ground radiotelephony communications should be conducted in the language normally used by the station on the ground.*

Letter	Word	Approximate pronunciation	
		International Phonetic Convention	*Latin alphabet representation*
A	**Alfa**	'ælfɑ	AL FAH
B	**Bravo**	'brɑ:'vo	BRAH VOH
C	**Charlie**	'tʃɑ:li *or* 'ʃɑ:li	CHAR LEE *or* SHAR LEE
D	**Delta**	'deltɑ	DELL TAH
E	**Echo**	'eko	ECK OH
F	**Foxtrot**	'fɔkstrɔt	FOKS TROT
G	**Golf**	gʌlf	GOLF
H	**Hotel**	ho:'tel	HOH TELL
I	**India**	'indi·ɑ	IN DEE AH
J	**Juliett**	'dʒu:li·'et	JEW LEE ETT
K	**Kilo**	'ki:lo	KEY LOH
L	**Lima**	'li:mɑ	LEE MAH
M	**Mike**	mɑik	MIKE
N	**November**	no'vembə	NO VEM BER
O	**Oscar**	'ɔskɑ	OSS CAH
P	**Papa**	pə'pɑ	PAH PAH
Q	**Quebec**	ke'bek	KEH BECK
R	**Romeo**	'ro:mi·o	ROW ME OH
S	**Sierra**	si'erɑ	SEE AIR RAH
T	**Tango**	'tængo	TANG GO
U	**Uniform**	'ju:nifɔ:m *or* 'u:nifɔrm	YOU NEE FORM *or* OO NEE FORM
V	**Victor**	'viktɑ	VIK TAH
W	**Whiskey**	'wiski	WISS KEY
X	**X-ray**	'eks'rei	ECKS RAY
Y	**Yankee**	'jænki	YANG KEY
Z	**Zulu**	'zu:lu:	ZOO LOO

Note.—In the approximate representation using the Latin alphabet, syllables to be emphasized are underlined.

Note 1.— The pronunciation of the words in the alphabet may vary according to the language habits of the speakers. In order to eliminate wide variations in pronunciation, a poster (No. P674) illustrating the desired pronunciation is available from ICAO.

Note 2.— The Spelling Alphabet specified in 5.2.1.2 is also prescribed for use in the Maritime Mobile Service (ITU Radio Regulations, Appendix 24).

Figure 5-1. The Radiotelephony Spelling Alphabet (*see* 5.2.1.2)

Note.— The language normally used by the station on the ground may not necessarily be the language of the State in which it is located.

5.2.1.1.2 **Recommendation.—** *Pending the development and adoption of a more suitable form of speech for universal use in aeronautical radiotelephony communications, the English language should be used as such and should be available, on request from any aircraft station unable to comply with 5.2.1.1.1, at all stations on the ground serving designated airports and routes used by international air services.*

Note 1.— While the Contracting State designates the airports to be used and the routes to be followed by international air services, the formulation of ICAO opinion and recommendations to Contracting States concerned is carried out periodically by Council, ordinarily on the basis of recommendations of Regional Air Navigation Meetings.

Note 2.— In certain regions the availability of another language, in addition to English, may be agreed upon regionally as a requirement for stations on the ground in that region.

Note 3.— The development mentioned in 5.2.1.1.2 is the subject of continuing study and the broad principles of this study are laid down in Attachment B.

5.2.1.1.3 **Recommendation.—** *Pending implementation of 5.2.1.1.2 and when the aircraft station and the station on the ground cannot use a common language, arrangements should be made between the Competent Authority and the aircraft operating agency concerned for the provision of an interpreter by the latter.*

5.2.1.1.4 When provided, such interpreters shall be permitted to have access to and use of radiotelephone channels under the supervision of the controller on duty.

5.2.1.1.5 The language normally used by and other languages that may be used on request at a station on the ground shall form part of the Aeronautical Information Publications and other published aeronautical information concerning such facilities.

5.2.1.2 *Word spelling in radiotelephony.* When proper names, service abbreviations and words of which the spelling is doubtful are spelled out in radiotelephony the alphabet in Figure 5-1 shall be used.

Note 1.— The pronunciation of the words in the alphabet as well as numbers may vary according to the language habits of the speakers. In order to eliminate wide variations in pronunciation, posters illustrating the pronunciation desired are available from ICAO.

Note 2.— The Spelling Alphabet specified in 5.2.1.2 is also prescribed for use in the Maritime Mobile Service (Radio Regulations, Appendix 24).

5.2.1.3 *Transmission of numbers in radiotelephony*

5.2.1.3.1 *Transmission of numbers*

5.2.1.3.1.1 All numbers, except as prescribed in 5.2.1.3.1.2, shall be transmitted by pronouncing each digit separately.

Note.— The following examples illustrate the application of this procedure (see *5.2.1.3.3.1 for pronunciation).*

aircraft call signs	*transmitted as*
CCA 238	Air China **two three eight**
OAL 242	Olympic **two four two**
flight levels	*transmitted as*
FL 180	flight level **one eight zero**
FL 200	flight level **two zero zero**
headings	*transmitted as*
100 degrees	heading **one zero zero**
080 degrees	heading **zero eight zero**
wind direction and speed	*transmitted as*
200 degrees 70 knots	wind **two zero zero** degrees **seven zero** knots
160 degrees 18 knots gusting 30 knots	wind **one six zero** degrees **one eight** knots gusting **three zero**
transponder codes	*transmitted as*
2 400	squawk **two four zero zero**
4 203	squawk **four two zero three**
runway	*transmitted as*
27	runway **two seven**
30	runway **three zero**
altimeter setting	*transmitted as*
1 010	QNH **one zero one zero**
1 000	QNH **one zero zero zero**

5.2.1.3.1.2 All numbers used in the transmission of altitude, cloud height, visibility and runway visual range (RVR) information, which contain whole hundreds and whole thousands, shall be transmitted by pronouncing each digit in the number of hundreds or thousands followed by the word HUNDRED or THOUSAND as appropriate. Combinations of thousands and whole hundreds shall be transmitted by pronouncing each digit in the number of thousands followed by the word THOUSAND followed by the number of hundreds followed by the word HUNDRED.

Note.— The following examples illustrate the application of this procedure (see 5.2.1.3.3.1 for pronunciation).

altitude	*transmitted as*
800	**eight hundred**
3 400	**three thousand four hundred**
12 000	**one two thousand**
cloud height	*transmitted as*
2 200	**two thousand two hundred**
4 300	**four thousand three hundred**
visibility	*transmitted as*
1 000	visibility **one thousand**
700	visibility **seven hundred**
runway visual range	*transmitted as*
600	RVR **six hundred**
1 700	RVR **one thousand seven hundred**

5.2.1.3.1.3 Numbers containing a decimal point shall be transmitted as prescribed in 5.2.1.3.1.1 with the decimal point in appropriate sequence being indicated by the word DECIMAL.

Note 1.— The following examples illustrate the application of this procedure:

Number	*Transmitted as*
100.3	ONE ZERO ZERO DECIMAL THREE
38 143.9	THREE EIGHT ONE FOUR THREE DECIMAL NINE

Note 2.— For identification of VHF frequencies not more than two significant digits after the decimal point are used; a single zero is to be considered significant (5.2.1.6.3.4.3 refers to frequencies separated by 25 kHz). The following examples illustrate the application of this procedure:

Number	*Transmitted as*
118.0	ONE ONE EIGHT DECIMAL ZERO
118.1	ONE ONE EIGHT DECIMAL ONE
118.125	ONE ONE EIGHT DECIMAL ONE TWO
118.150	ONE ONE EIGHT DECIMAL ONE FIVE

5.2.1.3.1.4 **PANS.—** *When transmitting time, only the minutes of the hour should normally be required. Each digit should be pronounced separately. However, the hour should be included when any possibility of confusion is likely to result.*

Note.— The following example illustrates the application of this procedure when applying the provisions of 5.2.1.1.2:

Time	*Statement*
0920 *(9:20 A.M.)*	TOO ZE-RO *or* ZE-RO NIN-er TOO ZE-RO
1643 *(4:43 P.M.)*	FOW-er TREE *or* WUN SIX FOW-er TREE

5.2.1.3.2 *Verification of numbers*

5.2.1.3.2.1 When it is desired to verify the accurate reception of numbers the person transmitting the message shall request the person receiving the message to read back the numbers.

5.2.1.3.3 *Pronunciation of numbers*

5.2.1.3.3.1 When the provisions of 5.2.1.1.2 are applied, numbers shall be transmitted using the following pronunciation:

Numeral or numeral element	*Pronunciation*
0	ZE-RO
1	WUN
2	TOO
3	TREE
4	FOW-er
5	FIFE
6	SIX
7	SEV-en
8	AIT
9	NIN-er
Decimal	DAY-SEE-MAL
Hundred	HUN-dred
Thousand	TOU-SAND

Note.— The syllables printed in capital letters in the above list are to be stressed; for example, the two syllables in ZE-RO are given equal emphasis, whereas the first syllable of FOW-er is given primary emphasis.

5.2.1.3.3.2 **Recommendation.—** *When the language normally used by the station on the ground is English the pronunciation given in 5.2.1.3.3.1 should be used.*

Note.— A poster (No. P674) illustrating the desired pronunciation is available from ICAO.

5.2.1.4 *Transmitting technique*

5.2.1.4.1 **PANS.—** *Each written message should be read prior to commencement of transmission in order to eliminate unnecessary delays in communications.*

5.2.1.4.2 Transmissions shall be conducted concisely in a normal conversational tone; full use shall be made of standard phraseologies wherever these are prescribed in relevant ICAO documents or procedures.

5.2.1.4.3 **PANS.—** *Speech transmitting technique should be such that the highest possible intelligibility is incorporated in each transmission. Fulfilment of this aim requires that air crew and ground personnel should:*

a) enunciate each word clearly and distinctly;

b) maintain an even rate of speech not exceeding 100 words per minute. When a message is transmitted to an aircraft and its contents need to be recorded the speaking rate should be at a slower rate to allow for the writing process. A slight pause preceding and following numerals makes them easier to understand;

c) maintain the speaking volume at a constant level;

d) be familiar with the microphone operating techniques particularly in relation to the maintenance of a constant distance from the microphone if a modulator with a constant level is not used;

e) suspend speech temporarily if it becomes necessary to turn the head away from the microphone.

5.2.1.4.4 **Recommendation.**— *Speech transmitting technique should be adapted to the prevailing communications conditions.*

5.2.1.4.5 **PANS.**— *Messages accepted for transmission should be transmitted in plain language or approved phrases without altering the sense of the message in any way. Approved ICAO abbreviations contained in the text of the message to be transmitted to aircraft should normally be converted into the unabbreviated words or phrases which these abbreviations represent in the language used, except for those which owing to frequent and common practice, are generally understood by aeronautical personnel.*

Note.— The abbreviations which constitute the exceptions mentioned in 5.2.1.4.5 are specifically identified in the abbreviation encode sections of the PANS — ICAO Abbreviations and Codes *(Doc 8400).*

5.2.1.4.6 **PANS.**— *To expedite communication, the use of phonetic spelling should be dispensed with, if there is no risk of this affecting correct reception and intelligibility of the message.*

5.2.1.4.7 **PANS.**— *The transmission of long messages should be interrupted momentarily from time to time to permit the transmitting operator to confirm that the frequency in use is clear and, if necessary, to permit the receiving operator to request repetition of parts not received.*

5.2.1.4.8 The following words and phrases shall be used in radiotelephony communications as appropriate and shall have the meaning ascribed hereunder:

Phrase	*Meaning*
ACKNOWLEDGE	"Let me know that you have received and understood this message."
AFFIRM	"Yes."
APPROVED	"Permission for proposed action granted."
BREAK	"I hereby indicate the separation between portions of the message." *(To be used where there is no clear distinction between the text and other portions of the message.)*
BREAK BREAK	"I hereby indicate the separation between messages transmitted to different aircraft in a very busy environment."
CANCEL	"Annul the previously transmitted clearance."
CHECK	"Examine a system or procedure." *(No answer is normally expected.)*
CLEARED	"Authorized to proceed under the conditions specified."
CONFIRM	"Have I correctly received the following...?" *or* "Did you correctly receive this message?"
CONTACT	"Establish radio contact with..."
CORRECT	"That is correct."
CORRECTION	"An error has been made in this transmission (*or* message indicated). The correct version is..."
DISREGARD	"Consider that transmission as not sent."
GO AHEAD	"Proceed with your message."
HOW DO YOU READ	"What is the readability of my transmission?" (*see* 5.2.1.7.4.)
I SAY AGAIN	"I repeat for clarity or emphasis."
MONITOR	"Listen out on (frequency)."
NEGATIVE	"No" *or* "Permission not granted" *or* "That is not correct".
OVER	"My transmission is ended, and I expect a response from you." *Note.— Not normally used in VHF communications.*
OUT	"This exchange of transmissions is ended and no response is expected." *Note.— Not normally used in VHF communications.*

READ BACK	"Repeat all, or the specified part, of this message back to me exactly as received."
RECLEARED	"A change has been made to your last clearance and this new clearance supersedes your previous clearance or part thereof."
REPORT	"Pass me the following information..."
REQUEST	"I should like to know..." *or* "I wish to obtain..."
ROGER	"I have received all of your last transmission." *Note.— Under no circumstances to be used in reply to a question requiring "READ BACK" or a direct answer in the affirmative (AFFIRM) or negative (NEGATIVE).*
SAY AGAIN	"Repeat all, or the following part, of your last transmission."
SPEAK SLOWER	"Reduce your rate of speech." *Note.— For normal rate of speech,* see *5.2.1.4.3 b).*
STANDBY	"Wait and I will call you."
VERIFY	"Check and confirm with originator."
WILCO	*(Abbreviation for "will comply".)* "I understand your message and will comply with it."
WORDS TWICE	a) *As a request:* "Communication is difficult. Please send every word, or group of words, twice." b) *As information:* "Since communication is difficult, every word, or group of words, in this message will be sent twice."

5.2.1.5 *Composition of messages*

5.2.1.5.1 Messages handled entirely by the aeronautical mobile service shall comprise the following parts in the order stated:

a) call indicating the addressee and the originator (*see* 5.2.1.6.3);

b) text (*see* 5.2.1.5.2.1.1).

Note.— The following examples illustrate the application of this procedure:

(call)	NEW YORK RADIO SWISSAIR ONE ONE ZERO
(text)	REQUEST SELCAL CHECK

or

(call)	SWISSAIR ONE ONE ZERO NEW YORK RADIO
(text)	CONTACT SAN JUAN ON FIVE SIX

5.2.1.5.2 Messages requiring handling by the AFTN for part of their routing and similarly messages which are not handled in accordance with predetermined distribution arrangements (*see* 3.3.7.1) shall be composed as follows:

5.2.1.5.2.1 *When originated in an aircraft:*

1) call (*see* 5.2.1.6.3);

2) the word FOR;

3) the name of the organization addressed;

4) the name of the station of destination;

5) the text.

5.2.1.5.2.1.1 The text shall be as short as practicable to convey the necessary information; full use shall be made of ICAO phraseologies.

Note.— The following example illustrates the application of this procedure:

(call)	BOSTON RADIO SWISSAIR ONE TWO EIGHT
(address)	FOR SWISSAIR BOSTON
(text)	NUMBER ONE ENGINE CHANGE REQUIRED

5.2.1.5.2.2 *When addressed to an aircraft.* When a message, prepared in accordance with 4.4.2, is retransmitted by an aeronautical station to an aircraft in flight, the heading and address of the AFTN message format shall be omitted during the retransmission on the aeronautical mobile service.

5.2.1.5.2.2.1 When the provisions of 5.2.1.5.2.2 are applied, the aeronautical mobile service message transmission shall comprise:

a) the text [incorporating any corrections (COR) contained in the AFTN message];

b) the word FROM;

c) the name of the originating organization and its location (taken from the origin section of the AFTN message).

5.2.1.5.2.2.2 **PANS.—** *When the text of a message to be transmitted by an aeronautical station to an aircraft in flight contains approved ICAO abbreviations, these abbreviations should normally be converted during the transmission of the* *message into the unabbreviated words or phrases which the abbreviations represent in the language used, except for those which, owing to frequent or common practice, are generally understood by aeronautical personnel.*

Note.— The abbreviations which constitute the exceptions mentioned in 5.2.1.5.2.2.2 are specifically identified in the abbreviations encode sections of the PANS — ICAO Abbreviations and Codes *(Doc 8400).*

5.2.1.6 *Calling*

5.2.1.6.1 *Radiotelephony call signs for aeronautical stations*

5.2.1.6.1.1 Aeronautical stations in the aeronautical mobile service shall be identified by:

a) the name of the location, and

b) the unit or service available.

5.2.1.6.1.2 The unit or service shall be identified in accordance with the table below except that the name of the location or the unit/service may be omitted provided satisfactory communication has been established.

Unit/service available	*Call sign suffix*
area control centre	CONTROL
approach control	APPROACH
approach control radar arrivals	ARRIVAL
approach control radar departures	DEPARTURE
aerodrome control	TOWER
surface movement control	GROUND
radar (in general)	RADAR
precision approach radar	PRECISION
direction-finding station	HOMER
flight information service	INFORMATION
clearance delivery	DELIVERY
apron control	APRON
company dispatch	DISPATCH
aeronautical station	RADIO

5.2.1.6.2 *Radiotelephony call signs for aircraft*

5.2.1.6.2.1 *Full call signs*

5.2.1.6.2.1.1 An aircraft radiotelephony call sign shall be one of the following types:

Type a) — the characters corresponding to the registration marking of the aircraft; or

Type b) — the telephony designator of the aircraft operating agency, followed by the last four characters of the registration marking of the aircraft;

Type c) — the telephony designator of the aircraft operating agency, followed by the flight identification.

Note 1.— The name of aircraft manufacturer or name of aircraft model may be used as a radiotelephony prefix to the Type a) call sign above.

Note 2.— The call signs referred to in a), b) and c) above comprise combinations in accordance with the ITU Radio Regulations (No. 2129 and No. 2130).

Note 3.— The telephony designators referred to in b) and c) above are contained in ICAO Doc 8585 — Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services.

Note 4.— Any of the foregoing call signs may be inserted in field 7 of the ICAO flight plan as the aircraft identification. Instructions on the completion of the flight plan form are contained in PANS-RAC, Doc 4444.

5.2.1.6.2.2 *Abbreviated call signs*

5.2.1.6.2.2.1 The aircraft radiotelephony call signs shown in 5.2.1.6.2.1.1 above, with the exception of c), may be abbreviated in the circumstances prescribed in 5.2.1.6.3.3.1 below. Abbreviated call signs shall be in the following form:

Type a) — the first character of the registration and at least the last two characters of the call sign;

Type b) — the telephony designator of the aircraft operating agency, followed by at least the last two characters of the call sign;

Type c) — no abbreviated form.

Note.— Either the name of the aircraft manufacturer or the aircraft model may be used in place of the first character in Type a) above.

5.2.1.6.3 *Radiotelephony procedures*

5.2.1.6.3.1 An aircraft shall not change the type of its radiotelephony call sign during flight, except temporarily on the instruction of an air traffic control unit in the interests of safety.

5.2.1.6.3.1.1 Except for reasons of safety no transmission shall be directed to an aircraft during take-off, during the last part of the final approach or during the landing roll.

		Type a)		*Type b)*	*Type c)*
Full call sign	N 57826	*CESSNA FABCD	*CITATION FABCD	VARIG PVMA	SCANDINAVIAN 937
Abbreviated call sign	N26 or N826	CESSNA CD or CESSNA BCD	CITATION CD or CITATION BCD	VARIG MA or VARIG VMA	(no abbreviated form)

* Examples illustrate the application of Note 1 to 5.2.1.6.2.1.1.

Figure 5-2. Examples of full call signs and abbreviated call signs
(*see* 5.2.1.6.2.1 and 5.2.1.6.2.2)

5.2.1.6.3.2 *Establishment of radiotelephony communications*

5.2.1.6.3.2.1 Full radiotelephony call signs shall always be used when establishing communication. The calling procedure of an aircraft establishing communication shall be in accordance with Table 5-1.

5.2.1.6.3.2.2 **PANS.**— *Stations having a requirement to transmit information to all stations likely to intercept should preface such transmission by the general call ALL STATIONS, followed by the identification of the calling station.*

Note.— No reply is expected to such general calls unless individual stations are subsequently called to acknowledge receipt.

5.2.1.6.3.2.3 The reply to the above calls shall be in accordance with Table 5-2.

5.2.1.6.3.2.4 **PANS.**— *When a station is called but is uncertain of the identification of the calling station, it should reply by transmitting the following:*

STATION CALLING . . . *(station called)* SAY AGAIN YOUR CALL SIGN

Note.— The following example illustrates the application of this procedure:

(CAIRO station replying)

STATION CALLING CAIRO *(pause)* SAY AGAIN YOUR CALL SIGN

5.2.1.6.3.2.5 Communications shall commence with a call and a reply when it is desired to establish contact, except that, when it is certain that the station called will receive the call, the calling station may transmit the message, without waiting for reply from the station called.

5.2.1.6.3.2.6 Interpilot air-to-air communication shall be established on the appropriate air-to-air frequency by either a directed call to a specific aircraft station or a general call, taking into account conditions pertaining to use of this channel.

Note.— For conditions on use of air-to-air channels see Annex 10, Volume I, Part II, 4.1.3.2.1, also Volume II, 5.2.2.1.1.3.

5.2.1.6.3.2.6.1 **PANS.**— *As the aircraft may be guarding more than one frequency, the initial call should include an indication of the air-to-air frequency and/or distinctive channel identification "INTERPILOT".*

Note.— The following examples illustrate the application of these calling procedures.

CLIPPER 123 — SABENA 901 — INTERPILOT — DO YOU READ

or

ANY AIRCRAFT VICINITY OF 30 NORTH 160 EAST — JAPANAIR 401 — INTERPILOT 128.95 — OVER

5.2.1.6.3.3 *Subsequent radiotelephony communications*

5.2.1.6.3.3.1 Abbreviated radiotelephony call signs, as prescribed in 5.2.1.6.2.2 above, shall be used only after satisfactory communication has been established and provided that no confusion is likely to arise. An aircraft station shall use its abbreviated call sign only after it has been addressed in this manner by the aeronautical station.

Table 5-1. Radiotelephony calling procedure* (*see* 5.2.1.6.3.2.1)

	Type a)	*Type b)*	*Type c)*
Designation of the station called	NEW YORK RADIO	NEW YORK RADIO	NEW YORK RADIO
Designation of the station calling	GABCD**	SPEEDBIRD ABCD**	AEROFLOT 321**

* *In certain cases where the call is initiated by the aeronautical station, the call may be effected by transmission of coded tone signals.*

** *With the exception of the telephony designators and the type of aircraft, each character in the call sign shall be spoken separately. When individual letters are spelled out, the radiotelephony spelling alphabet prescribed in 5.2.1.2 shall be used. Numbers are to be spoken in accordance with 5.2.1.3.*

Table 5-2. Radiotelephony reply procedure (*see* 5.2.1.6.3.2.3)

	Type a)	*Type b)*	*Type c)*
Designation of the station called	GABCD*	SPEEDBIRD ABCD*	AEROFLOT 321*
Designation of the answering station	NEW YORK RADIO	NEW YORK RADIO	NEW YORK RADIO
Invitation to proceed with transmission	GO AHEAD	GO AHEAD	GO AHEAD

* *With the exception of the telephony designators and the type of aircraft, each character in the call sign shall be spoken separately. When individual letters are spelled out, the radiotelephony spelling alphabet prescribed in 5.2.1.2 shall be used. Numbers are to be spoken in accordance with 5.2.1.3.*

5.2.1.6.3.3.2 After contact has been established, continuous two-way communication shall be permitted without further identification or call until termination of the contact.

5.2.1.6.3.3.3 In order to avoid any possible confusion, when issuing ATC clearances and reading back such clearances, controllers and pilots shall always add the call sign of the aircraft to which the clearance applies.

5.2.1.6.3.4 *Indication of transmitting frequency*

5.2.1.6.3.4.1 **PANS.**— *As the aeronautical station operator generally guards more than one frequency, the call should be followed by an indication of the frequency used, unless other suitable means of identifying the frequency are known to exist.*

5.2.1.6.3.4.2 **PANS.**— *When no confusion is likely to arise, only the first two digits of the High Frequency (in kHz) need be used to identify the transmitting channel.*

Note.— The following example illustrates the application of this procedure:

(PAA 325 calling Kingston on 8 871 kHz)

KINGSTON CLIPPER THREE TWO FIVE — ON EIGHT EIGHT

5.2.1.6.3.4.3 **PANS.**— *Wherever VHF communications channels are separated by 25 kHz, only the first 5 digits should be used to identify the transmitting frequency in radiotelephony communications.*

Note.— The following examples illustrate the application of this procedure:

a) *Message — Donlon Control requesting Air Penguin 801 to contact Donlon Radar on 126.000 MHz.*

Phraseology — AIR PENGUIN EIGHT ZERO ONE DONLON CONTROL CONTACT DONLON RADAR ON ONE TWO SIX DECIMAL ZERO ZERO.

b) *Message — Donlon Control requesting Air Penguin 801 to contact Donlon Radar on 132.675 MHz.*

Phraseology — AIR PENGUIN EIGHT ZERO ONE DONLON CONTROL CONTACT DONLON RADAR ON ONE THREE TWO DECIMAL SIX SEVEN.

5.2.1.7 *Test procedures*

5.2.1.7.1 **PANS.**— *The form of test transmissions should be as follows:*

a) the identification of the station being called;

b) the aircraft identification;

c) the words "RADIO CHECK";

d) the frequency being used.

5.2.1.7.2 **PANS.**— *The reply to a test transmission should be as follows:*

a) the identification of the aircraft;

b) the identification of the aeronautical station replying;

c) information regarding the readability of the aircraft transmission.

5.2.1.7.3 **PANS.**— *The test transmission and reply thereto should be recorded at the aeronautical station.*

5.2.1.7.4 **PANS.**— *When the tests are made, the following readability scale should be used:*

Readability Scale

1 Unreadable
2 Readable now and then
3 Readable but with difficulty
4 Readable
5 Perfectly readable

5.2.1.8 *Exchange of communications*

5.2.1.8.1 Communications shall be concise and unambiguous, using standard phraseology whenever available.

5.2.1.8.1.1 **Recommendation.**— *Abbreviated procedures should only be used after initial contact has been established and where no confusion is likely to arise.*

5.2.1.8.2 *Acknowledgement of receipt.* The receiving operator shall make certain that the message has been received correctly before acknowledging receipt.

Note.— Acknowledgement of receipt is not to be confused with acknowledgement of intercept in radiotelephony network operations.

5.2.1.8.2.1 When transmitted by an aircraft station, the acknowledgement of receipt of a message shall comprise the call sign of that aircraft.

5.2.1.8.2.2 **PANS.**— *An aircraft station should acknowledge receipt of important air traffic control messages or parts thereof by reading them back and terminating the readback by its radio call sign.*

Note 1.— Air traffic control clearances, instructions and information requiring readback are specified in the Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services *(PANS-RAC, Doc 4444).*

Note 2.— The following example illustrates the application of this procedure:

(ATC clearance by network station to an aircraft)

Station:
TWA NINE SIX THREE MADRID

Aircraft:
MADRID TWA NINE SIX THREE — GO AHEAD

Station:
TWA NINE SIX THREE MADRID — ATC CLEARS TWA NINE SIX THREE TO DESCEND TO NINE THOUSAND FEET

Aircraft (acknowledging):
CLEARED TO DESCEND TO NINE THOUSAND FEET — TWA NINE SIX THREE

Station (denoting accuracy of readback):
MADRID

5.2.1.8.2.3 When acknowledgement of receipt is transmitted by an aeronautical station:

1) *to an aircraft station:* it shall comprise the call sign of the aircraft, followed if considered necessary by the call sign of the aeronautical station;

2) *to another aeronautical station:* it shall comprise the call sign of the aeronautical station that is acknowledging receipt.

5.2.1.8.2.3.1 **PANS.**— *An aeronautical station should acknowledge position reports and other flight progress reports by reading back the report and terminating the readback by its call sign, except that the readback procedure may be suspended temporarily whenever it will alleviate congestion on the communication channel.*

5.2.1.8.2.4 **PANS.**— *It is permissible for verification for the receiving station to read back the message as an additional acknowledgement of receipt. In such instances, the station to which the information is read back should acknowledge the correctness of readback by transmitting its call sign.*

5.2.1.8.2.5 **PANS.**— *If both position report and other information — such as weather reports — are received in the same message, the information should be acknowledged with the words such as "WEATHER RECEIVED" after the position* *report has been read back, except when intercept of the information is required by other network stations. Other messages should be acknowledged, the aeronautical station transmitting its call sign only.*

5.2.1.8.3 *End of conversation.* A radiotelephone conversation shall be terminated by the receiving station using its own call sign.

5.2.1.8.4 *Corrections and repetitions*

5.2.1.8.4.1 When an error has been made in transmission, the word "CORRECTION" shall be spoken, the last correct group or phrase repeated, and then the correct version transmitted.

5.2.1.8.4.2 If a correction can best be made by repeating the entire message, the operator shall use the phrase "CORRECTION, I SAY AGAIN" before transmitting the message a second time.

5.2.1.8.4.3 **Recommendation.—** *When an operator transmitting a message considers that reception is likely to be difficult, he should transmit the important elements of the message twice.*

5.2.1.8.4.4 If the receiving operator is in doubt as to the correctness of the message received, he shall request repetition either in full or in part.

5.2.1.8.4.5 If repetition of an entire message is required, the words "SAY AGAIN" shall be spoken. If repetition of a portion of a message is required, the operator shall state: "SAY AGAIN ALL BEFORE...(first word satisfactorily received)"; or "SAY AGAIN...(word before missing portion) TO...(word after missing portion)"; or "SAY AGAIN ALL AFTER...(last word satisfactorily received)".

5.2.1.8.4.6 **Recommendation.—** *Specific items should be requested, as appropriate, such as "SAY AGAIN ALTIMETER", "SAY AGAIN WIND".*

5.2.1.8.4.7 If, in checking the correctness of a readback, an operator notices incorrect items, he shall transmit the words "NEGATIVE I SAY AGAIN" at the conclusion of the readback followed by the correct version of the items concerned.

5.2.1.8.5 *"Operations normal" reports*

5.2.1.8.5.1 **PANS.—** *When "operations normal" reports are transmitted by aircraft, they should consist of the prescribed call followed by the words "OPERATIONS NORMAL".*

5.2.2 Establishment and assurance of communications

5.2.2.1 *Communications watch/ Hours of service*

5.2.2.1.1 During flight, aircraft stations shall maintain watch as required by the appropriate Authority and shall not cease watch, except for reasons of safety, without informing the aeronautical station(s) concerned.

5.2.2.1.1.1 Aircraft on long over-water flights, or on flights over designated areas over which the carriage of an emergency locator transmitter (ELT) is required, shall continuously guard the VHF emergency frequency 121.5 MHz, except for those periods when aircraft are carrying out communications on other VHF channels or when airborne equipment limitations or cockpit duties do not permit simultaneous guarding of two channels.

5.2.2.1.1.2 Aircraft shall continuously guard the VHF emergency frequency 121.5 MHz in areas or over routes where the possibility of interception of aircraft or other hazardous situations exist, and a requirement has been established by the appropriate authority.

5.2.2.1.1.3 **Recommendation.—** *Aircraft on flights other than those specified in 5.2.2.1.1.1 and 5.2.2.1.1.2 should guard the emergency frequency 121.5 MHz to the extent possible.*

5.2.2.1.1.4 The user of the air-to-air VHF communications channel shall ensure that adequate watch is maintained on designated ATS frequencies, the frequency of the aeronautical emergency channel, and any other mandatory watch frequencies.

5.2.2.1.2 Aeronautical stations shall maintain watch as required by the appropriate Authority.

5.2.2.1.3 Aeronautical stations shall maintain a continuous listening watch on VHF emergency channel 121.5 MHz during the hours of service of the units at which it is installed.

Note.— See Annex 10, Volume I, Part II, 4.1.3.1.2 and 4.1.3.1.3 for provisions related to the utilization of 121.5 MHz at aeronautical stations.

5.2.2.1.4 When it is necessary for an aircraft station or aeronautical station to suspend operation for any reason, it shall, if possible, so inform other stations concerned, giving the time at which it is expected that operation will be resumed. When operation is resumed, other stations concerned shall be so informed.

5.2.2.1.4.1 When it is necessary to suspend operation beyond the time specified in the original notice, a revised time of resumption of operation shall, if possible, be transmitted at or near the time first specified.

5.2.2.1.5 **Recommendation.—** *When two or more ATS frequencies are being used by a controller, consideration should be given to providing facilities to allow ATS and aircraft transmissions on any of the frequencies to be simultaneously retransmitted on the other frequencies in use thus permitting aircraft stations within range to hear all transmissions to and from the controller.*

5.2.2.2 *Principles of network operation (HF communications)*

5.2.2.2.1 **PANS.—** *The aeronautical stations of a radiotelephony network should assist each other in accordance with the following network principles, in order to provide the air-ground communication service required of the network by aircraft flying on the air routes for which the network is responsible.*

5.2.2.2.2 **PANS.—** *When the network comprises a large number of stations, network communications for flights on any individual route segment should be provided by selected stations, termed "regular stations" for that segment.*

Note 1.— The selection of stations to act as regular stations for a particular route segment will, where necessary, be undertaken by regional or local agreement, after consultation, if necessary, between the States responsible for the network.

Note 2.— In principle, the regular stations will be those serving the locations immediately concerned with flights on that route segment, i.e. points of take-off and landing, appropriate flight information centres or area control centres and, in some cases, additional suitably located stations required to complete the communication coverage or for intercept purposes.

Note 3.— In selecting the regular stations, account will be taken of the propagation characteristics of the frequencies used.

5.2.2.2.3 **PANS.—** *In areas or on routes where radio conditions, length of flights or distance between aeronautical stations require additional measures to ensure continuity of air-ground communication throughout the route segment, the regular stations should share between them a responsibility of primary guard whereby each station will provide the primary guard for that portion of the flight during which the messages from the aircraft can be handled most effectively by that station.*

5.2.2.2.4 **PANS.—** *During its tenure of primary guard, each regular station should, among other things:*

a) be responsible for designating suitable primary and secondary frequencies for its communications with the aircraft;

b) receive all position reports and handle other messages from and to the aircraft essential to the safe conduct of the flight;

c) be responsible for the action required in case of failure of communications (see 5.2.2.7.2).

5.2.2.2.5 **PANS.—** *The transfer of primary guard from one station to the next will normally take place at the time of the traversing of flight information region or control area boundaries, this guard being provided at any time, as far as possible, by the station serving the flight information centre or area control centre in whose area the aircraft is flying. However, where communication conditions so demand, a station may be required to retain primary guard beyond such geographical boundaries or release its guard before the aircraft reaches the boundary, if appreciable improvement in air-ground communication can be effected thereby.*

5.2.2.3 *Frequencies to be used*

5.2.2.3.1 Aircraft stations shall operate on the appropriate radio frequencies.

5.2.2.3.1.1 The air-ground control radio station shall designate the frequency(ies) to be used under normal conditions by aircraft stations operating under its control.

5.2.2.3.1.2 **PANS.—** *In network operation, the initial designation of primary and secondary frequencies should be made by the network station with which the aircraft makes pre-flight check or its initial contact after take-off. This station should also ensure that other network stations are advised, as required, of the frequency(ies) designated.*

5.2.2.3.2 **Recommendation.—** *An aeronautical station, when designating frequencies in accordance with 5.2.2.3.1.1 or 5.2.2.3.1.2, should take into account the appropriate propagation data and distance over which communications are required.*

5.2.2.3.3 **Recommendation.—** *If a frequency designated by an aeronautical station proves to be unsuitable, the aircraft station should suggest an alternative frequency.*

5.2.2.3.4 **PANS.—** *When, notwithstanding the provisions of 5.1.1, air-ground frequencies are used for the exchange between network stations of messages essential for* *co-ordination and co-operation between the stations, such communication should, so far as possible, be effected over network frequencies not being used at that time for the bulk of the air-ground traffic. In all cases, the communication with aircraft stations should take priority over the inter-ground station communications.*

5.2.2.4 *Establishment of communications*

5.2.2.4.1 Aircraft stations shall, if possible, communicate directly with the air-ground control radio station appropriate to the area in which the aircraft are flying. If unable to do so, aircraft stations shall use any relay means available and appropriate to transmit messages to the air-ground control radio station.

5.2.2.4.2 When normal communications from an aeronautical station to an aircraft station cannot be established, the aeronautical station shall use any relay means available and appropriate to transmit messages to the aircraft station. If these efforts fail, the originator shall be advised in accordance with procedures prescribed by the appropriate Authority.

5.2.2.4.3 **PANS.**— *When, in network operation, communication between an aircraft station and a regular station has not been established after calls on the primary and secondary frequencies, aid should be rendered by one of the other regular stations for that flight, either by calling the attention of the station first called or, in the case of a call made by an aircraft station, by answering the call and taking the traffic.*

5.2.2.4.3.1 **PANS.**— *Other stations of the network should render assistance by taking similar action only if attempts to establish communications by the regular stations have proved unsuccessful.*

5.2.2.4.4 **PANS.**— *The provisions of 5.2.2.4.3 and 5.2.2.4.3.1 should also be applied:*

a) on request of the air traffic services unit concerned;

b) when an expected communication from an aircraft has not been received within a time period such that the occurrence of a communication failure is suspected.

Note.— A specific time period may be prescribed by the appropriate ATS Authority.

5.2.2.5 *Transfer of HF communications*

5.2.2.5.1 **PANS.**— *An aircraft station should be advised by the appropriate aeronautical station to transfer from one radio frequency or network to another. In the absence of such advice, the aircraft station should notify the appropriate aeronautical station before such transfer takes place.*

5.2.2.5.2 **PANS.**— *In the case of transfer from one network to another, the transfer should preferably take place while the aircraft is in communication with a station operating in both networks to ensure continuity of communications. If, however, the change of network must take place concurrently with the transfer of communication to another network station, the transfer should be co-ordinated by the two network stations prior to advising or authorizing the frequency change. The aircraft should also be advised of the primary and secondary frequencies to be used after the transfer.*

5.2.2.5.3 An aircraft station which has transferred communications watch from one radio frequency to another shall, when so required by the appropriate ATS Authority, inform the aeronautical station concerned that communications watch has been established on the new frequency.

5.2.2.5.4 **PANS.**— *When entering a network after take-off, an aircraft station should transmit its take-off time or time over the last check-point, to the appropriate regular station.*

5.2.2.5.5 **PANS.**— *When entering a new network, an aircraft station should transmit the time over the last check-point, or of its last reported position, to the appropriate regular station.*

5.2.2.5.6 **PANS.**— *Before leaving the network, an aircraft station should in all cases advise the appropriate regular station of its intention to do so by transmitting one of the following phrases, as appropriate:*

a) when transferring to a pilot-to-controller channel:
Aircraft: CHANGING TO . . . *(air traffic services unit concerned)*

b) after landing:
Aircraft: LANDED . . . *(location)* . . . *(time)*

5.2.2.6 *Transfer of VHF communications*

5.2.2.6.1 An aircraft shall be advised by the appropriate aeronautical station to transfer from one radio frequency to another in accordance with agreed procedures. In the absence of such advice, the aircraft station shall notify the appropriate aeronautical station before such a transfer takes place.

5.2.2.6.2 When establishing initial contact on, or when leaving, a VHF frequency, an aircraft station shall transmit such information as may be prescribed by the appropriate Authority.

5.2.2.7 *Communications failure*

5.2.2.7.1 *Air-ground*

5.2.2.7.1.1 When an aircraft station fails to establish contact with the aeronautical station on the designated frequency, it shall attempt to establish contact on another frequency appropriate to the route. If this attempt fails, the aircraft station shall attempt to establish communication with other aircraft or other aeronautical stations on frequencies appropriate to the route. In addition, an aircraft operating within a network shall monitor the appropriate VHF frequency for calls from nearby aircraft.

5.2.2.7.1.2 If the attempts specified under 5.2.2.7.1.1 fail, the aircraft station shall transmit its message twice on the designated frequency(ies), preceded by the phrase "TRANSMITTING BLIND" and, if necessary, include the addressee(s) for which the message is intended.

5.2.2.7.1.2.1 **PANS.**— *In network operation, a message which is transmitted blind should be transmitted twice on both primary and secondary frequencies. Before changing frequency, the aircraft station should announce the frequency to which it is changing.*

5.2.2.7.1.3 *Receiver failure*

5.2.2.7.1.3.1 When an aircraft station is unable to establish communication due to receiver failure, it shall transmit reports at the scheduled times, or positions, on the frequency in use, preceded by the phrase "TRANSMITTING BLIND DUE TO RECEIVER FAILURE". The aircraft station shall transmit the intended message, following this by a complete repetition. During this procedure, the aircraft shall also advise the time of its next intended transmission.

5.2.2.7.1.3.2 An aircraft which is provided with air traffic control or advisory service shall, in addition to complying with 5.2.2.7.1.3.1, transmit information regarding the intention of the pilot-in-command with respect to the continuation of the flight of the aircraft.

5.2.2.7.1.3.3 When an aircraft is unable to establish communication due to airborne equipment failure it shall, when so equipped, select the appropriate SSR code to indicate radio failure.

Note.— General rules which are applicable in the event of communications failure are contained in Annex 2 to the Convention.

5.2.2.7.2 *Ground-to-air*

5.2.2.7.2.1 When an aeronautical station has been unable to establish contact with an aircraft station after calls on the frequencies on which the aircraft is believed to be listening, it shall:

a) request other aeronautical stations to render assistance by calling the aircraft and relaying traffic, if necessary;

b) request aircraft on the route to attempt to establish communication with the aircraft and relay traffic, if necessary.

5.2.2.7.2.2 The provisions of 5.2.2.7.2.1 shall also be applied:

a) on request of the air traffic services unit concerned;

b) when an expected communication from an aircraft has not been received within a time period such that the occurrence of a communication failure is suspected.

Note.— A specific time period may be prescribed by the appropriate ATS Authority.

5.2.2.7.2.3 **Recommendation.**— *If the attempts specified in 5.2.2.7.2.1 fail, the aeronautical station should transmit messages addressed to the aircraft, other than messages containing air traffic control clearances, by blind transmission on the frequency(ies) on which the aircraft is believed to be listening.*

5.2.2.7.2.4 Blind transmission of air traffic control clearances shall not be made to aircraft, except at the specific request of the originator.

5.2.2.7.3 *Notification of communications failure.* The air-ground control radio station shall notify the appropriate air traffic services unit and the aircraft operating agency, as soon as possible, of any failure in air-ground communication.

5.2.3 HF message handling

5.2.3.1 *General*

5.2.3.1.1 **PANS.**— *When operating within a network, an aircraft station should, in principle, whenever communications conditions so permit, transmit its messages to the stations of the network from which they can be most readily delivered to their ultimate destinations. In particular, aircraft reports required by air traffic services should be transmitted to the network station serving the flight information centre or area control centre in whose area the aircraft is flying. Conversely, messages to aircraft in flight should, whenever possible, be transmitted directly to the aircraft by the network station serving the location of the originator.*

Note.— Exceptionally, an aircraft may need to communicate with an aeronautical station outside the network appropriate to its particular route segment. This is permissible, provided it can be done without interrupting the continuous watch with the communication network appropriate to the route segment, when such watch is required by the appropriate ATS Authority, and provided it does not cause undue interference with the operation of other aeronautical stations.

5.2.3.1.2 **PANS.—** *Messages passed from an aircraft to a network station should, whenever possible, be intercepted and acknowledged by other stations of the network, which serve locations where the information is also required.*

Note 1.— Determination of the arrangements for dissemination of air-ground messages without address will be a matter for multilateral or local agreement.

Note 2.— In principle, the number of stations required to intercept are to be kept to a minimum consistent with the operational requirement.

5.2.3.1.2.1 **PANS.—** *Acknowledgement of intercept should be made immediately after the acknowledgement of receipt by the station to which the message was passed.*

5.2.3.1.2.2 **PANS.—** *Acknowledgement of an intercept message should be made by transmitting the radio call sign of the station having intercepted the message, followed by the word ROGER, if desired, and the call sign of the station having transmitted the message.*

5.2.3.1.2.3 **PANS.—** *In the absence of acknowledgement of intercept within one minute, the station accepting the message from the aircraft should forward it, normally over the aeronautical fixed service, to the station(s) which have failed to acknowledge intercept.*

5.2.3.1.2.3.1 **PANS.—** *If, in abnormal circumstances, forwarding is necessary using the air-ground channels, the provisions of 5.2.2.3.4 should be observed.*

5.2.3.1.2.4 **PANS.—** *When such forwarding is done over the aeronautical fixed telecommunication network, the messages should be addressed to the network station(s) concerned.*

5.2.3.1.2.5 **PANS.—** *The station(s) to which the messages have been forwarded should carry out local distribution of them in the same way as if they had been received directly from the aircraft over the air-ground channel.*

5.2.3.1.2.6 The aeronautical station receiving an air-report or a message containing meteorological information transmitted by an aircraft in flight shall forward the message without delay:

1) to the air traffic services unit and meteorological offices associated with the station:

2) to the aircraft operating agency concerned or its representative when that agency has made a specific request to receive such messages.

5.2.3.1.3 **PANS.—** *The provisions of 5.2.3.1.2 should also be applied, if practicable, in non-network operation.*

5.2.3.1.4 **Recommendation.—** *When a message addressed to an aircraft in flight is received by the aeronautical station included in the address, and when that station is not able to establish communication with the aircraft to which the message is addressed, the message should be forwarded to those aeronautical stations on the route which may be able to establish communication with the aircraft.*

Note.— This does not preclude the transmission by the forwarding aeronautical station, of the original message to the aircraft addressed, if the forwarding station is later able to communicate with that aircraft.

5.2.3.1.4.1 **Recommendation.—** *If the aeronautical station to which the message is addressed is unable to dispose of the message in accordance with 5.2.3.1.4, the station of origin should be advised.*

5.2.3.1.4.2 The aeronautical station forwarding the message shall amend the address thereof, by substituting for its own location indicator the location indicator of the aeronautical station to which the message is being forwarded.

5.2.3.2 *Transmission of ATS messages to aircraft*

5.2.3.2.1 **PANS.—** *If it is not possible to deliver an ATS message to the aircraft within the time specified by ATS, the aeronautical station should notify the originator. Thereafter, it should take no further action with respect to this message unless specifically instructed by ATS.*

5.2.3.2.2 **PANS.—** *If delivery of an ATS message is uncertain because of inability to secure an acknowledgement, the aeronautical station should assume that the message has not been received by the aircraft and should advise the originator immediately that, although the message has been transmitted, it has not been acknowledged.*

5.2.3.2.3 **PANS.—** *The aeronautical station, having received the message from ATS, should not delegate to another station the responsibility for delivery of the message to the aircraft. However, in case of communication difficulties, other stations should assist, when requested, in relaying the message to the aircraft. In this case, the station having received the message from ATS should obtain without delay definite assurance that the aircraft has correctly acknowledged the message.*

5.2.3.3 *Recording of air-ground communications on teletypewriter*

5.2.3.3.1 **PANS.—** *When recording on teletypewriter, the following procedure should be used:*

a) each line should begin at the left margin;

b) a new line should be used for each transmission;

c) each communication should contain some or all of the following items in the order shown:

1) call sign of the calling station;

2) text of the message;

3) call sign of the station called or the receiving station, followed by the appropriate abbreviation to indicate "Received", "Readback", or "No reply heard";

4) call sign of station(s) acknowledging intercept followed by appropriate abbreviation to indicate "Received";

5) designation of frequency used;

6) time in UTC of the communication;

d) missing parts of the message text should be indicated by typing the three periods (space . space . space . space) or three letters M (space M space M space M space);

e) correction of typing errors should be made by keyboard manipulation (space E space E space E space), followed by the correct information. Errors detected after the completion of the entry should be corrected after the last entry, using the abbreviation COR, followed by the correct information.

5.2.4 SELCAL procedures

Introductory Note.— The procedures contained in 5.2.4 are applicable when SELCAL is used and replace certain of the procedures related to calling contained in 5.2.1.

5.2.4.1 *General*

5.2.4.1.1 **PANS.—** *With the selective calling system known as SELCAL, the voice calling is replaced by the transmission of coded tones to the aircraft over the radiotelephony channels. A single selective call consists of a combination of four pre-selected audio tones whose transmission requires approximately 2 seconds. The tones are generated in the aeronautical station coder and are received by a decoder connected to the audio output of the airborne receiver. Receipt of the assigned tone code (SELCAL code) activates a cockpit call system in the form of light and/or chime signals.*

5.2.4.1.2 **PANS.—** *SELCAL should be utilized by suitably equipped stations for ground-to-air selective calling on the en-route HF and VHF radio channels.*

5.2.4.1.3 **PANS.—** *On aircraft equipped with SELCAL, the pilot is still able to keep a conventional listening watch if required.*

5.2.4.2 *Notification to aeronautical stations of aircraft SELCAL codes*

5.2.4.2.1 **PANS.—** *It is the responsibility of the aircraft operating agency and the aircraft to ensure that all aeronautical stations, with which the aircraft would normally communicate during a particular flight, know the SELCAL code associated with its radiotelephone call sign.*

5.2.4.2.2 **PANS.—** *When practicable, the aircraft operating agency should disseminate to all aeronautical stations concerned, at regular intervals, a list of SELCAL codes assigned to its aircraft or flights.*

5.2.4.2.3 **PANS.—** *The aircraft should:*

a) include the SELCAL code in the flight plan submitted to the appropriate air traffic services unit; and

b) ensure that the HF aeronautical station has the correct SELCAL code information by establishing communications temporarily with the HF aeronautical station while still within VHF coverage.

Note.— Provisions regarding completion of the flight plan are set forth in the Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services *(Doc 4444).*

5.2.4.3 *Pre-flight check*

5.2.4.3.1 **PANS.—** *The aircraft station should contact the appropriate aeronautical station and request a pre-flight SELCAL check and, if necessary, give its SELCAL code.*

5.2.4.3.2 **PANS.—** *When primary and secondary frequencies are assigned, a SELCAL check should normally be made first on the secondary frequency and then on the primary frequency. The aircraft station would then be ready for continued communication on the primary frequency.*

5.2.4.3.3 **PANS.—** *Should the pre-flight check reveal that either the ground or airborne SELCAL installation is inoperative, the aircraft should maintain a continuous listening watch on its subsequent flight until SELCAL again becomes available.*

5.2.4.4 *Establishment of communications*

5.2.4.4.1 **PANS.—** *When an aeronautical station initiates a call by SELCAL, the aircraft replies with its radio call sign, followed by the phrase "GO AHEAD".*

5.2.4.5 *En-route procedures*

5.2.4.5.1 **PANS.**— *Aircraft stations should ensure that the appropriate aeronautical station(s) are aware that SELCAL watch is being established or maintained.*

5.2.4.5.2 **PANS.**— *When so prescribed on the basis of regional air navigation agreements, calls for scheduled reports from aircraft may be initiated by an aeronautical station by means of SELCAL.*

5.2.4.5.3 **PANS.**— *Once SELCAL watch has been established by a particular aircraft station, aeronautical stations should employ SELCAL whenever they require to call aircraft.*

5.2.4.5.4 **PANS.**— *In the event the SELCAL signal remains unanswered after two calls on the primary frequency and two calls on the secondary frequency, the aeronautical station should revert to voice calling.*

5.2.4.5.5 **PANS.**— *Stations in a network should keep each other immediately advised when malfunctioning occurs in a SELCAL installation on the ground or in the air. Likewise, the aircraft should ensure that the aeronautical stations concerned with its flight are immediately made aware of any malfunctioning of its SELCAL installation, and that voice calling is necessary.*

5.2.4.5.6 **PANS.**— *All stations should be advised when the SELCAL installation is again functioning normally.*

5.2.4.6 *SELCAL code assignment to aircraft*

5.2.4.6.1 **PANS.**— *In principle, the SELCAL code in the aircraft should be associated with the radiotelephony call sign, i.e. where the flight number (service number) is employed in the radio call sign, the SELCAL code in the aircraft should be listed against the flight number. In all other cases, the SELCAL code in the aircraft should be listed against the aircraft registration.*

Note.— The use of aircraft radio call signs, consisting of the airline abbreviation followed by the flight service number, is increasing among aircraft operators throughout the world. The SELCAL equipment in aircraft should, therefore, be of a type which permits a particular code being associated with a particular flight number, i.e. equipment which is capable of adjustment in code combinations. At this stage, however, many aircraft SELCAL equipments are of the single code type, and it will not be possible for aircraft with such equipment to satisfy the principle set out above. This should not militate against use of the flight number type of radio call sign by an aircraft so equipped if it wishes to apply this type of call sign, but it is essential when a single code airborne equipment is used in conjunction with a flight number type radio call sign that the ground stations be advised in connection with each flight of the SELCAL code available in the aircraft.

5.3 Distress and urgency radiotelephony communication procedures

5.3.1 General

Note.— The distress and urgency procedures contained in 5.3 relate to the use of radiotelephony. The provisions of Article 39 of the ITU Radio Regulations are generally applicable in the event that radiotelegraphy may still be employed in the aeronautical mobile service, and are also applicable to radiotelephony communications between aircraft stations and stations in the maritime mobile service.

5.3.1.1 Distress and urgency traffic shall comprise all radiotelephony messages relative to the distress and urgency conditions respectively. Distress and urgency conditions are defined as:

a) *Distress:* a condition of being threatened by serious and/or imminent danger and of requiring immediate assistance.

b) *Urgency:* a condition concerning the safety of an aircraft or other vehicle, or of some person on board or within sight, but which does not require immediate assistance.

5.3.1.2 The radiotelephony distress signal MAYDAY and the radiotelephony urgency signal PAN PAN shall be used at the commencement of the first distress and urgency communication respectively.

5.3.1.2.1 At the commencement of any subsequent communication in distress and urgency traffic, it shall be permissible to use the radiotelephony distress and urgency signals.

5.3.1.3 The originator of messages addressed to an aircraft in distress or urgency condition shall restrict to the minimum the number and volume and content of such messages as required by the condition.

5.3.1.4 If no acknowledgement of the distress or urgency message is made by the station addressed by the aircraft, other stations shall render assistance, as prescribed in 5.3.2.2 and 5.3.3.2 respectively.

Note.— "Other stations" is intended to refer to any other station which has received the distress or urgency message and has become aware that it has not been acknowledged by the station addressed.

5.3.1.5 Distress and urgency traffic shall normally be maintained on the frequency on which such traffic was initiated until it is considered that better assistance can be provided by transferring that traffic to another frequency.

Note.— 121.5 MHz or alternative available VHF or HF frequencies may be used as appropriate.

5.3.1.6 In cases of distress and urgency communications, in general, the transmissions by radiotelephony shall be made slowly and distinctly, each word being clearly pronounced to facilitate transcription.

5.3.2 Radiotelephony distress communications

5.3.2.1 *Action by the aircraft in distress*

5.3.2.1.1 In addition to being preceded by the radiotelephony distress signal MAYDAY (*see* 5.3.1.2), preferably spoken three times, the distress message to be sent by an aircraft in distress shall:

a) be on the air-ground frequency in use at the time;

b) consist of as many as possible of the following elements spoken distinctly and, if possible, in the following order:

   1) name of the station addressed (time and circumstances permitting);

   2) the identification of the aircraft;

   3) the nature of the distress condition;

   4) intention of the person in command;

   5) present position, level (i.e. flight level, altitude, etc., as appropriate) and heading.

Note 1.— The foregoing provisions may be supplemented by the following measures:

a) the distress message of an aircraft in distress being made on the emergency frequency 121.5 MHz or another aeronautical mobile frequency, if considered necessary or desirable. Not all aeronautical stations maintain a continuous guard on the emergency frequency;

b) the distress message of an aircraft in distress being broadcast, if time and circumstances make this course preferable;

c) the aircraft transmitting on the maritime mobile service radiotelephony calling frequencies;

d) the aircraft using any means at its disposal to attract attention and make known its conditions (including the activation of the appropriate SSR mode and code);

e) any station taking any means at its disposal to assist an aircraft in distress;

f) any variation on the elements listed under 5.3.2.1.1 b), when the transmitting station is not itself in distress, provided that such circumstance is clearly stated in the distress message.

Note 2.— The station addressed will normally be that station communicating with the aircraft or in whose area of responsibility the aircraft is operating.

5.3.2.2 *Action by the station addressed or first station acknowledging the distress message*

5.3.2.2.1 The station addressed by aircraft in distress, or first station acknowledging the distress message, shall:

a) immediately acknowledge the distress message;

b) take control of the communications or specifically and clearly transfer that responsibility, advising the aircraft if a transfer is made;

c) take immediate action to ensure that all necessary information is made available, as soon as possible, to:

   1) the ATS unit concerned;

   2) the aircraft operating agency concerned, or its representative, in accordance with pre-established arrangements;

   Note.— The requirement to inform the aircraft operating agency concerned does not have priority over any other action which involves the safety of the flight in distress, or of any other flight in the area, or which might affect the progress of expected flights in the area.

d) warn other stations, as appropriate, in order to prevent the transfer of traffic to the frequency of the distress communication.

5.3.2.3 *Imposition of silence*

5.3.2.3.1 The station in distress, or the station in control of distress traffic, shall be permitted to impose silence, either on all stations of the mobile service in the area or on any station which interferes with the distress traffic. It shall address these instructions "to all stations", or to one station only, according to circumstances. In either case, it shall use:

— STOP TRANSMITTING;

— the radiotelephony distress signal MAYDAY.

5.3.2.3.2 The use of the signals specified in 5.3.2.3.1 shall be reserved for the aircraft station in distress and for the station controlling the distress traffic.

5.3.2.4 *Action by all other stations*

5.3.2.4.1 The distress communications have absolute priority over all other communications, and a station aware of them shall not transmit on the frequency concerned, unless:

a) the distress is cancelled or the distress traffic is terminated;

b) all distress traffic has been transferred to other frequencies;

c) the station controlling communications gives permission;

d) it has itself to render assistance.

5.3.2.4.2 Any station which has knowledge of distress traffic, and which cannot itself assist the station in distress, shall nevertheless continue listening to such traffic until it is evident that assistance is being provided.

5.3.2.5 *Termination of distress communications and of silence*

5.3.2.5.1 When an aircraft is no longer in distress, it shall transmit a message cancelling the distress condition.

5.3.2.5.2 When the station which has controlled the distress communication traffic becomes aware that the distress condition is ended, it shall take immediate action to ensure that this information is made available, as soon as possible, to:

1) the ATS unit concerned;

2) the aircraft operating agency concerned, or its representative, in accordance with pre-established arrangements.

5.3.2.5.3 The distress communication and silence conditions shall be terminated by transmitting a message, including the words "DISTRESS TRAFFIC ENDED", on the frequency or frequencies being used for the distress traffic. This message shall be originated only by the station controlling the communications when, after the reception of the message prescribed in 5.3.2.5.1, it is authorized to do so by the appropriate authority.

5.3.3 Radiotelephony urgency communications

5.3.3.1 *Action by the aircraft reporting an urgency condition except as indicated in 5.3.3.4*

5.3.3.1.1 In addition to being preceded by the radiotelephony urgency signal PAN PAN (*see* 5.3.1.2), preferably spoken three times and each word of the group pronounced as the French word "panne", the urgency message to be sent by an aircraft reporting an urgency condition shall:

a) be on the air-ground frequency in use at the time;

b) consist of as many as required of the following elements spoken distinctly and, if possible, in the following order:

1) the name of the station addressed;

2) the identification of the aircraft;

3) the nature of the urgency condition;

4) the intention of the person in command;

5) present position, level (i.e. flight level, altitude, etc., as appropriate) and heading;

6) any other useful information.

Note 1.— The foregoing provisions of 5.3.3.1.1 are not intended to prevent an aircraft broadcasting an urgency message, if time and circumstances make this course preferable.

Note 2.— The station addressed will normally be that station communicating with the aircraft or in whose area of responsibility the aircraft is operating.

5.3.3.2 *Action by the station addressed or first station acknowledging the urgency message*

5.3.3.2.1 The station addressed by an aircraft reporting an urgency condition, or first station acknowledging the urgency message, shall:

a) acknowledge the urgency message;

b) take immediate action to ensure that all necessary information is made available, as soon as possible, to:

1) the ATS unit concerned;

2) the aircraft operating agency concerned, or its representative, in accordance with pre-established arrangements;

Note.— The requirement to inform the aircraft operating agency concerned does not have priority over any other action which involves the safety of the flight in distress, or of any other flight in the area, or which might affect the progress of expected flights in the area.

c) if necessary, exercise control of communications.

5.3.3.3 *Action by all other stations*

5.3.3.3.1 The urgency communications have priority over all other communications, except distress, and all stations shall take care not to interfere with the transmission of urgency traffic.

5.3.3.4 *Action by an aircraft used for medical transports*

5.3.3.4.1 The use of the signal described in 5.3.3.4.2 shall indicate that the message which follows concerns a protected medical transport pursuant to the 1949 Geneva Conventions and Additional Protocols.

5.3.3.4.2 For the purpose of announcing and identifying aircraft used for medical transports, a transmission of the radiotelephony urgency signal PAN PAN, preferably spoken three times, and each word of the group pronounced as the French word "panne", shall be followed by the radiotelephony signal for medical transports MAY-DEE-CAL, pronounced as in the French "médical". The use of the signals described above indicates that the message which follows concerns a protected medical transport. The message shall convey the following data:

a) the call sign or other recognized means of identification of the medical transports;

b) position of the medical transports;

c) number and type of medical transports;

d) intended route;

e) estimated time en route and of departure and arrival, as appropriate; and

f) any other information such as flight altitude, radio frequencies guarded, languages used, and secondary surveillance radar modes and codes.

5.3.3.5 *Action by the station addressed or by other stations receiving a medical transports message*

5.3.3.5.1 The provisions of 5.3.3.2 and 5.3.3.3 shall apply as appropriate to stations receiving a medical transports message.

5.4 Communications related to acts of unlawful interference

5.4.1 The station addressed by an aircraft being subjected to an act of unlawful interference, or first station acknowledging a call from such aircraft, shall render all possible assistance, including notification of appropriate ATS units as well as any other station, agency or person in a position to facilitate the flight.

CHAPTER 6. AERONAUTICAL RADIO NAVIGATION SERVICE

6.1 General

6.1.1 The aeronautical radio navigation service comprises all types and systems of radio navigation aids in the international aeronautical service.

6.1.2 An aeronautical radio navigation aid which is not in continuous operation shall, if practicable, be put into operation on receipt of a request from an aircraft, any controlling authority on the ground, or an authorized representative of an aircraft operating agency.

6.1.2.1 **Recommendation.—** *Requests from aircraft should be made to the aeronautical station concerned on the air-ground frequency normally in use.*

6.1.2.1.1 When radiotelegraphy is used, requests from aircraft shall be made using the appropriate Q signal.

6.1.3 Arrangements shall be made for the local aeronautical information service unit to receive without delay essential information about changes in the operational status of non-visual aids as required for pre-flight briefing and dissemination in accordance with the provisions of Annex 15.

6.2 Direction finding

Introductory Notes

1) Direction-finding stations work either singly or in groups of two or more stations under the direction of a main direction-finding station.

2) A direction-finding station working alone can only determine the direction of an aircraft in relation to itself.

6.2.1 **Recommendation.—** *A direction-finding station working alone should give the following, as requested:*

1) true bearing of the aircraft, using the signal QTE or appropriate phrase;

2) true heading to be steered by the aircraft, with no wind, to head for the direction-finding station using the signal QUJ or appropriate phrase;

3) magnetic bearing of the aircraft, using the signal QDR or appropriate phrase;

4) magnetic heading to be steered by the aircraft with no wind to make for the station, using the signal QDM or appropriate phrase.

6.2.2 **Recommendation.—** *When direction-finding stations work as a network to determine the position of an aircraft, the bearings taken by each station should be sent immediately to the station controlling the direction-finding network to enable the position of the aircraft to be determined.*

6.2.2.1 **Recommendation.—** *The station controlling the network should, on request, give the aircraft its position in one of the following ways:*

1) position in relation to a point of reference or in latitude and longitude, using the signal QTF or appropriate phrase;

2) true bearing of the aircraft in relation to the direction-finding station or other specified point, using the signal QTE or appropriate phrase, and its distance from the direction-finding station or point, using the signal QGE or appropriate phrase;

3) magnetic heading to steer with no wind, to make for the direction-finding station or other specified point using the signal QDM or appropriate phrase, and its distance from the direction-finding station or point, using the signal QGE or appropriate phrase.

6.2.3 Aircraft stations shall normally make requests for bearings, courses or positions, to the aeronautical station responsible, or to the station controlling the direction-finding network.

6.2.4 To request a bearing, heading or position, the aircraft station shall call the aeronautical station or the direction-finding control station on the listening frequency. The aircraft shall then specify the type of service that is desired by the use of the appropriate phrase or Q signal.

6.2.5 As soon as the direction-finding station or group of stations is ready, the station originally called by the aircraft station shall where necessary request transmission for direction-finding service or send the appropriate Q signal, and, if necessary, indicate the frequency to be used by the aircraft station, the number of times the transmission should be repeated, the duration of the transmission required or any special transmission requirement.

6.2.5.1 In radiotelegraphy, the aircraft station shall, after changing if necessary to the new transmitting frequency, reply by sending its call sign, two dashes of about ten seconds of duration each and then repeating its call sign, unless some other period has been specified by the direction-finding station.

6.2.5.2 In radiotelephony, an aircraft station which requests a bearing shall end the transmission by repeating its call sign. If the transmission has been too short for the direction-finding station to obtain a bearing, the aircraft shall give a longer transmission for two periods of approximately ten seconds, or alternatively provide such other signals as may be requested by the direction-finding station.

Note.— Certain types of VHF/DF stations require the provision of a modulated signal (voice transmission) in order to take a bearing.

6.2.6 When a direction-finding station is not satisfied with its observation, it shall request the aircraft station to repeat the transmission.

6.2.7 When a heading or bearing has been requested, the direction-finding station shall advise the aircraft station in the following form:

1) the appropriate phrase or Q signal;
2) bearing or heading in degrees in relation to the direction-finding station, sent as three figures;
3) class of bearing (except in QDL procedure);
4) time of observation, if necessary (except in QDL procedure).

6.2.8 When a position has been requested, the direction-finding control station, after plotting all simultaneous observations, shall determine the observed position of the aircraft and shall advise the aircraft station in the following form:

1) the appropriate phrase or Q signal;
2) the position;
3) class of position;
4) time of observation.

6.2.9 As soon as the aircraft station has received the bearing, heading or position, it shall repeat back the message for confirmation, or correction, except in QDL procedure.

6.2.10 When positions are given by bearing or heading and distance from a known point other than the station making the report, the reference point shall be an aerodrome, prominent town or geographic feature. An aerodrome shall be given in preference to other places. When a large city or town is used as a reference place, the bearing or heading, and the distance given shall be measured from its centre.

6.2.11 When the position is expressed in latitude and longitude, groups of figures for degrees and minutes shall be used followed by the letter N or S for latitude and the letter E or W for longitude, respectively. In radiotelephony the words NORTH, SOUTH, EAST or WEST shall be used.

6.2.12 According to the estimate by the direction-finding station of the accuracy of the observations, bearings and positions shall be classified as follows:

Bearings:

Class A — accurate within plus or minus 2 degrees;

Class B — accurate within plus or minus 5 degrees;

Class C — accurate within plus or minus 10 degrees;

Class D — accuracy less than Class C.

Note.— The observational characteristics for classification of bearings are given in the table of Appendix 41 to the current ITU Radio Regulations.

Positions:

Class A — accurate within 9.3 km (5 NM);

Class B — accurate within 37 km (20 NM);

Class C — accurate within 92 km (50 NM);

Class D — accuracy less than Class C.

6.2.13 Direction-finding stations shall have authority to refuse to give bearings, heading or positions when conditions are unsatisfactory or when bearings do not fall within the calibrated limits of the station, stating the reason at the time of refusal.

6.2.14 An aircraft station requiring a series of bearings or headings, shall call the direction-finding station concerned, on the appropriate frequency, and request the service by the signal QDL followed by other appropriate Q signals, except that when the series has commenced, the call signs of the stations may be omitted if no confusion is likely to arise.

Note.— Certain MF and HF direction-finding stations are maintained for emergency and distress use only. The use of these stations, the hours of service, the call sign, location and frequencies of communication stations, and certain exceptions to the above procedure are shown in the pertinent publications.

CHAPTER 7. AERONAUTICAL BROADCASTING SERVICE

7.1 General

7.1.1 Broadcast material

7.1.1.1 The text of broadcast material shall be prepared by the originator in the form desired for transmission.

7.1.2 Frequencies and schedules

7.1.2.1 Broadcasts shall be made on specified frequencies and at specified times.

7.1.2.2 Schedules and frequencies of all broadcasts shall be publicized in appropriate documents. Any change in frequencies or times shall be publicized by NOTAM at least two weeks in advance of the change.* Additionally, any such change shall, if practicable, be announced on all regular broadcasts for 48 hours preceding the change and shall be transmitted once at the beginning and once at the end of each broadcast.

**Note.— This does not prevent an emergency change of frequency when required in circumstances which do not permit the promulgation of a NOTAM at least two weeks in advance of the change.*

7.1.2.3 Scheduled broadcasts (other than sequential collective type broadcasts), shall be started at the scheduled time by the general call. If a broadcast must be delayed, a short notice shall be transmitted at the scheduled time advising recipients to "stand by" and stating the approximate number of minutes of delay.

7.1.2.3.1 After definite advice has been given to stand by for a certain period, the broadcast shall not be started until the end of the stand-by period.

7.1.2.4 Where broadcasts are conducted on a time-allotment basis, transmission shall be terminated by each station promptly at the end of the allotted time period whether or not transmission of all material has been completed.

7.1.2.4.1 In sequential collective type broadcasts each station shall be ready to commence its broadcasts at the designated time. If for any reason a station does not commence its broadcast at the designated time, the station immediately following in sequence shall wait and then commence its broadcast at its own designated time.

7.1.3 Interruption of service

7.1.3.1 In the event of interruption of service at the station responsible for a broadcast, the broadcast shall, if possible, be made by another station until normal service is resumed. If this is not possible, and the broadcast is of the type intended for interception by fixed stations, the stations which are required to copy the broadcasts shall continue to listen on the specified frequencies until normal service is resumed.

7.2 Radiotelephone broadcast procedures

7.2.1 Broadcast technique

7.2.1.1 Transmissions by radiotelephone shall be as natural, short and concise as practicable consistent with clarity.

7.2.1.2 Rate of speech on radiotelephone broadcasts shall not exceed 100 words per minute.

7.2.2 Preamble of the general call

7.2.2.1 The preamble of each radiotelephone broadcast shall consist of the general call, station name, and optionally the time of broadcast (UTC).

Note.— The following example illustrates the application of this procedure:

(general call)	*ALL STATIONS*
(the words THIS IS)	*THIS IS*
(station name)	*NEW YORK RADIO*
(time of broadcast)	*TIME, ZERO ZERO FOUR FIVE*

ATTACHMENTS TO ANNEX 10 — VOLUME II

Attachment A to Volume II —

LIST OF SPECIALIZED COM TERMS AND THEIR DEFINITIONS RELATED TO AERONAUTICAL TELECOMMUNICATIONS PLANNING

On 25 March 1964 the Council at the 11th Meeting of its Fifty-first Session approved the following list of specialized communication terms and their definitions for general use within ICAO. The Council further requested States to use the terms in the approved manner in particular in correspondence with ICAO, in working papers presented by them to ICAO meetings and in any other appropriate texts.

Those terms which are marked with an asterisk are already used and defined in the main body of Annex 10 while the remaining terms were selected as terms in general use by aeronautical telecommunications people but having caused difficulty at some ICAO meetings or having resulted in the development of conflicting definitions by different meetings.

1. For general use

**Aeronautical telecommunication agency.* An agency responsible for operating a station or stations in the aeronautical telecommunication service.

**Aeronautical telecommunication service.* A telecommunication service provided for any aeronautical purpose.

**Aeronautical telecommunication station.* A station in the aeronautical telecommunication service.

**Aircraft operating agency.* The person, organization or enterprise engaged in, or offering to engage in, an aircraft operation.

**Double channel simplex.* Simplex using two frequency channels one in each direction.

Note.— This method was sometimes referred to as cross band.

**Duplex.* A method in which telecommunication between two stations can take place in both directions simultaneously.

**Frequency channel.* A continuous portion of the frequency spectrum appropriate for a transmission utilizing a specified class of emission.

Note.— The classification of emissions and information relevant to the portion of the frequency spectrum appropriate for a given type of transmission (bandwidths) are specified in the ITU Radio Regulations, Article 4, RR 264 to RR 273 inclusive.

**International telecommunication service.* A telecommunication service between offices or stations of different States, or between mobile stations which are not in the same State, or are subject to different States.

**Offset frequency simplex.* A variation of single channel simplex wherein telecommunication between two stations is effected by using in each direction frequencies that are intentionally slightly different but contained within a portion of the spectrum allotted for the operation.

**Simplex.* A method in which telecommunication between two stations takes place in one direction at a time.

Note.— In application to the aeronautical mobile service this method may be subdivided as follows:

a) single channel simplex;

b) double channel simplex;

c) offset frequency simplex.

**Single channel simplex.* Simplex using the same frequency channel in each direction.

2. For use in aeronautical fixed service planning

**Aeronautical fixed service (AFS).* A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.

**Aeronautical fixed telecommunication network (AFTN).* An integrated world-wide system of aeronautical fixed circuits provided, as part of the aeronautical fixed service, for the exchange of messages between the aeronautical fixed stations within the network.

Note.— "Integrated" is to be interpreted as a mode of operation necessary to ensure that messages can be transmitted from any aeronautical fixed station within the network to any other aeronautical fixed station within the network.

**AFTN communication centre.* An AFTN station whose primary function is the relay or retransmission of AFTN traffic from (or to) a number of other AFTN stations connected to it.

**AFTN destination station.* An AFTN station to which messages are addressed for local delivery to the addressee.

AFTN entry-exit points. Centres through which AFTN traffic entering and leaving an ICAO Air Navigation Region should flow.

**AFTN group.* Three or more radio stations in the aeronautical fixed telecommunications network exchanging communications on the same radio frequency.

**AFTN origin station.* An AFTN station where messages are handed in for transmission over the AFTN.

**AFTN station.* A station forming part of the aeronautical fixed telecommunication network (AFTN) and operating as such under the authority or control of a State.

**Automatic relay installation.* A teletypewriter installation where automatic equipment is used to transfer messages from incoming to outgoing circuits.

Note.— This term covers both fully automatic and semi-automatic installations.

Channel. A single means of direct fixed service communication between two points.

Circuit. A communication system which includes all the direct AFTN channels between two points.

**Communication centre.* An aeronautical fixed station which relays or retransmits telecommunication traffic from (or to) a number of other aeronautical fixed stations directly connected to it.

**Fully automatic relay installation.* A teletypewriter installation where interpretation of the relaying responsibility in respect of an incoming message and the resultant setting-up of the connections required to effect the appropriate retransmissions is carried out automatically, as well as all other normal operations of relay, thus obviating the need for operator intervention, except for supervisory purposes.

**Incoming circuit responsibility list.* A list, for each incoming circuit of a communication centre, of the location indicators for which relay responsibilities are to be accepted in respect of messages arriving on that circuit.

**Location indicator.* A four-letter code group formulated in accordance with rules prescribed by ICAO and assigned to the location of an aeronautical fixed station.

Relay time. The relay time of a COM centre is the elapsed time between the instant that a message has been completely received at that centre and the instant that it has been completely retransmitted on an outgoing circuit.

Route (AFTN). The path followed by a particular channel of a circuit.

Routing (AFTN). The chosen itinerary to be followed by messages on the AFTN between acceptance and delivery.

**Routing Directory.* The combination of the Incoming Circuit Responsibility Lists and the Routing List of a given communication centre.

**Routing List.* A list in a communication centre indicating for each addressee the outgoing circuit to be used.

**Semi-automatic relay installation.* A teletypewriter installation where interpretation of the relaying responsibility in respect of an incoming message and the resultant setting-up of the connections required to effect the appropriate retransmissions require the intervention of an operator but where all other normal operations of relay are carried out automatically.

**"Torn-tape" relay installation.* A teletypewriter installation where messages are received and relayed in teletypewriter tape form and where all operations of relay are performed as the result of operator intervention.

Transit time. The elapsed time between the instant of filing a message with an AFTN station for transmission on the network, and the instant that it is made available to the addressee.

**Tributary station.* An aeronautical fixed station that may receive or transmit messages but which does not relay except for the purpose of serving similar stations connected through it to a communication centre.

3. For use in aeronautical mobile service planning

**Aerodrome control radio station.* A station providing radio communication between an aerodrome control tower and aircraft or mobile aeronautical stations.

****Aeronautical mobile service.*** A radiocommunication service between aircraft stations and aeronautical stations, or between aircraft stations.

****Aeronautical station.*** A land station in the aeronautical mobile service. In certain instances, an aeronautical station may be placed on board a ship or an earth satellite.

****Aircraft station.*** A mobile station in the aeronautical service on board an aircraft or an airspace vehicle.

****Air-ground communication.*** Two-way communication between aircraft and stations or locations on the surface of the earth.

****Air-ground control radio station.*** An aeronautical telecommunication station having primary responsibility for handling communications pertaining to the operation and control of aircraft in a given area.

****Air-to-ground communication.*** One-way communication from aircraft to stations or locations on the surface of the earth.

****Alternative means of communication.*** A means of communication provided with equal status, and in addition to the primary means.

General purpose system (GP). Air-ground radiotelephony facilities providing for all categories of traffic listed in 5.1.8.

Note.— In this system communication is normally indirect, i.e. exchanged through the intermediary of a third person.

****Ground-to-air communication.*** One-way communication from stations or locations on the surface of the earth to aircraft.

****Non-network communications.*** Radiotelephony communications conducted by a station of the aeronautical mobile service, other than those conducted as part of a radiotelephony network.

****Operational control communications.*** Communications required for the exercise of authority over the initiation, continuation, diversion or termination of a flight in the interest of the safety of the aircraft and the regularity and efficiency of a flight.

Note.— Such communications are normally required for the exchange of messages between aircraft and aircraft operating agencies.

"Pilot-controller" system. Air-ground radiotelephony facilities implemented primarily to provide a means of direct communication between pilots and controllers.

****Primary means of communication.*** The means of communication to be adopted normally by aircraft and ground stations as a first choice where alternative means of communication exists.

****Radiotelephony network.*** A group of radiotelephony aeronautical stations which operate on and guard frequencies from the same family and which support each other in a defined manner to ensure maximum dependability of air-ground communications and dissemination of air-ground traffic.

****Regular station.*** A station selected from those forming an en-route air-ground radiotelephony network to communicate with or to intercept communications from aircraft in normal conditions.

Attachment B to Volume II —

DEVELOPMENT OF RADIOTELEPHONY SPEECH FOR INTERNATIONAL AVIATION

1. Introduction

1.1 The procedures concerning the languages to be used in radiotelephony communications are detailed in 5.2.1.1.

1.2 The primary means for exchanging information in air-ground communications is the language of the ground stations, which will in most cases be the national language of the State responsible for the station. Paragraph 5.2.1.1.2 recommends, however, that where English is not the language of the ground station the English language should be available on request. This means, in effect, that as long as the present provisions of the Annex remain in force and if its recommendations are fully applied, the English language, used in accordance with the standard phraseology and other provisions of the Annex, will be available as a universal medium for radiotelephone communications.

1.3 The universal availability of at least one medium of radiotelephone communication is important both for safety and efficiency in international air navigation. The effect on efficiency is too obvious to need comment. The effect on safety is less obvious, since it might be contended that safety could be ensured by international operators' taking care to assign crew members to particular flights with primary reference to their language qualifications, so that they would always be able to maintain communication with each of the ground stations with which they had need to make contact, in some language acceptable to that station.

1.4 That means of assuring safety, however, can hardly be satisfactory in practice. It is always possible that an emergency may require communication with a ground station not foreseen in the original planning, and that the handicapping or prevention of such emergency communications by the lack of a language common to the aircrew and the ground station could lead to an accident.

2. The development of an international medium

2.1 The foregoing considerations led to the acceptance by the Council of the Recommended Practice contained in 5.2.1.1.2. This provision, however, is considered only as a first step towards a complete solution of the problem. It has been evident from experience with the difficulty of understanding a spoken language over the radiotelephone, especially where participants in the conversation are having to use a language that they do not use in the ordinary affairs of life, that a final answer will only be achieved when the English language has been thoroughly simplified by codification and limitation and, where necessary, by the addition of words from other languages. The process has been started in the present Annex, through the establishment of certain standard terms, standard pronunciation of digits, and a spelling alphabet; but that is only a beginning. Such a development, which is likely to be a time-consuming one, is needed for the greatest possible safety, which demands the utmost clarity and brevity in radiotelephony. The dependence of safety on brevity arises from the scarcity of communication channels and from the importance of the time factor in the most important application of radiotelephony to aviation. The need for continued development in the interest of clarity derives from the enormous variety of practice that may exist in speaking what is nominally a single language, not only among people learning it artificially and therefore hampered by insufficient practice and by phonetic difficulties, but even among users of the same mother tongue. Variations of vocabulary, syntax, and accent may make mutual understanding difficult even in the quietness of a studio, and impossible in the rush of a precision approach radar communication over a distorted radiotelephone.

2.2 The Fourth COM Division which met in April 1951 established the following basic principles:

a) the English language should be the basis for the development of the requisite phraseologies. Words with Latin roots should be given preference in developing the phraseologies;

b) words and phrases should be selected in such a way as to ensure optimum transmissibility over radiotelephone channels and should be incapable of misinterpretation;

c) words and phrases should be avoided which will be liable to differences of pronunciation likely to cause misunderstanding;

d) spoken Q code groups, which by their common usage, have already become part of aviation terminology, may be used where they provide a preferable alternative to a long or complex phrase, e.g. QFE, QFF, QNE, QNH, QTE;

e) where phrases already in general use have proved by experience to be phonetically suitable irrespective of the language from which they were derived, they should not be arbitrarily changed;

f) new phraseologies developed during the study should be clear, unambiguous and, where practicable, concise. However, clarity should not be sacrificed in the interest of brevity;

g) phrases should be developed on the principle that they represent a thought expressed in a live language; however, the grammatical construction should be as simple as possible;

h) positive and negative instructions or advice should be clearly differentiated;

i) where practicable, words containing sounds or syllabic constructions traditionally difficult in pronunciation by non-English-speaking personnel should be avoided.

2.3 The Council endorsed those principles. Furthermore, it urged that Contracting States collaborate to the maximum extent possible in the development of the work by undertaking national research projects on this question. The results of such researches should be reported to ICAO so that the maximum exchange of ideas between various countries using different languages may be continued throughout the study. The results of ICAO studies will likewise be communicated regularly to all Contracting States.

2.4 As a guide to Contracting States co-operating with ICAO in the study of this question, the Council considered that the problem required the assistance of specialists other than those in the field of communications and, furthermore, was of the opinion that in order to secure the optimum results it would be necessary to conduct a study of recorded two-way voice communications from selected language zones throughout the world, both where English may be used only occasionally and where different habits of English speech are employed. Such a study should contain an analysis of vocabulary and phraseology by experts in the fields of comparative linguistics, phonetics, language structure and electrosonics. The Council also was of the opinion that it would be necessary to conduct experimental trials of the agreed phraseologies under controlled conditions before they were given any status as Procedures or Standards.

2.5 After agreement has been reached on a list of phraseologies that could be expected to remain comparatively stable, the Council considered that it would be desirable to investigate the possibility of ICAO assisting aeronautical personnel in learning the phrases by the dissemination of suitable training media. It was visualized, for example, that use could be made of special films and records to assist such training.

2.6 The fulfilment of this programme is a prerequisite to the efficient universal use of radiotelephony in aviation. In attacking the problem with the sole objective of attaining the highest efficiency in air-ground communication, the co-operation of all States may be expected and the burden now largely carried by non-English-speaking countries will be more equitably shared; for the extent of the new language having to be acquired by non-English-speaking personnel will be reduced, while the English-speaking States will at the same time accept the obligation of training their personnel to keep within the agreed limits in the use of their own language.

9/11/95

Attachment C to Volume II —
GUIDANCE MATERIAL FOR AFTN COMMUNICATIONS PROCEDURES

1. Address stripping

1.1 Introduction

1.1.1 This material is intended to provide information, guidance and clarification related to the application of address stripping to the AFTN. It is associated with the provisions in Chapter 4, 4.4.8.

1.1.2 These provisions recommend the application of address stripping to those elements of the AFTN other than the CIDIN.

1.2 Description of address stripping applied to messages in AFTN format

1.2.1 Address stripping applied to messages in AFTN format is the process performed by an AFTN communication centre in removing from the address those addressee indicators not required for:

a) relay by the AFTN communication centre to which the message is transmitted;

b) processing or delivery to addressee(s) by the AFTN destination station to which the message is transmitted; and

c) processing or delivery to addressee(s) served by AFTN destination stations on a multi-point circuit to which the message is transmitted.

1.2.1.1 A demonstration of address stripping in this context is provided in Figure C-1.

1.3 Consideration relative to the application of address stripping to messages in AFTN format

1.3.1 The advantages of address stripping include:

a) elimination of definition, storage and maintenance of incoming circuit responsibility lists and associated processing on the basis that all addressee indicators are to be processed for onward routing action, i.e. none to be ignored;

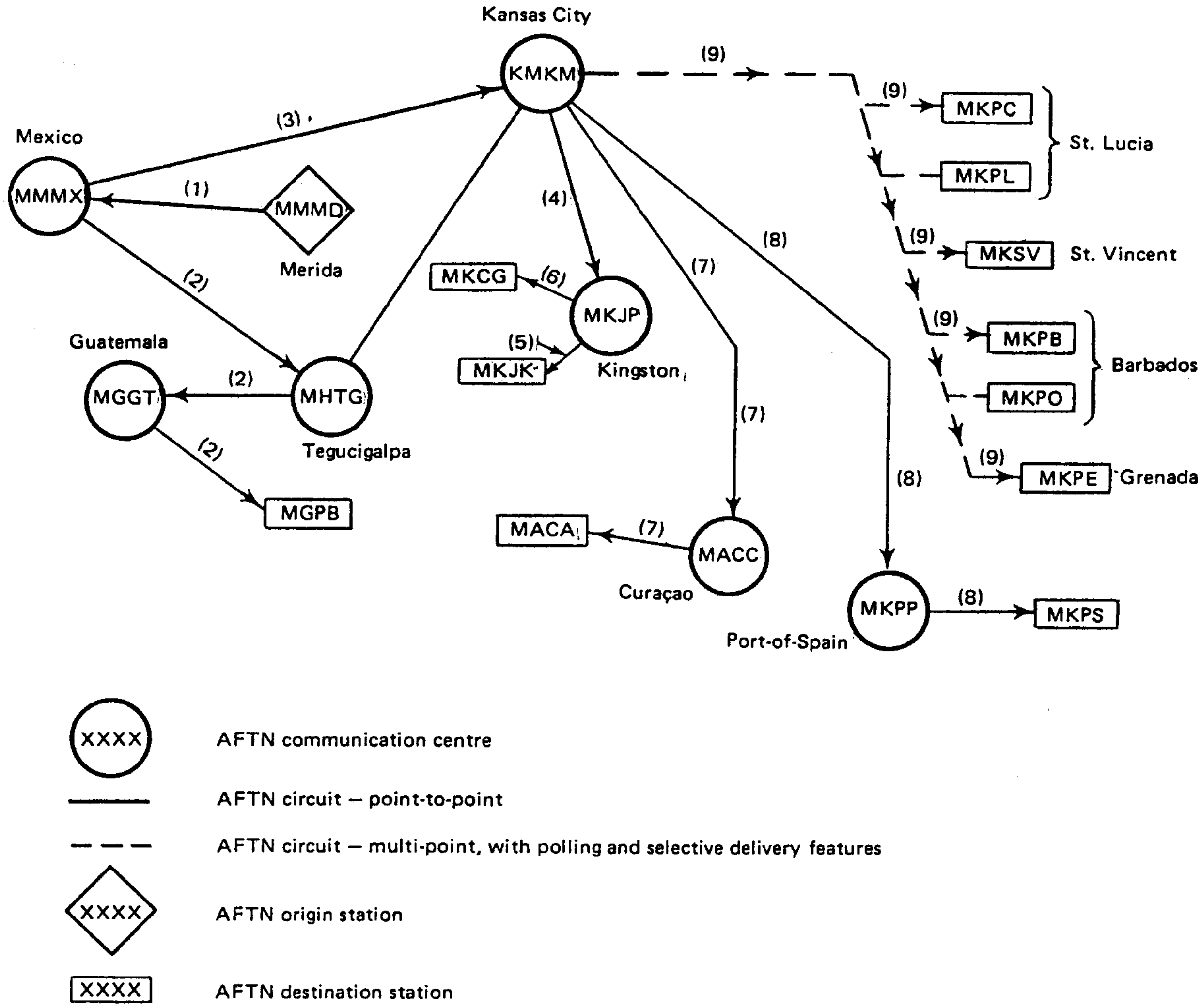
b) elimination of the VVV diversion indicator;

c) elimination of multiple delivery or non-delivery caused by erroneous or mis-applied incoming circuit responsibility list;

d) reduction of overhead by progressively removing addressee indicators as a message transits the network;

e) simplification of implementation; and

f) simplification of the preparation, co-ordination, maintenance and application of routing directories.



(1) Addressee indicators (abbreviated to location indicator only) as applied by AFTN origin station (Merida) and input to the AFTN communication centre (Mexico) serving that station:

MGPB MKCG MKJK MACA MKPS MKPC MKSV MKPB MKPE

(2) through (9) demonstrate the addressee indicators (abbreviated) retained on the message following address stripping as it transits the circuit indicated.

(2) MGPB
(3) MKCG MKJK MACA MKPS MKPC MKSV MKPB MKPE
(4) MKCG MKJK
(5) MKJK
(6) MKCG
(7) MACA
(8) MKPS
(9) MKPC MKSV MKPB MKPE
(Note. — Address stripping applied to a multi-point circuit results in all selected stations receiving the addressee indicators for all addressed stations on the same circuit.)

Figure C-1. Demonstration of address stripping on the conventional AFTN reflecting point-to-point and multi-point environments

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Attachment D to Volume II —

GUIDANCE MATERIAL FOR THE TRANSMISSION OF LONG MESSAGES ON THE AFTN

1. Introduction

1.1 The requirement for the transmission of separate messages over the AFTN when a text exceeding 1 800 characters is encountered is detailed in 4.4.5.7 and 4.4.16.3.11. When messages have to be divided into two or more parts, the following procedure should be applied.

2. Procedure

2.1 Each message part should carry the same address and origin with the sequence of each part indicated on the last line of text as follows:

(End of first message)	/ / END PART 01 / /
(End of second message)	/ / END PART 02 / /
... etc. ...	
(End of last message)	/ / END PART XX/XX / /

Note.— The following example illustrates the application of the above procedure, for a three-part message. The message part sequence information is included in the text character count.

a) *First message:*

(Address)	GG EGLLYMYX
(Origin)	102030 KWBCYMYX
(Text)	text
	/ / END PART 01 / /
(Ending)	NNNN

b) *Second message:*

(Address)	GG EGLLYMYX
(Origin)	102030 KWBCYMYX
(Text)	text continued
	/ / END PART 02 / /
(Ending)	NNNN

c) *Third and last message:*

(Address)	GG EGLLYMYX
(Origin)	102030 KWBCYMYX
(Text)	remainder of text
	/ / END PART 03/03 / /
(Ending)	NNNN

— END —

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10
TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME III — COMMUNICATION SYSTEMS

(PART I — DIGITAL DATA COMMUNICATION SYSTEMS;
PART II — VOICE COMMUNICATION SYSTEMS)

FIRST EDITION — JULY 1995

The first edition of Annex 10, Volume III was adopted by the Council on 20 March 1995 and becomes applicable on 9 November 1995.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

FOREWORD

Historical background

Standards and Recommended Practices for Aeronautical Telecommunications were first adopted by the Council on 30 May 1949 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 10 to the Convention. They became effective on 1 March 1950. The Standards and Recommended Practices were based on recommendations of the Communications Division at its Third Session in January 1949.

Up to and including the Seventh Edition, Annex 10 was published in one volume containing four Parts together with associated attachments: Part I — Equipment and Systems, Part II — Radio Frequencies, Part III — Procedures, and Part IV — Codes and Abbreviations.

By Amendment 42, Part IV was deleted from the Annex; the codes and abbreviations contained in that Part were transferred to a new document, Doc 8400.

As a result of the adoption of Amendment 44 on 31 May 1965, the Seventh Edition of Annex 10 was replaced by two volumes: Volume I (First Edition) containing Part I — Equipment and Systems, and Part II — Radio Frequencies, and Volume II (First Edition) containing Communication Procedures.

As a result of the adoption of Amendment 70 on 20 March 1995, Annex 10 was restructured to include five volumes: Volume I — Radio Navigation Aids; Volume II — Communication Procedures; Volume III — Communication Systems; Volume IV — Surveillance Radar and Collision Avoidance Systems; and Volume V — Aeronautical Radio Frequency Spectrum Utilization. By Amendment 70, Volumes III and IV were published in 1995 and Volume V was planned for publication with Amendment 71.

Table A shows the origin of Annex 10, Volume III subsequent to Amendment 70, together with a summary of the principal subjects involved and the dates on which the Annex and the amendments were adopted by Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards, Recommended Practices and Procedures specified in Annex 10 should be notified and take effect in accordance with the provisions of Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been deliberately written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices*:

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 10, Volume III

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
70	Air Navigation Commission. Third Meeting of the Aeronautical Mobile Communications Panel (AMCP)	Introduction of new Volume III and SARPs related to the Aeronautical Mobile-Satellite Service (AMSS)	20 March 1995 24 July 1995 9 November 1995

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

PART I — DIGITAL DATA COMMUNICATION SYSTEMS

CHAPTER 1. DEFINITIONS

Note 1.— All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union.

Note 2.— This Part of Annex 10 includes Standards and Recommended Practices for certain forms of equipment for communication systems. While the Contracting State will determine the necessity for specific installations in accordance with the conditions prescribed in the relevant Standard or Recommended Practice, review of the need for specific installation and the formulation of ICAO opinion and recommendations to Contracting States concerned, is carried out periodically by Council, ordinarily on the basis of recommendations of Regional Air Navigation Meetings (Doc 8144, Directives to Regional Air Navigation Meetings and Rules of Procedure for their Conduct*).*

Note 3.— This chapter contains general definitions relevant to communication systems. Definitions specific to each of the systems included in this volume are contained in the relevant chapters.

Aircraft earth station (AES). A mobile earth station in the aeronautical mobile-satellite service located on board an aircraft (see also "GES").

Bit error rate (BER). The number of bit errors in a sample divided by the total number of bits in the sample, generally averaged over many such samples.

Carrier-to-multipath ratio (C/M). The ratio of the carrier power received directly, i.e. without reflection, to the multipath power, i.e. carrier power received via reflection.

Carrier-to-noise density ratio (C/N_o). The ratio of the total carrier power to the average noise power in a 1 Hz bandwidth, usually expressed in dBHz.

Channel rate. The rate at which bits are transmitted over the RF channel. These bits include those bits used for framing and error correction, as well as the information bits. For burst transmission, the channel rate refers to the instantaneous burst rate over the period of the burst.

Channel rate accuracy. This is relative accuracy of the clock to which the transmitted channel bits are synchronized. For example, at a channel rate of 1.2 kbits/s, maximum error of one part in 10^6 implies the maximum allowed error in the clock is $\pm 1.2 \times 10^{-3}$ Hz.

Circuit mode. A configuration of the communications network which gives the appearance to the application of a dedicated transmission path.

Doppler shift. The frequency shift observed at a receiver due to any relative motion between transmitter and receiver.

End-to-end. Pertaining or relating to an entire communication path, typically from (1) the interface between the information source and the communication system at the transmitting end to (2) the interface between the communication system and the information user or processor or application at the receiving end.

End-user. An ultimate source and/or consumer of information.

Equivalent isotropically radiated power (EIRP). The total power which would have to be radiated by an isotropic antenna to produce the same flux density at the desired location.

Energy per symbol to noise density ratio (E_s/N_o). The ratio of the average energy transmitted per channel symbol to the average noise power in a 1 Hz bandwidth, usually expressed in dB. For A-BPSK and A-QPSK, one channel symbol refers to one channel bit.

Forward error correction (FEC). The process of adding redundant information to the transmitted signal in a manner which allows correction, at the receiver, of errors incurred in the transmission.

Gain-to-noise temperature ratio. The ratio, usually expressed in dB/K, of the antenna gain to the noise at the receiver output of the antenna subsystem. The noise is expressed as the temperature that a 1 ohm resistor must be raised to produce the same noise power density.

Ground earth station (GES). An earth station in the fixed satellite service, or, in some cases, in the aeronautical mobile-satellite service, located at a specified fixed point on land to provide a feeder link for the aeronautical mobile-satellite service.

Note.— This definition is used in the ITU's Radio Regulations under the term "aeronautical earth station." The definition herein as "GES" for use in the SARPs is to clearly distinguish it from an aircraft earth station (AES), which is a mobile station on an aircraft.

Point-to-point. Pertaining or relating to the interconnection of two devices, particularly end-user instruments. A communication path of service intended to connect two discrete end-users; as distinguished from broadcast or multipoint service.

Slotted aloha. A random access strategy whereby multiple users access the same communications channel independently, but each communication must be confined to a fixed time slot. The same timing slot structure is known to all users, but there is no other co-ordination between the users.

Time division multiplex (TDM). A channel sharing strategy in which packets of information from the same source but with different destinations are sequenced in time on the same channel.

Time division multiple access (TDMA). A channel sharing strategy in which packets of information from different sources and with the same or different destinations are sequenced in time on the same channel.

Transit delay. In packet data systems, the elapsed time between a request to transmit an assembled data packet and an indication at the receiving end that the corresponding packet has been received and is ready to be used or forwarded.

CHAPTER 2. GENERAL

[to be developed]

CHAPTER 3. AERONAUTICAL TELECOMMUNICATIONS NETWORK

[to be developed]

CHAPTER 4. AERONAUTICAL MOBILE-SATELLITE SERVICE

4.1 DEFINITIONS AND DESCRIPTIONS OF CHANNEL TYPES; GENERAL; SYSTEM CAPABILITIES

4.1.1 Definitions and descriptions of channel types

4.1.1.1 DEFINITIONS

Adjacent beams. Beams which have the minimum spatial separation in a given direction and whose corresponding phase shifter states differ for at least one element.

Application. The ultimate use of an information system, as distinguished from the system itself.

Aviation-BPSK (A-BPSK). The particular form of binary phase shift keyed modulation which is used in AMSS for channel rates of 2.4, 1.2 and 0.6 kbits/s. A-BPSK is a modulation technique which maps a "0" to a phase shift of −90° and "1" to a phase shift of +90°. The phase-encoded A-BPSK data stream is then filtered with a filter which satisfies the amplitude and phase versus frequency limits defined by Tables A1-1 and A1-2 in Appendix 1 to Chapter 4.

Aviation-QPSK (A-QPSK). The particular form of offset quaternary phase shift keyed modulation which is used in AMSS for channel rates greater than 2 400 bits/s. A-QPSK is a modulation technique which maps a "0" into a 0 degrees and "1" into a 180 degrees, or "0" into 90 degrees and "1" into 270 degrees, alternating between the two options on successive bits. The encoded A-QPSK data stream is then filtered such that the modulated spectrum meets the amplitude mask of Table A1-3 and the phase mask defined in Table A1-2 in Appendix 1 to Chapter 4.

Burst. A time-defined, contiguous set of one or more related signal units which may convey user information and protocols, signalling, and any necessary preamble.

Cyclic redundancy check. The last two bytes of each signal unit form a cyclic redundancy check of the whole signal unit as follows. The check bits for error detection are calculated from the first 10 octets of a standard length signal unit, or from the first 17 octets of an extended length signal unit or from the first 4 octets of the burst identifier, using the following generator polynomial:

$$x^{16} + x^{12} + x^5 + 1$$

Note.— See CCITT (Red Book) Recommendation X.25, Section 2.2.7 for the method of calculation and the bit order.

Direct link service (DLS). A data communications service which makes no attempt to automatically correct errors, detected or undetected, at the link layer of the satellite communications path. (Error control may be effected by end-user systems.)

Epoch. A span of time related to the beginning and end, or lifetime, of an event or a sequence of associated events.

Frame. A structured, repeating time-segment of a communication link architecture that provides for time-predictable communication activities between its beginning and end.

Global beam. Satellite antenna directivity whose main lobe encompasses the entire earth's surface that is within line-of-sight view of the satellite.

Initial signal unit (ISU). The first of the series of signal units followed by SSUs.

Link interface control information (LICI). The control information exchanged between the link layer and any of its service users as part of the link interface data unit (LIDU).

Link interface data unit (LIDU). The total information transferred in a single interaction across the interface between the link layer and a link service user. Each LIDU contains link interface control information (LICI) and may also contain a single link service data unit (LSDU).

Link service data unit (LSDU). A part of the link interface data unit (LIDU) and is the same as the subnetwork protocol data unit (SNPDU).

Lone signal unit (LSU). A single signal unit comprising the total message.

Near-geostationary orbits. Satellites operating in near-geostationary orbits have an orbit period of 24 hours with an inclination of up to five degrees from the equatorial plane.

Network co-ordination station (NCS). The entity of the overall AMS(R)S system that has functional responsibilities to: co-ordinate communications traffic and satellite connectivity within its satellite region; and provide inter-system co-ordination with adjacent satellite regions served by other satellites.

P channel synchronization. The state of the P channel demodulator when the P channel unique word is reliably detected.

P channel degradation/loss. A declaration that is made when the P channel bit error rate rises above 10^{-4} over an averaging period of 3 minutes, or more than 10 short-term interruptions (loss of P channel synchronization for less than 10 seconds) are experienced in any 3-minute period; or when the P channel synchronization is lost for more than 10 seconds.

Q number, Q level, Q precedence. A definition of the transmission precedence of a message or signalling sequence, using numbers from 0 to 15 (with 15 transmitted first).

Reliable link service (RLS). A data communications service provided by the satellite subnetwork which automatically provides for error control over its link through error detection and requested retransmission of signal units found to be in error.

Satellite region. A geographically defined sub-area within the view of a satellite within which services can be provided by that satellite.

Satellite service area. A geographically defined sub-area within the view of a satellite within which services are provided by that satellite. Note that a satellite service area might be sub-divided in terms of operational characteristics, conditions, or limitations for a variety of reasons.

Signal unit (SU). A time-ordered, contiguous set of data octets used for signalling and control, and for user packet data transmissions. Standard-length SUs are 96 bits (12 octets) used in P, T and C channels. R channel SUs are 152 bits (19 octets), and the T channel uses a header SU of 48 bits (6 octets).

Spot beam. Satellite antenna directivity whose main lobe encompasses significantly less than the earth's surface that is within line-of-sight view of the satellite. May be designed so as to improve system resource efficiency with respect to geographical distribution of user earth stations.

Subsequent signal unit (SSU). In a series of SUs, the signal unit(s) following the initial signal unit.

Superframe. A recurring, time-structured set of data transmission frames, which also includes a superframe marker (see also the definition of "frame").

4.1.1.2 DESCRIPTION OF CHANNEL TYPES

4.1.1.2.1 *P channel.* Packet mode time division multiplex (TDM) channel transmitted continuously from the aeronautical ground earth station (GES) in the to-aircraft direction to carry signalling and user data. A P channel being used for system management functions is designated P_{smc}, while a P channel being used for other functions is designated by P_d. The functional designations P_{smc} and P_d do not necessarily apply to separate physical channels.

4.1.1.2.2 *R channel.* Random access (slotted Aloha) channel, used in the from-aircraft direction to carry signalling and user data. An R channel being used for system management functions is designated R_{smc}, while an R channel being used for other functions is designated R_d. The functional designations R_{smc} and R_d do not necessarily apply to separate physical channels.

4.1.1.2.3 *T channel.* Reservation time division multiple access (TDMA) channel, used in the from-aircraft direction only. The receiving GES reserves time slots for transmissions requested by aircraft earth stations (AESs) according to message length. The sending AES transmits the message in the reserved time slots according to priority.

4.1.1.2.4 *C channel.* Circuit-mode single channel per carrier (SCPC) channel, used in both to-aircraft and from-aircraft directions. This channel is time division multiplexed to provide a primary channel for voice or data traffic and a sub-band channel for signalling, supervision and data messages. The use of the channel is controlled by assignment and release signalling at the start and end of each transaction.

4.1.2 General

4.1.2.1 When aeronautical mobile-satellite service (AMSS), using near-geostationary orbiting satellites, is installed and maintained in operation as an aid to air traffic services, it shall conform with the provisions of 4.1 to 4.10.

4.1.2.2 Requirements for mandatory carriage of AMSS equipment including the level of system capability shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation time-scales for the carriage of equipment.

4.1.2.3 The agreements indicated in 4.1.2.2 shall provide at least two years' notice of mandatory carriage of airborne systems.

4.1.2.4 **Recommendation.—** *Civil aviation authorities should co-ordinate, with national authorities and service providers, those implementation aspects of AMSS which will permit its world-wide interoperability and optimum use, as appropriate.*

Note.— Provisions on the allocation and assignment of ICAO 24-bit aircraft addresses for use by the AMSS are contained in Annex 10, Volume I, Appendix C to Part I.

4.1.3 System capabilities

Note.— A system providing aeronautical mobile-satellite service (AMSS) comprises the AES, the satellite and the GES. A Level 1 (2, 3 or 4) system consists of an AES with Level 1 (2, 3 or 4) capability with one or more satellites and one or more GESs having the capabilities to operate compatibly with all capabilities of the AES.

4.1.3.1 *Scope*. A level of system capability shall include the performance of the AES, the satellite and the GES. All AESs, as a minimum, shall have a Level 1 capability and shall continuously monitor the P channel after log-on to the GES. Each GES shall provide at all times when operating AMS(R)S, a Level 1 capability as a minimum.

4.1.3.1.1 There shall be a P channel and an R channel P_{smc} and R_{smc} capability which perform system management functions for each satellite service area.

4.1.3.1.2 For the case where there is one transmit channel unit shared between the R and T channels, R channel transmissions shall be delayed, whenever necessary, to avoid interrupting a T channel transmission.

4.1.3.2 *Level 1*. An AES with Level 1 capability shall have the capabilities for:

a) receiving and processing data on one P channel at channel rates of 0.6 and 1.2 kbits/s; and

b) processing and transmitting data on one R channel and on one T channel at channel rates of 0.6 and 1.2 kbits/s.

Simultaneous transmission on the R channel and the T channel shall not be required.

4.1.3.2.1 An AES with Level 1 capability shall receive and process continuously the assigned P channel once logged on with the GES to enable receipt of AES-addressed messages and respond to GES commands.

4.1.3.2.2 **Recommendation.—** *An AES with Level 1 capability should have the capabilities described in 4.1.3.2 for the additional channel rate of 2.4 kbits/s.*

Note.— An AES with Level 1 capability provides basic packet mode data communications based on the open system interconnection model to support aviation safety communications. An AES with Level 1 capability requires one receive channel and one transmit channel.

4.1.3.3 *Level 2*. An AES with Level 2 capability shall have the capabilities for:

a) receiving and processing data on one P channel at channel rates of 0.6 and 10.5 kbits/s; and

b) processing and transmitting data on one R channel and on one T channel at channel rates of 0.6 and 10.5 kbits/s.

Simultaneous transmission on the R channel and the T channel shall not be required. Simultaneous reception on more than one P channel shall not be required.

4.1.3.3.1 **Recommendation.—** *An AES with Level 2 capability should have the capabilities described in 4.1.3.3 a) for the additional channel rate of 4.8 kbits/s.*

4.1.3.4 *Level 3*. An AES with Level 3 capability shall provide the capabilities for:

a) an AES with Level 2 capability; and

b) receiving, processing and transmitting digital information on one C channel at a channel rate of 21.0 kbits/s.

Simultaneous operation of the C channel with either the R channel or the T channel shall not be required.

4.1.3.4.1 **Recommendation.—** *Level 3 channel capability should be provided at channel rates of 5.25, 6.0 and 10.5 kbits/s.*

Note.— An AES with Level 3 capability provides digitized voice capability on a C channel in addition to the Level 2 packet mode data capability. Pre-emption requirements are described in Sections 4.8 and 4.9. Two receive channels and one transmit channel are required.

4.1.3.5 *Level 4*. An AES with Level 4 capability shall provide the capabilities for:

a) an AES with Level 3 capability;

b) simultaneous operation of a C channel with the R channel; and

c) simultaneous operation of the C channel with the T channel.

Simultaneous operation of the three channels (C, R and T) shall not be required.

4.1.3.5.1 **Recommendation.—** *Level 4 channel capability should be provided at channel rates of 5.25, 6.0 and 10.5 kbits/s.*

Note.— An AES with Level 4 capability provides digitized voice capability on a C channel simultaneously with packet mode data capability on the R channel or the T channel. Two receive channels and two transmit channels are required.

4.1.3.5.2 **Recommendation.—** *A Level 4 AES should be capable of simultaneous R and T channel transmissions whenever the C channel is not in use.*

4.2 BROADBAND RF CHARACTERISTICS

4.2.1 Frequency bands

4.2.1.1 USE OF AMS(R)S BANDS

Note.— Categories of messages, and their relative priorities within the aeronautical mobile (R) service, are given in Annex 10, Volume II, 5.1.8. These categories and priorities are equally valid for the aeronautical mobile (R) satellite service (see ITU Radio Regulation No. 3651).

4.2.1.1.1 Every aircraft earth station and ground earth station shall be designed to ensure that messages defined in Annex 10, Volume II, 5.1.8 are not delayed by the transmission and/or reception of other types of messages employing frequencies within the bands stated in 4.2.1.2 and 4.2.1.3 or other frequencies to which the station can tune. Message types not defined in Annex 10, Volume II, 5.1.8 shall be terminated if necessary, and without warning, to allow Annex 10, Volume II, 5.1.8 type messages to be transmitted and received.

Note.— See ITU Radio Regulations, Article 8, No. 729A.

4.2.1.2 TO-AIRCRAFT

4.2.1.2.1 The aircraft earth station shall be capable of receiving in the frequency band 1 544 to 1 555 MHz.

Note.— Use of the band 1 544 to 1 545 MHz by mobile satellite services is limited to distress and safety operations.

4.2.1.2.2 **Recommendation.—** *The aircraft earth station should be capable of receiving in the frequency band 1 555 to 1 559 MHz.*

Note.— The band 1 555 to 1 559 MHz may be protected and utilized by some States for national and international AMS(R)S purposes.

4.2.1.2.3 **Recommendation.—** *The aircraft earth station should also be capable of receiving in the frequency band 1 525 to 1 544 MHz.*

Note.— The band 1 525 to 1 544 MHz may be used to communicate for purposes of distress and public correspondence with stations of the maritime mobile-satellite service in accordance with No. 3571 of the ITU Radio Regulations.

4.2.1.3 FROM-AIRCRAFT

4.2.1.3.1 The aircraft earth station shall be capable of transmitting in the frequency band 1 645.5 to 1 656.5 MHz.

Note.— Use of the band 1 645.5 to 1 646.5 MHz by mobile-satellite services is limited to distress and safety operations.

4.2.1.3.2 **Recommendation.—** *The aircraft earth station should be capable of transmitting in the frequency band 1 656.5 to 1 660.5 MHz.*

Note.— The band 1 656.5 to 1 660.5 MHz may be protected and utilized by some States for national and international AMS(R)S purposes.

4.2.1.3.3 **Recommendation.—** *The aircraft earth station should also be capable of transmitting in the frequency band 1 626.5 to 1 645.5 MHz.*

Note.— The band 1 626.5 to 1 645.5 MHz may be used to communicate for purposes of distress and public correspondence with stations of the maritime mobile-satellite service in accordance with No. 3571 of the ITU Radio Regulations.

4.2.1.4 TUNING INCREMENTS

4.2.1.4.1 Channels shall be allocated throughout the bands in increments of 2.5 kHz, for the to- and from-aircraft transmission path.

4.2.1.4.2 Channel assignment and tuning of the aircraft earth station shall be achieved under control from the GES.

4.2.1.5 CHANNEL NUMBERING

4.2.1.5.1 The channel number (Ct) shall be defined with respect to the centre frequency on the to-aircraft transmission path by the formula:

$$Ct = \frac{\text{frequency of transmission (MHz)} - 1\ 510.0}{0.0025}$$

4.2.1.5.2 The channel number (Cf) shall be defined with respect to the centre frequency on the from-aircraft transmission path by the formula:

$$Cf = \frac{\text{frequency of transmission (MHz)} - 1\ 611.5}{0.0025}$$

4.2.2 Frequency accuracy

The frequency of transmission from the aircraft earth station, as would be received at the satellite, shall not vary from the nominal channel frequency by more than ±383 Hz due to all causes.

Note.— The frequency of transmissions received by a subsonic aircraft should not vary from the nominal channel frequency by more than ±2.18 kHz due to all causes.

4.2.3 Aircraft earth stations RF characteristics

Note.— The following requirements apply over the entire transmit and receive frequency bands.

4.2.3.1 GENERAL ANTENNA CHARACTERISTICS

4.2.3.1.1 *Reference coverage volume.* Antenna systems shall be installed to meet performance requirements for transmitting and receiving over a coverage volume of 360 degrees of azimuth and from 5 to 90 degrees in elevation from a horizontal plane for aircraft in straight and level flight.

4.2.3.1.1.1 **Recommendation.—** *To the maximum extent possible, antenna systems should be installed to meet performance requirements for transmitting and receiving over a coverage volume of 360 degrees in azimuth and from 5 to 90 degrees in elevation from a horizontal plane for aircraft attitudes of +20/-5 degrees of pitch and ±25 degrees of roll.*

4.2.3.1.2 *Polarization.* The polarization shall be right-hand circular for both receiving and transmitting, in accordance with the definition of CCIR Recommendation 573.

4.2.3.1.3 *Antenna switching.* Aircraft earth stations that require more than one antenna shall be capable of switching from one antenna to another in the same antenna sub-system so as to introduce a signal interruption of not more than 40 ms.

Note.— 4.2.3.2 and 4.2.3.3 outline the requirements for high gain and low gain antennas only. This does not preclude the future introduction of mid-gain antennas; however, some of the considerations which must be made before such an introduction are described in the guidance material contained in Attachment A to Part I of Annex 10, Volume III.

4.2.3.2 LOW GAIN ANTENNA SUB-SYSTEMS

4.2.3.2.1 *Gain-to-noise temperature ratio.* Receiving sub-systems employing low gain antennas shall achieve a gain-to-noise temperature ratio (G/T) of not less than −26 dB/K over not less than 85 per cent of the reference coverage volume defined in 4.2.3.1.1; and not less than −31 dB/K over the remaining 15 per cent of the reference coverage volume. The only exception to this is the region greater than 70 degrees in elevation from the horizontal plane where the G/T may be not less than −28 dB/K.

4.2.3.2.2 *Axial ratio.* The axial ratio shall be less than 6 dB for elevation angles of 45 to 90 degrees and less than 20 dB for elevation angles of 5 to 45 degrees or the AES antenna shall have sufficient gain to compensate for additional polarization loss in excess of that caused by the axial ratios. The condition for including the compensation shall assume the satellite axial ratio to be 2.5 dB, with major axes of the polarization ellipses orthogonal.

4.2.3.2.3 **Recommendation.—** *To the maximum extent possible, the G/T should be not less than −26 dB/K and the axial ratio should be less than 6 dB over 100 per cent of the reference coverage volume.*

4.2.3.3 HIGH GAIN ANTENNA SUB-SYSTEMS

4.2.3.3.1 *Gain-to-noise temperature ratio.* Receiving sub-systems employing high gain antennas shall achieve a gain-to-noise temperature ratio (G/T) of not less than −13 dB/K over not less than 75 per cent of the reference coverage volume and shall be not less than −25 dB/K over the remaining 25 per cent of the reference coverage volume defined in 4.2.3.1.1.

4.2.3.3.2 *Axial ratio.* The axial ratio shall be less than 6 dB over the 75 per cent of the reference coverage volume referred to in 4.2.3.3.1 where the G/T must exceed −13 dB/K or the AES antenna shall have sufficient gain to compensate for additional polarization loss in excess of that caused by this axial ratio. The condition for including the compensation shall assume the satellite axial ratio to be 2.5 dB, with the major axes of the polarization ellipses orthogonal.

4.2.3.3.3 **Recommendation.—** *To the maximum extent possible, the G/T should be not less than −13 dB/K and the axial ratio should be less than 6 dB over 100 per cent of the reference coverage volume.*

4.2.3.3.4 *Discrimination.* The antenna gain pattern for both transmit and receive functions shall discriminate by not less than 13 dB between the directions of wanted and unwanted satellites spaced 45 degrees or greater in longitude over not less than 75 per cent of the reference coverage volume defined in 4.2.3.1.1.

4.2.3.3.4.1 **Recommendation.—** *The antenna gain pattern for both transmit and receive functions should discriminate by not less than 13 dB between the directions of wanted and unwanted satellites spaced 45 degrees or greater in longitude over 100 per cent of the reference coverage volume defined in 4.2.3.1.1.*

4.2.3.3.5 *Phase discontinuity.* Beam steering transitions between adjacent beam positions of a switched beam antenna shall not cause RF phase transitions greater than 12 degrees in the transmitted signal for 99 per cent of all possible adjacent beam combinations.

4.2.3.3.5.1 **Recommendation.**— *Beam steering transitions between adjacent beam positions of a switched beam antenna should not cause RF phase transitions greater than 12 degrees in the transmitted signal for 100 per cent of all possible adjacent beam combinations.*

Note.— This requirement only applies to individual array performance in the case of multiple array antennas.

4.2.3.4 RECEIVER REQUIREMENTS

4.2.3.4.1 *Receiver spurious and linearity performance.* The required performance defined in 4.4.2.3 and 4.4.5.4 shall be achieved when the receiving antenna is illuminated in the direction of maximum gain by a power flux density of −100 dBW/m^2 distributed across the 1 525 to 1 559 MHz band.

4.2.3.4.2 *Receiver out-of-band performance.* The required performance defined in 4.4.2.3 and 4.4.5.4 shall be achieved in the presence of out-of-band interference at levels typical of normal operating conditions.

4.2.3.4.3 *Received phase noise.* The design of the receiver and the demodulators shall be such as to ensure full compliance with the performance requirements whenever the received signal phase noise characteristic does not exceed the mask defined in Table 4-1.*

4.2.3.4.4 *Capture range.* The receiver shall be capable of acquiring and maintaining lock to signals with a frequency offset from nominal of up to ±2.180 kHz at carrier-to-noise levels as shown in Table 4-2.

4.2.3.4.5 *Receiver Doppler rate.* The receiver shall be capable of acquiring and maintaining performance per 4.3.3 with a rate of change of frequency of 30 Hz per second.

4.2.3.5 TRANSMITTER REQUIREMENTS

4.2.3.5.1 *EIRP LIMITS*

4.2.3.5.1.1 For low gain antenna operation, the minimum value of EIRP per carrier in the direction of the satellite, when commanded to the maximum setting, shall be 13.5 dBW. The EIRP radiated in any direction shall not exceed 22.8 dBW.

4.2.3.5.1.2 For high gain antenna operation, the minimum value of EIRP per carrier in the direction of the satellite, when commanded to the maximum setting, shall be 25.5 dBW. The EIRP radiated in any direction shall not exceed 34.8 dBW at the maximum setting.

4.2.3.5.1.3 At settings less than the maximum setting, the EIRP per carrier radiated in any direction shall not exceed the EIRP radiated toward the wanted satellite by more than 5 dB.

4.2.3.5.1.4 For multicarrier operation, the maximum allowable operating EIRP shall be the level at which:

a) the total intermodulation product contribution from active sources is the maximum permitted in 4.2.3.5.7 (in-band intermodulation products), or

b) the gain-to-noise temperature ratio is the minimum permitted in 4.2.3.2.1 or 4.2.3.3.1, as applicable.

4.2.3.5.2 *EIRP control.* The EIRP per carrier in the direction of the wanted satellite shall be adjustable over a range of 15 dB in steps of 1 dB by command from the GES.

4.2.3.5.3 **Recommendation.**— *The minimum EIRP of the power control range should be a function of the channel rate and the satellite beam characteristics to minimize the interference potential.*

4.2.3.5.4 *Carrier-off level.* The EIRP in any direction, summed across the 1 626.5 to 1 660.5 MHz band, when all carriers are commanded off shall be −24.5 dBW or less.

4.2.3.5.5 *Log-on EIRP.* When logging on to a GES, the EIRP of the AES shall be at least 13.5 dBW.

4.2.3.5.6 *In-band spurious EIRP.* When transmitting a modulated carrier at any level up to the maximum allowable operating EIRP, the composite radiated in-band spurious and noise EIRP (excluding intermodulation products) referenced to a 4 kHz band shall not exceed −55 dBc. This requirement shall not apply to the frequency band on either side of the carrier centre frequency which is described in 4.3.2.1.

4.2.3.5.7 *In-band intermodulation products.* For a multicarrier AES, the EIRP of each in-band intermodulation product shall be at least 24 dB below the EIRP of each carrier when transmitting two equal carriers with a total EIRP equal to the maximum allowable operating EIRP of the AES in the band 1 626.5 to 1 660.5 MHz.

* All tables are located at the end of this chapter.

4.2.3.5.8 *Out-of-band EIRP density levels.* When transmitting a carrier at any level up to the maximum power level as described in 4.2.3.5.1, the out-of-band EIRP including spurious, harmonics and noise generated by the AES in any direction shall not exceed the levels shown in Table 4-3.

4.2.3.5.8.1 AMSS transmissions shall not cause harmful interference to satellite navigation receiver operation where such receiver is operated on the same aircraft as the AES.

4.2.3.5.8.2 **Recommendation.—** *The EIRP density should not exceed −140 dBc/1 MHz from 1 598 to 1 609.26 MHz.*

4.2.3.5.9 *Phase noise.* The phase noise induced on a modulated carrier shall have a power spectral density not exceeding the envelope defined in Table 4-4.

4.2.3.5.10 *Transmitter Doppler rate.* The maximum rate of change of the frequency of the transmitted signal when compensated for aircraft acceleration in the direction of the satellite shall not exceed 15 Hz per second. The Doppler adjustment resolution shall not exceed 10 Hz and the associated frequency changes shall be made without introducing phase discontinuity into the transmitted signal.

4.3 RF CHANNEL CHARACTERISTICS

4.3.1 Modulation

4.3.1.1 *Modulation for channel rates 2.4 kbits/s and below.* For channel rates of 2.4, 1.2 and 0.6 kbits/s, the modulation shall be aviation binary phase shift keying (A-BPSK).

4.3.1.2 *Modulation for channel rates above 2.4 kbits/s.* For channel rates above 2.4 kbits/s the modulation shall be aviation quadrature phase shift keying (A-QPSK).

4.3.2 *Radiated power spectral density.* The following bounds on radiated power spectral density shall apply in any direction normalized to the peak spectral density in that direction. The bounds shall apply to a single carrier and shall be centred at the carrier frequency. The lower bound shall not apply when the AES is transmitting the unmodulated preamble at the beginning of a burst.

4.3.2.1 *From-aircraft.* The power spectrum radiated by the AES shall fall within the mask defined by Table 4-5.

4.3.2.2 *To-aircraft.* The power spectrum received by the AES shall be within the mask defined by Table 4-6 for A-BPSK and Table 4-7 for A-QPSK.

4.3.3 *Demodulator performance.* Where the channel rates are implemented as defined in 4.1, the bit error rate (BER) performance of the channel demodulators after descrambling shall be equal to or better than that shown in Table 4-8. This performance shall be attained under the following conditions:

a) in the presence of two adjacent interfering carriers on either side of the wanted carrier at a level of 5 dB higher than the wanted carrier with a frequency uncertainty from the nominal carrier spacing as specified and for the AES demodulator, with the AES operating up to its maximum allowable operating EIRP;

b) while receiving a signal transmitted with the maximum phase noise characteristics described in 4.2.3.5.9;

c) during 12° RF phase discontinuities occurring at the rate of one per second; and

d) under Rician channel conditions for fading bandwidths of 20, 60 and 100 Hz with a carrier to multipath ratio of 7 dB for systems using a low gain antenna or low and high gain antennas; or 10 dB for systems using only a high gain antenna.

4.3.4 Acquisition performance

4.3.4.1 *Time to acquire superframe synchronization.* The period from the command to the antenna to acquire the satellite to superframe synchronization shall not exceed 16 seconds.

Note.— This assumes the AES is within the satellite service area of that P channel.

4.3.4.2 **Recommendation.—** *The period from the command to the antenna to acquire the satellite to superframe synchronization should be as small as possible.*

4.3.4.3 *C channel AES demodulator acquisition.* The probability of failing to achieve frame lock on the first unique word following the burst preamble shall be less than one in 10^4 at an E_s/N_0 of 1.0 dB in a Gaussian channel, including conditions of 4.3.3 a) and b); and with the maximum burst-to-burst frequency uncertainty of ±30 Hz and maximum channel rate accuracy deviation of 4.4.5.1.

4.3.4.4 C CHANNEL GES DEMODULATOR ACQUISITION

4.3.4.4.1 *Channel rate of 21.0 kbit/s.* The probability of the GES demodulator failing to achieve frame lock within three seconds of the start of C channel transmission shall be less than one in 10^2.

4.3.4.4.2 *Other C channel rates.* The probability of the GES demodulator failing to achieve frame lock within 0.75 seconds of the start of C channel transmission shall be less than one in 10^2.

4.3.4.4.3 **Recommendation.—** *The GES demodulator should achieve C channel frame lock as soon as possible after the start of C channel transmission.*

4.4 CHANNEL FORMAT TYPES AND RATES

4.4.1 General

4.4.1.1 *Aircraft system-timing reference point.* The reference timing point for signals generated and received by the AES shall be at the antenna.

4.4.1.2 *Channel rates.* The channel rates as applicable to the system capability levels defined in 4.1.3 shall be as shown in Table 4-9.

4.4.1.3 *Signal units (SUs).* All information to be transmitted over the P, R, T and sub-band C channels shall be in the format of signal units. For the P, T and sub-band C channel each signal unit shall consist of 96 bits. For the R channel each signal unit shall consist of 152 bits. The signal unit formats shall be as specified in Appendix 2.

4.4.1.3.1 *Cyclic redundancy check (CRC).* The last two bytes of each SU shall form a CRC of the SU. Any received SU which fails the CRC shall be discarded.

4.4.1.3.2 *Signal quality estimation.* The AES shall make information such as P channel degradation/loss and C channel bit error rate available to the AES management functions and GES management functions as appropriate.

4.4.2 P channel

4.4.2.1 *Channel rate accuracy.* The channel rate error shall not exceed one part in 10^6.

4.4.2.2 FRAME FORMAT

4.4.2.2.1 *General characteristics.* All P channel frames shall be either 500 ms, or a multiple of 500 ms to provide simple derivation of an 8-second superframe which shall be used for R channel and T channel slot allocation. Each P channel frame shall consist of five fields identified as: format identifier, superframe boundary marker, dummy field (for data rates greater than 2.4 kbits/s), information field and unique word, as shown in Figure 4-1* for channel rates of 2.4 kbits/s and less, and in Figure 4-2 for channel rates greater than 2.4 kbits/s.

4.4.2.2.2 *Format identifier.* This field shall consist of the 4 bits: 0001. Other values for this field are reserved for future use.

4.4.2.2.3 *Superframe boundary marker.* This field shall consist of 12 bits.

— 4 bits to indicate the start of a new superframe
  1111 for frame 0 in a superframe of 8 seconds
  0000 for all remaining frames in the superframe
— 4 bits to indicate frame of superframe
  0000,0001,0010,0011 at 0.6 kbits/s
  0000,0001,.....,0111 at 1.2 kbits/s
  0000,0001,.....,1111 at 2.4 kbits/s and above
— 4 bits which repeat the previous 4 bits.

4.4.2.2.4 *Dummy field.* For channel rates above 2.4 kbits/s this field shall be:

16 bits for 4.8 kbits/s
178 bits for 10.5 kbits/s

The dummy field shall consist of the sequence 0001 repeated until the required number of bits is obtained.

Note.— The dummy field is included to make each frame 0.5 seconds long. There is no dummy field required for data rates of 2.4 kbits/s and below.

4.4.2.2.5 *Information field.* The information field shall contain multiple signal units which are scrambled, coded and interleaved, in that order. The number of bits in the information field shall be as indicated in Table 4-10.

Note.— The number of bits in the information field is dependent on the data rate and the number of interleaver blocks in the field.

4.4.2.2.5.1 *Scrambling.* A scrambler with a 15-stage generator register shall be used for data scrambling before FEC coding. The polynomial for the generator register of the scrambler and the descrambler shall be $1 + X + X^{15}$. The scrambler and descrambler shall be clocked at the information rate with the first scrambled bit output before the first shift. In the absence of programming commands, the shift register shall be initialized to 1101 0010 1011 001 (leftmost bit in shift register stage 1) at the beginning of the information field of each frame. The scrambler and descrambler functions shall be as illustrated in Figure 4-3. The scrambler shall be re-initialized at the beginning of the information field of each frame.

* All figures are located at the end of this chapter.

Note.— The concept of a scrambler is explained in CCIR Report 384-3, Annex III, Section 3, Method 1.

4.4.2.2.5.2 *Forward error correction (FEC).* The information field shall use rate ½ forward error correction coding. The FEC coding shall be implemented with a constraint length 7 rate ½ convolutional encoder. The generator polynomials for this code shall be:

G1: $1 + X^2 + X^3 + X^5 + X^6$
G2: $1 + X + X^2 + X^3 + X^6$

The output sequence of the encoded symbols shall be G1, G2 as shown in Figure 4-3. The convolutional encoder shall not be initialized between frames.

Note.— There are no flush bits on the P channel.

4.4.2.2.5.3 *Interleaving.* All P channels shall employ block interleaving. The column depth (number of rows) of the interleaver shall be 64 transmission bits, while the number of columns shall depend on the transmission rate as shown in Table 4-11. At the transmitter, the output of the convolutional encoder shall be written into the 64-bit columns until the prescribed number of columns are full. The rows shall then be permuted using the algorithm $Row_j = (Row_i * 27)$ modulo 64. The content of the interleaver shall then be transmitted row by row as shown in Figure 4-4. At the receiver, the soft decision data from the demodulator shall be written into the interleaver row by row, and when it is full the interleaver rows shall be permuted using the converse algorithm $Row_j = (Row_i * 19)$ modulo 64. The soft decision data shall then be read column by column into the FEC decoder.

4.4.2.2.6 *Unique word.* With A-BPSK each P channel frame shall end with the 32-bit unique word 1110 0001 0101 1010 1110 1000 1001 0011, with the leftmost bit transmitted first. With A-QPSK, the unique word shall be the A-BPSK unique word repeated in each of the in-phase and quadrature channels.

4.4.2.3 *Performance.* The over-all physical layer shall be configured and operated such that the average bit error rate is 10^{-5} or less after descrambling.

4.4.3 R channel

4.4.3.1 *Channel rate accuracy.* The channel rate error shall not exceed one part in 2R, where R is the channel rate, and one part in 10^4.

4.4.3.2 *Burst timing.* The beginning of each R channel burst shall occur within ±300μs of the beginning of an R channel slot defined by the received P channel superframe. As shown in Figure 4-5, each P channel superframe shall define 8, 16, 32 and 64 random access slots for R channel data rates of 0.6, 1.2, 2.4 and 10.5 kbits/s, respectively.

4.4.3.3 BURST FORMAT

4.4.3.3.1 *General characteristics.* Each R channel burst shall consist of three fields: the preamble, the unique word and the information field as shown in Figure 4-6.

4.4.3.3.2 *Preamble.* The preamble for the R channel shall consist of an unmodulated carrier portion followed by a modulated portion. The length of these depend on the data rate as shown in Table 4-12. The unmodulated portion of the A-BPSK preamble shall be a signal of constant phase and the modulated portion shall consist of alternating "0" and "1" input to a standard A-BPSK modulator. The first bit of the modulated portion shall be a "0" and shall give a −90 degree phase change relative to the phase of the unmodulated signal. The unmodulated portion of the A-QPSK preamble shall be a signal of constant phase corresponding to the output of an ideal A-QPSK modulator with all "0"s at its input. The modulated portion shall consist of alternating "0" and "1" (commencing with a "0" in the first bit) on the I channel and continuous "0"s on the Q channel.

Note.— It is intended that the unmodulated portion of the preamble be used for carrier acquisition and the modulated portion for clock acquisition.

4.4.3.3.3 *Unique word.* The Standard in 4.4.2.2.6 shall apply.

4.4.3.3.4 *Information field.* The information field of each R channel burst shall consist of 160 bits and shall contain an extended signal unit plus 8 flush bits prior to convolutional encoding, where an extended SU shall have 152 bits and a Flush field shall be 0000 0000. The information field shall be scrambled, coded and interleaved, in that order.

4.4.3.3.4.1 *Scrambling.* The Standard in 4.4.2.2.5.1 shall apply, except that the flush bits are not scrambled.

4.4.3.3.4.2 *Forward error correction (FEC) coding.* The Standard in 4.4.2.2.5.2 shall apply, except that the encoder is re-initialized to the all 0s state at the beginning of the information frame of each burst.

4.4.3.3.4.3 *Interleaving.* All R channels shall employ block interleaving. The number of rows in the interleaver shall be 64 transmission bits, while the number of columns shall be 5. Row interchanging in the interleaver shall be performed in accordance with 4.4.2.2.5.3.

4.4.3.4 *Performance.* The Standard in 4.4.2.3 shall apply.

4.4.4 T channel

4.4.4.1 *Channel rate accuracy.* The channel rate error shall not exceed one part in 2R, where R is the channel rate, and one part in 10^4.

4.4.4.2 *Timing relative to P channel.* The beginning of each T channel burst shall occur within ±300μs of the beginning of the assigned T channel slot defined by the received P channel superframe. As shown in Figure 4-7, each P channel superframe shall be divided into 16 nominal frames with 64 T channel slots in each frame. The shortest guard time between the T channel bursts of two different aircraft is under control of the GES and shall be 5 slots.

4.4.4.3 BURST STRUCTURE

4.4.4.3.1 *General characteristics.* Each T channel burst shall consist of three fields: the preamble, the unique word and the information field as shown in Figure 4-8.

4.4.4.3.2 *Preamble.* The Standard in 4.4.3.3.2 shall apply.

4.4.4.3.3 *Unique word.* The Standard in 4.4.2.2.6 shall apply.

4.4.4.3.4 *Information field.* The information field of each T channel burst shall consist of a burst identifier, n SUs and 16 flush bits prior to convolutional encoding, as follows.

Burst identifier — this field has 48 bits which shall identify the originating aircraft and the destination GES,

n SUs — from 2 to 31 standard length signal units of 96 bits each, and

Flush — a field of 16 bits (all 0s) to flush out the convolutional encoder.

The information field shall be scrambled, coded and interleaved, in that order.

4.4.4.3.4.1 *Scrambling.* The Standard in 4.4.2.2.5.1 shall apply, except that the scrambler shall be re-initialized at the beginning of the information field of each burst.

4.4.4.3.4.2 *Forward error correction (FEC) coding.* The Standard in 4.4.2.2.5.2 shall apply, except that the convolutional encoder shall be initialized to the all 0s state at the beginning of the information field of each burst.

4.4.4.3.4.3 *Interleaving.* All T channels shall employ block interleaving. The number of rows in the interleaver shall be 64 transmission bits, while the number of columns shall depend on the data rate as shown in Table 4-13. At the transmitter the output of the convolutional encoder shall be written into the 64-bit columns, until the specified number of columns are full. The interleaver row interchange algorithm shall be in accordance with 4.4.2.2.5.3.

4.4.4.4 *Performance.* The Standard in 4.4.2.3 shall apply.

4.4.5 C channel

4.4.5.1 *Channel rate accuracy.* The channel rate error shall not exceed one part in 2R, where R is the channel rate, and one part in 10^4.

4.4.5.2 TRANSMISSION FORMATS

4.4.5.2.1 *Preamble.* The preamble for the C channel shall consist of an unmodulated carrier portion followed by a modulated portion. The length of these shall depend on the channel rate as shown in Table 4-14 as applicable to the system capability levels defined in 4.1.3. The preamble shall be as described in the text of 4.4.3.3.2 and in Table 4-14.

4.4.5.2.2 *Postamble.* The postamble of the C channel shall consist of continuous "0"s on the I channel, and alternating "0" and "1" (commencing with "0") on the Q channel. The length of the postamble shall be equivalent to a single interleaver block for channels with interleaving, and 96 bits for channels without interleaving.

4.4.5.2.3 *To-aircraft.* The C channel shall operate in burst mode in the to-aircraft direction. In this mode, the C channel burst shall consist of a preamble followed by a series of contiguous frames followed by a postamble. Each frame shall consist of three fields: the unique word, a dummy field and the information field, as in Figures 4-9 and 4-10. Each frame shall be 500 ms long.

4.4.5.2.4 *From-aircraft.* The C channel shall operate in continuous mode in the from-aircraft direction. Each transmission shall begin with the preamble described in 4.4.5.2.1. In this mode, the C channel frame shall consist of three fields: the unique word, a dummy field and the information field as in Figures 4-9 and 4-10. Each frame shall be 500 ms long.

Note.— In the P, R and T channels the information field refers to the information bits after forward error correction coding. With the C channel the information field may or may not include coding depending upon the particular C channel type.

4.4.5.3 FRAME FORMAT

4.4.5.3.1 *Unique word.* The unique word shall consist of two identical 44-bit sequences on the I and Q channels of the A-QPSK signal: 0100 0010 1101 1010 1111 0011 0100 1011 1011 0001 0001, with the leftmost bit transmitted first.

4.4.5.3.2 *Dummy field.* Where the channel rates are implemented as defined in 4.1.3, the number of bits in the dummy field shall be:

— 62 at 10.5 kbits/s;
— 44 at 21.0 kbits/s;
— 37 at 5.25 kbits/s; and
— 32 at 6.0 kbits/s.

The dummy bits shall consist of the sequence 0101 1010 0011 1100 repeated until the required number of bits is obtained.

4.4.5.3.3 *INFORMATION FIELD FOR CODED CHANNELS*

4.4.5.3.3.1 At the channel rate of 21.0 kbits/s this field shall contain 10 368 bits which shall be subdivided into 27 interleaver blocks of 384 bits each.

4.4.5.3.3.2 **Recommendation.**— *At the recommended channel rate of 6.0 kbits/s this field should contain 2 880 bits which are subdivided into 15 interleaver blocks of 192 bits each.*

4.4.5.3.3.3 *Information field structure including sub-band data.* Prior to scrambling, FEC encoding and interleaving, the information field shall consist of a fill-in field followed by 25 alternating sub-band data and transparent data (voice) subfields as shown in Figure 4-9.

4.4.5.3.3.3.1 At a channel rate of 21.0 kbits/s the fill-in field shall consist of 84 zeros, each subfield shall contain 12 sub-band data bits and 192 primary bits, and the last 12 bits of the 25th sub-band data subfield shall be filled with zeros.

4.4.5.3.3.3.2 **Recommendation.**— *At the recommended channel rate of 6.0 kbits/s the fill-in field should consist of 40 zeros, each subfield should contain 8 sub-band data bits and 48 primary bits, and the last 8 bits of the 25th sub-band data subfield should be filled with zeros.*

4.4.5.3.3.4 *Scrambling.* The Standard in 4.4.2.2.5.1 shall apply.

4.4.5.3.3.5 *Forward error correction (FEC) coding.* The Standard in 4.4.2.2.5.2 shall apply.

4.4.5.3.3.6 *Interleaving*

4.4.5.3.3.6.1 At the channel rate of 21.0 kbits/s the number of rows in the interleaver shall be 64 transmission bits, while the number of columns shall be 6.

4.4.5.3.3.6.2 **Recommendation.**— *At the recommended channel rate of 6.0 kbits/s the number of rows in the interleaver should be 64 transmission bits and the interleaver columns should be 3.*

4.4.5.3.3.6.3 At the transmitter the output of the convolutional encoder shall be written into the 64-bit columns, until the specified number of columns are full. The rows shall then be permuted using the algorithm described in 4.4.2.2.5.3.

4.4.5.3.4 *Information field for uncoded channels.* Where the channel rates are implemented as defined in 4.1, at the channel rate of 10.5 kbits/s this field shall contain 5 100 bits and at the recommended channel rate of 5.25 kbits/s this field shall contain 2 500 bits.

4.4.5.3.4.1 *Information field structure including sub-band data.* Prior to scrambling this field shall be divided into 25 alternating sub-band data and primary fields as shown in Figure 4-10. Where the channel rates are implemented as defined in 4.1.3, at the channel rate of 10.5 kbits/s each subfield shall contain 12 sub-band data bits and 192 primary bits; the last 12 bits of the 25th sub-band data subfield shall be filled with zeros. Where the channel rates are implemented as defined in 4.1.3, at the channel rate of 5.25 kbits/s each subfield shall contain 4 sub-band data bits and 96 primary bits; the last 4 bits of the 25th sub-band data subfield shall be filled with zeros.

Note.— Interleaving is not applicable at the channel rates of 10.5 and 5.25 kbits/s because the data is not forward error correction coded at these rates.

4.4.5.4 *Performance.* The C channel physical layer shall be configured and operated such that the average bit error rate is 10^{-3} or less after descrambling.

Note.— GES measurements of received BER permit GES commands to the AES for adjustment of the AES transmitted power. The GES also receives performance data measurement results made by the AES to enable GES output power adjustments.

4.5 LINK LAYER P CHANNEL AND R CHANNEL PROTOCOLS

4.5.1 General

Note.— The AMSS protocols are defined in terms of the OSI layered reference model. Section 4.5 defines the functional requirements of the link layer for P and R channels to transfer user data and signalling between the AES and the GES.

4.5.1.1 For each AES and GES, the link layer shall interface to the following:

a) the subnetwork layer;

b) the AES/GES management;

c) the circuit-mode services;

d) the physical layer.

4.5.1.2 The term link service user when used with respect to the link layer in 4.5 shall include items a), b) and c) in the list above.

4.5.2 Link interface data unit (LIDU)

4.5.2.1 The link interface data unit (LIDU) shall be the total information unit transferred across the interface between the link service user and the link layer in a single interaction. Each LIDU shall comprise link interface control information (LICI) and, if required, one LSDU.

4.5.2.2 The LIDU exchanged between the link layer and the subnetwork layer shall contain an LSDU and LICI, except that the transmission status indication LIDU (Table 4-25) passed by the link layer to the subnetwork layer at the transmitting end shall contain only LICI. The LIDU exchanged between the link layer and the AES/GES management and between the link layer and the circuit-mode services shall contain only LICI.

4.5.2.3 LINK INTERFACE CONTROL INFORMATION (LICI)

4.5.2.3.1 The LICI parameters exchanged between the link layer and the subnetwork layer shall be as defined in Table 4-11.

4.5.2.3.2 The LICI parameters exchanged between the link layer and the circuit-mode services shall be as defined in Table 4-38.

4.5.2.3.3 The LICI parameters exchanged between the link layer and the AES and GES management functions shall be as defined in 4.9.2.1.2 and Table 4-45, respectively.

4.5.2.4 LINK SERVICE DATA UNIT (LSDU)

Note.— The link service data unit (LSDU) is a part of an LIDU whose identity is preserved between the two link service users communicating with each other.

4.5.2.4.1 The link service data unit (LSDU) shall contain link service user data and shall be extracted from the LIDU received from the subnetwork layer.

4.5.2.4.2 *LINK SERVICE DATA UNIT FORMAT*

The LSDU format shall be the same as the format of satellite subnetwork protocol data units (SNPDUs) in the SSND sublayer described in 4.7.

4.5.3 Link protocol data unit (LPDU)

4.5.3.1 The link protocol data units (LPDUs) shall be the signal units (SUs) described in 4.5.3.2.

4.5.3.2 SIGNAL UNIT (SU)

4.5.3.2.1 There shall be two lengths of SUs for the P and R channels:

a) 96 bits (12 octets): standard length SUs for P channel;

b) 152 bits (19 octets): extended length SUs for R channel.

4.5.3.2.2 Each SU shall contain control information, and may include user data depending upon the SU type.

4.5.3.2.3 *LIDU-TO-SU SET MAPPING*

4.5.3.2.3.1 Each LIDU received by the link layer, before being transmitted to the peer link layer, shall be mapped into an SU set. Each SU set shall comprise either a single signal unit called a "lone signal unit" (LSU) or more than one signal unit of which the first shall be an "initial signal unit" (ISU) and those that follow shall be "subsequent signal units" (SSUs).

4.5.3.2.3.2 *For LIDU comprised of LSDU and LICI*

4.5.3.2.3.2.1 For the P channel, an LSDU of length 2, 3 or 4 octets shall be mapped into standard length LSUs of Figures A2-37, A2-39 and A2-40 in Appendix 2 to Chapter 4, respectively. An LSDU of length greater than 4 octets, shall result in an ISU followed by a maximum of 63 SSUs. For an LSDU of length greater than 4 octets, the first two octets of the LSDU shall be mapped into the 2-octet user data field of an ISU (Appendix 2 to Chapter 4, Figure A2-37). The remaining octets shall be mapped into the 8-octet user data fields of subsequent SSUs (Appendix 2 to Chapter 4, Figure A2-38) ordered by sequence numbers (Appendix 3 to Chapter 4, Item 59). The number of SSUs shall depend upon the number of octets in the LSDU. The control information in each SU of the

SU set shall be mapped from the information contained in the LICI and the information generated by the internal link layer protocol processes.

Note.— Each ISU contains information indicating the number of octets in the user data field of the last SSU of the SU set.

4.5.3.2.3.2.2 For the R channel, an LSDU shall map into a maximum of 3 extended length SUs, with the ISU of the SU set containing the first 11-octets (Appendix 2 to Chapter 4, Figure A2-44) of the LSDU in its user data field. The remaining octets shall be mapped into the 11-octet user data field of SSUs ordered by sequence indicator (Appendix 3 to Chapter 4, Item 58). The control information in each SU of the SU set shall be mapped from the information contained in the LICI and the information generated by the internal link layer protocol processes.

4.5.3.2.3.3 *For LIDU comprised of LICI only*

For an LIDU containing LICI only, the SU set shall be generated by mapping the information contained in the LICI and generated by the internal link layer protocol processes into the fields of the control information of the appropriate SU.

4.5.3.2.4 *SU SET-TO-LIDU MAPPING*

4.5.3.2.4.1 At the receiving end, an SU set shall be reassembled into an LIDU before being passed to the link service user.

4.5.3.2.4.2 For an SU set with SU(s) containing user data, the resulting LIDU shall contain LSDU and LICI. The LSDU shall be reassembled by combining the user data field of each SU of the received complete SU set. The LICI shall be generated from the control information in the SUs.

4.5.3.2.4.3 For an SU set with SU(s) containing no user data, the resulting LIDU shall contain only LICI. The LICI shall be generated from the control information in the received SUs.

4.5.3.3 SIGNAL UNIT FORMAT

4.5.3.3.1 The formats of all SUs transmitted on the P and the R channels shall be as shown in Appendix 2 to Chapter 4. The signal unit field mapping and the transmission order of the bits shall be as shown in Figure A2-1. The signal unit field coding and definitions shall be as described in Appendix 3 to Chapter 4.

4.5.3.3.2 SUs not recognized by the receiving link layer shall be ignored.

Note.— SUs not specified in Appendix 2 to Chapter 4 may be in use under mutual agreement between an AMSS service provider and an AMSS user for non-safety services.

4.5.4 LIDU routing

The receiving link layer (in either the GES or the AES) shall use the message type parameter in the LICI to route the LIDU to the appropriate link service user. The transmitting link layer (in the GES and the AES) shall use the routing parameter in the LICI received from the circuit-mode services (Table 4-38) to route the SU set corresponding to an LIDU, for transmission on the sub-band C channel or the R/P channels.

4.5.5 Precedence (Q number)

Each SU of the SU set generated from an LIDU shall be assigned a precedence (Q number) by the link layer according to the precedence parameter passed to it in the LICI by the link service user. Each link layer signalling SU shall be assigned a Q number according to its message type. A Q number shall be in the range from 0 (lowest precedence) to 15 (highest precedence).

4.5.6 DLS and RLS services

4.5.6.1 The link layer shall provide two distinct types of services, designated as direct link service (DLS) and reliable link service (RLS).

4.5.6.2 DLS shall be a link-layer service in which the SUs shall be transmitted to the peer link layer without making any provision for identification and retransmission of any lost SUs.

Note.— DLS is only available to AES/GES management functions and circuit-mode services.

4.5.6.3 RLS shall be a link-layer service that provides for the identification and retransmission of any lost SUs.

4.5.7 P channel protocol

Note.— In this subsection, the use of the terms "AES" and "GES" refer to the link layer functions for the P channel protocol within the AES and the GES.

4.5.7.1 GENERAL

The link layer functions for the P channel shall be as defined in 4.5.7.2 and 4.5.7.3.

4.5.7.2 GROUND EARTH STATION (GES)

4.5.7.2.1 Upon receipt of an LIDU, the GES shall assign an available (not currently assigned to an LIDU with the same Q number) reference number to it whenever this can be done in accordance with 4.5.7.2.2; however, the GES shall not assign a reference number to LIDUs received from the circuit-mode services and to system table broadcast LIDUs received from the GES management. If a reference number cannot be assigned to an LIDU, the LIDU shall be stored until one is assigned to it.

Note.— The circuit-mode LIDUs are assigned application reference numbers by the circuit-mode services.

4.5.7.2.2 At any Q precedence level, each assignment of a reference number to an LIDU destined to a particular AES shall be to the oldest LIDU among all the LIDUs without a reference number at that Q level destined to this AES. The GES shall not assign a reference number to an RLS LIDU if there is a reference number currently assigned to another LIDU with the same Q number and addressed to the same AES. Two consecutive reference number assignments for LIDUs of the same Q number shall not be made with the same reference number except for two DLS LIDUs which are mapped into LSUs. In the case of RLS, the reference number assigned by the GES shall not be equal to the last assigned reference number to an RLS LIDU with the same Q number and addressed to the same AES.

4.5.7.2.3 For DLS, the reference number shall be released immediately after it is assigned. For RLS, the reference number shall be released after the GES sends a transmission status indication LIDU (Table 4-25) to the link service user in the GES. The GES shall not reassign a released reference number until all the reference numbers that were available before its release have been assigned, in accordance with 4.5.7.2.2, the only exception to that shall be for a reference number that was assigned to a DLS LIDU mapping into an LSU, which may be immediately reassigned to another DLS LIDU mapping into an LSU.

4.5.7.2.4 After the assignment of a reference number to the LIDU or upon receipt of circuit-mode LIDU, an SU set shall be generated according to 4.5.3.2.3. Among all the SUs awaiting transmission, the oldest of the SUs with the highest Q number shall always be transmitted first. The ISU or the RTX SU of an SU set shall be transmitted before the SSUs, and the SSUs shall be transmitted in the descending order of their sequence numbers (Appendix 3 to Chapter 4, Item 59). After the transmission of the complete SU set, the GES shall do the following:

4.5.7.2.4.1 For RLS:

a) If a P channel acknowledgement (PACK) SU (Appendix 2 to Chapter 4, Figure A2-49) indicating no error in the SU set is received from the AES, the GES shall send a transmission status indication LIDU indicating success (Table 4-25) to the link service user in the GES.

b) If a PACK SU (Appendix 2 to Chapter 4, Figure A2-49) indicating missing SUs in the SU set is received from the AES and if another PACK SU of the PACK SU set is not received within tG2 seconds (Appendix 4 to Chapter 4) from the time the last PACK SU of the PACK SU set was received, or if no more PACK SUs identifying missing SUs are expected, the GES shall transmit a retransmission SU set. The retransmission SU set shall comprise a retransmission header (RTX) SU (Appendix 2 to Chapter 4, Figure A2-41) followed by the missing SUs identified in the received PACK SUs of the PACK SU set. The GES shall then proceed as in 4.5.7.2.4.1; however, if a PACK SU indicating missing SUs in the SU set is received from the AES before the complete retransmission SU set has been transmitted, the GES shall discard the received PACK SU.

c) If a PACK SU (Appendix 2 to Chapter 4, Figure A2-49) requesting a complete retransmission of the SU set is received from the AES, the GES shall retransmit the entire SU set as a sequence of an ISU and SSUs. The GES shall then proceed as in 4.5.7.2.4.1

d) If no PACK SU associated with the SU set is received from the AES within tG1 seconds (Appendix 4 to Chapter 4) from the time the last SSU of the SU set (original or retransmitted) was transmitted, the GES shall transmit a request for acknowledgement (RQA) SU (Appendix 2 to Chapter 4, Figure A2-27) to the AES. The GES shall transmit the RQA SU every tG1 seconds from the time the last RQA SU was sent, until a response is received from the AES, or until the number of times the RQA SU was sent equals five. If tG1 seconds elapse after the fifth retransmission of the RQA SU without receiving any corresponding PACK SU from the AES, the GES shall send a transmission status indication LIDU indicating failure (Table 4-25) to the link service user in the GES and shall cease processing that SU set; otherwise, the GES shall proceed as in 4.5.7.2.4.1.

4.5.7.2.4.2 If a PACK SU identifying an SU set which is not present in the GES is received from an AES, the GES shall discard the received PACK SU.

4.5.7.2.5 If there are no SUs (data or signalling) to be transmitted, the GES shall transmit an AES system table broadcast SU (Appendix 2 to Chapter 4, Figures A2-30 to A2-34), if one has been generated from an LIDU received from the GES management; otherwise, the GES shall transmit a fill-in SU (Appendix 2 to Chapter 4, Figure A2-42).

4.5.7.3 AIRCRAFT EARTH STATION (AES)

4.5.7.3.1 Upon receipt of an SU set comprised of an LSU, the AES shall form an LIDU according to 4.5.3.2.4 and pass it to the appropriate link service user in the AES. For an LSU using RLS, the AES shall then send a PACK SU indicating no error to the GES. The AES shall command the selection of an R channel frequency and then shall resend that PACK SU if an RQA SU identifying this SU set is received before another SU set for this AES with the same Q number.

4.5.7.3.2 Upon receipt of SUs comprising an SU set, the AES shall reassociate the received SUs into an SU set according to their reference numbers, Q numbers and sequence numbers (Appendix 3 to Chapter 4, Items 43, 46 and 59, respectively). For such an SU set, if an SSU is received without its corresponding ISU or RTX SU having been received, the AES shall discard the SSU.

4.5.7.3.3 For an SU set comprised of multiple SUs, following receipt of an ISU the AES shall determine whether or not any more SSUs corresponding to the SU set headed by the ISU are expected from the GES in accordance with the following criterion:

No more SSUs corresponding to the SU set are expected if either the last SSU in the SU set, or an SU of lower Q number than the one awaiting completion, or an SU with the same Q number as the one awaiting completion but with a different reference number, or an AES system table broadcast SU, or a fill-in SU, is received.

Note.— To apply this criterion, the AES considers all received SUs independently of their AES ID.

4.5.7.3.3.1 When an SU set with the same Q number and AES ID as an SU set awaiting completion but with a different reference number is received from the GES, the AES shall discard the incomplete SU set awaiting completion.

4.5.7.3.3.2 The AES shall discard the received SU set if the received SU set (complete or incomplete) has the same Q number, and reference number as the last SU set that has been completed and reassembled into an LIDU at that Q number.

4.5.7.3.4 If no more SUs corresponding to the SU set are expected, the AES shall determine whether or not there are any missing SUs in the received SU set. The AES shall then do the following:

4.5.7.3.4.1 For DLS:

a) If there are no missing SUs, the AES shall reassemble the SUs into an LIDU according to 4.5.3.2.4 and pass the LIDU to the appropriate link service user in the AES.

b) If there are any missing SUs, the AES shall discard the incomplete SU set.

4.5.7.3.4.2 For RLS:

a) If there are no missing SUs in the SU set, the AES shall reassemble the SU set into an LIDU according to subsection 4.5.3.2.4 and forward it to the appropriate link service user. The AES shall then send a PACK SU indicating no errors to the GES. If subsequently an RQA SU requesting acknowledgement for that same SU set is received, the AES shall command the selection of an R channel frequency and then shall retransmit that PACK SU.

b) If the number of missing SUs is less than 43, the AES shall send to the GES one or more PACK SUs comprising the PACK SU set, identifying the missing SUs and requesting their retransmission.

Note.— A PACK SU indicating errors can identify as many as three missing SUs.

c) If more than 42 SUs in an SU set are missing, the AES shall send to the GES a PACK SU set comprised of one PACK SU requesting retransmission of the entire SU set.

4.5.7.3.4.2.1 After sending a PACK SU set requesting partial or complete retransmission to the GES, the AES shall then do the following:

a) If an RQA SU is received from the GES within tA1 seconds (Appendix 4 to Chapter 4) from the time the PACK SU set was transmitted to the GES, the AES shall command the selection of an R channel frequency and then shall retransmit the last PACK SU set to the GES and shall proceed as in 4.5.7.3.4.2.1. If an RQA SU is received from the GES before the complete PACK SU set has been transmitted, the AES shall discard the RQA SU.

b) Upon receipt of SUs headed by an RTX SU or an ISU from the GES, the AES shall determine whether or not any more SUs corresponding to the retransmitted SU set are expected in accordance with the criterion described in 4.5.7.3.3. The AES shall then determine whether or not the incomplete SU set identified in the RTX SU is present in the AES. If the incomplete SU set is not present in the AES, the AES shall discard the received SU set headed by RTX SU; otherwise, the AES shall insert the received SUs headed by RTX SU into the incomplete SU set. After inserting the received retransmitted SUs into the incomplete SU set and discarding any duplicated SUs (as required), the AES shall determine whether or not the resultant SU set is complete. The AES then shall do the following:

1) If the SU set is complete, the AES shall send a PACK SU indicating no error to the GES. Then the AES shall reassemble the complete SU set into an LIDU according to 4.5.3.2.4 and shall pass it to the appropriate link service user in the AES. If subsequently, an RQA SU requesting acknowledgement for that same SU set is received before another SU set for this AES with the same Q number, the AES shall command the selection of an R channel frequency and then shall retransmit that PACK SU.

2) If the SU set is not complete, the AES shall send to the GES one or more PACK SUs comprising a PACK SU set, in accordance with 4.5.7.3.4.2 b) and c). The AES shall then proceed as in 4.5.7.3.4.2.1.

c) If no response is received from the GES within tA1 seconds (Appendix 4 to Chapter 4) from the time the complete PACK SU set requesting retransmissions was sent, the AES shall command the selection of an R channel frequency and then shall send the PACK SU set again to the GES identifying the missing SUs. The AES shall retransmit the PACK SU set every tA1 seconds (Appendix 4 to Chapter 4), from the time the last PACK SU set was sent, until a corresponding retransmitted SU set is received from the GES, or until the number of times the PACK SU set, identifying the same missing SUs, was sent equals five. If tA1 seconds elapse after the fifth retransmission of the PACK SU set without receiving any retransmitted SUs from the GES, the AES shall discard the incomplete SU set.

4.5.7.3.5 The AES shall respond to a request for acknowledgement (RQA) SU received from the GES by sending a PACK SU requesting the retransmission of the entire SU set if the RQA SU identifies an SU set not received at the AES.

4.5.7.3.6 The AES link layer shall pass the revision number of the system table broadcast to the AES management upon receipt of the first SU of a system table broadcast sequence received on the satellite/beam-identifying P_{smc} channel. The broadcast LIDU corresponding to a series of a complete or partial broadcast sequence (*see* 4.10.4.5.2.2) shall be assembled and passed to the AES management after all the expected SUs of the series have been received, or after an SU of another series with a revision number equal to or greater than the series awaiting completion is received.

4.5.8 R channel protocol

Note.— In 4.5.8, the use of the terms "AES" and "GES" refers to the link layer functions for the R channel protocol within the AES and the GES.

4.5.8.1 GENERAL

4.5.8.1.1 The link layer functions associated with the R channel protocol shall be as defined in 4.5.8.2 and 4.5.8.3.

4.5.8.2 AIRCRAFT EARTH STATION (AES)

4.5.8.2.1 Upon receipt of an LIDU for RLS, the AES shall assign a reference number (Appendix 3 to Chapter 4, Item 46) to it if there is no reference number currently assigned to an LIDU for RLS with the same Q number as the received LIDU. Upon receipt of an LIDU for DLS, the AES shall assign an available (not currently assigned to an LIDU with the same Q number) reference number to it; however, the AES shall not assign a reference number to LIDUs received from the circuit-mode services. If a reference number is not assigned to an LIDU, the LIDU shall be stored until one is assigned to it. Each assignment of a reference number shall be to the oldest received LIDU without a reference number. Two consecutive reference number assignments for LIDUs of the same Q number shall not be made with the same reference number, except for two LIDUs which are mapped into DLS LSU.

Note.— Circuit-mode services LIDUs are assigned application reference numbers by the circuit-mode services.

4.5.8.2.2 For DLS, the reference number shall be released immediately after it is assigned. For RLS, the reference number shall be released after the AES sends a transmission status indication LIDU (Table 4-25) to the link service user in the AES. The AES shall not reassign a released reference number until all the reference numbers that were available before its release have been assigned; the only exception to that is for a reference number that was assigned to a DLS LIDU mapping into an LSU, which may be immediately reassigned to another DLS LIDU mapping into an LSU.

4.5.8.2.3 After the assignment of a reference number to an LIDU or upon the receipt of a circuit-mode services LIDU, an SU set shall be generated according to 4.5.3.2.3. Among all the SUs awaiting transmission, the oldest SU of the SUs with the highest Q number shall always be transmitted first. The SUs of an SU set shall be transmitted in the ascending order of their sequence indicators (Appendix 3 to Chapter 4, Item 58).

4.5.8.2.4 *For RLS.* For each transmitted SU set, the AES shall do the following:

a) Respond to the R channel acknowledgement (RACK) SUs received from the destination GES as follows:

1) If the RACK SU (Appendix 2 to Chapter 4, Figure A2-28) indicates that the SU set has been completely received at the GES, the AES shall

send a transmission status indication LIDU indicating success (Table 4-25) to the link service user in the AES.

2) If the RACK SU (Appendix 2 to Chapter 4, Figure A2-29) identifies one or more SUs that have not been received, the AES shall command the selection of an R channel frequency and retransmit the missing SUs in the ascending order of their sequence indicators. If any other RACK SU identifying missing SUs is received, the AES shall discard it if the transmission of all missing SUs identified in the previously received RACK SU is not yet completed. However, if either:

i) in addition to the first RACK SU, five more RACK SUs identifying missing SUs are received before the AES has completely transmitted any of the identified missing SUs in the first RACK SU,

or

ii) the first RACK SU identified two missing SUs, and one SU has been transmitted, and subsequent to the transmission five more RACK SUs identifying missing SUs have been received without transmitting another SU,

then, the AES shall send a transmission status indication LIDU indicating failure (Table 4-25) to the link service user in the AES and shall cease processing that SU set.

Note.— A RACK SU received at the AES would identify at most two missing SUs from an SU set.

b) If a RACK SU from the destination GES does not arrive within tA3 seconds (Appendix 4 to Chapter 4) from the time the last SU in a set (the original SU set or a retransmitted set of SUs corresponding to the original SU set) was transmitted, the AES shall command the selection of an R channel frequency from the available group of R channel frequencies and shall retransmit the set of SUs. The AES shall repeat this process until an acknowledgement from the GES is received, except that the number of times the same set of SUs was retransmitted shall not exceed 5. If a RACK SU does not arrive within tA3 seconds after the fifth repetition, the AES shall send a transmission status indication LIDU indicating failure (Table 4-25) to the link service user in the AES and shall cease processing that SU set.

4.5.8.3 GROUND EARTH STATION (GES)

4.5.8.3.1 The GES shall associate the SUs received from logged-on AESs into sets according to their AES IDs, Q numbers, reference numbers and sequence indicators (Appendix 3 to Chapter 4, Item 58).

4.5.8.3.2 *FOR RLS*

4.5.8.3.2.1 After an SU of an SU set has been received by the GES without completing the set, the GES shall send a RACK SU identifying the remaining missing SUs to the AES if any of the following is true:

a) if the received SU is either the last SU of the SU set or the last SU of the missing SUs of the SU set;

b) if a period of tG4 seconds (Appendix 4 to Chapter 4) elapses without another SU (DLS or RLS) from the same AES having been received; or

c) if the GES subsequently receives from the same AES an SU with a lower Q number or an SU, indicating DLS, of the same Q number but different reference number.

If after sending a RACK SU, identifying the missing SUs, the GES receives no SU in response within tG3 seconds, it shall retransmit the RACK SU to the AES, except that, instead of sending the RACK SU, the GES shall discard the SU set if a total of 6 identical RACK SUs have been sent and no missing SU was received within tG3 seconds since the last RACK SU was transmitted. The GES shall also discard an incomplete SU set if an SU indicating RLS and having the same Q number but different reference number than the SUs of the set, is received from the same AES.

4.5.8.3.2.2 Whenever a complete SU set has been received, the GES shall reassemble an LIDU according to 4.5.3.2.4, shall pass it to the appropriate link service user, and shall send a RACK SU indicating no error to the AES.

4.5.8.3.2.3 After an LIDU has been formed the GES shall discard all SU sets with the same Q number and reference number subsequently received from the same AES until at least one SU with the same Q number and a different reference number has been received from the same AES, and shall retransmit, for each discarded SU set, a RACK SU indicating no error to the AES.

4.5.8.3.2.4 Whenever two or more SUs of the same Q number and reference number and sequence indicator have been received from the same AES before the corresponding LIDU has been formed, all but one shall be discarded.

4.5.8.3.3 *FOR DLS*

After an SU of an SU set has been received by the GES without completing the set, if any of the following is true, the GES shall discard the received SUs:

a) if the received SU is the last SU in the set;

b) if a period of tG4 seconds (Appendix 4 to Chapter 4) elapses without another SU (DLS or RLS) from the same AES having been received; or

c) if the GES subsequently receives from the same AES an SU with a lower Q number or an SU of the same Q number but different reference number.

If and when the SU set becomes complete, the GES shall reassemble the set into an LIDU according to 4.5.3.2.4 and shall pass it to the appropriate link service user. However, if the SUs of the complete SU set specify a different GES ID and the SU set corresponds to a circuit-mode services LIDU, the GES shall send the SU set to the GES whose ID is specified.

4.6 LINK LAYER T CHANNEL AND SUB-BAND C CHANNEL PROTOCOLS

4.6.1 General

4.6.1.1 The link layer functions for T and sub-band C channels to transfer user data and signalling shall be as defined in this section.

4.6.1.2 The P and R channels, described in 4.5, shall be used to set up T and sub-band C channels as described in 4.6.5 and 4.6.6, respectively.

4.6.2 Link interface data unit (LIDU)

4.6.2.1 The LIDU exchanged between the link layer and the subnetwork layer for transmission on the T channel shall contain link interface control information (LICI) and link service data unit (LSDU), except that the transmission status indication LIDU (Table 4-25) passed by the link layer to the subnetwork layer at the transmitting end shall contain only LICI.

4.6.2.2 The LIDU exchanged between the link layer and circuit-mode services and between the link layer and AES/GES management functions for transmission on the sub-band C channel shall contain LICI only.

4.6.2.3 LINK INTERFACE CONTROL INFORMATION (LICI)

4.6.2.3.1 The LICI parameters exchanged between the link layer and the subnetwork layer shall be as defined in Table 4-25.

4.6.2.3.2 The LICI parameters exchanged between the link layer and circuit-mode services shall be as defined in Table 4-38. The LICI parameters exchanged between the link layer and subnetwork management functions shall be as defined in Tables 4-44 and 4-45.

4.6.2.4 LINK SERVICE DATA UNIT (LSDU)

The link service data unit (LSDU) shall contain link service user data and shall be extracted from the LIDU received from the subnetwork layer.

4.6.3 Signal unit (SU)

4.6.3.1 There shall be two lengths of SUs for the T channel and one length for the sub-band C channel:

a) 48 bits (6 octets): burst identifier lone signal unit (LSU) (Appendix 2 to Chapter 4, Figure A2-43) for T channel.

b) 96 bits (12 octets): standard length SUs for T and sub-band C channels.

4.6.3.2 Each SU of the SU set corresponding to an LIDU received from the satellite subnetwork layer shall contain control information and user data. The SUs of the SU set corresponding to an LIDU received from the circuit-mode services and AES/GES management shall contain only control information.

4.6.3.3 LIDU-TO-SU SET MAPPING

4.6.3.3.1 *FOR LIDU COMPRISED OF LSDU AND LICI*

An LIDU shall be mapped into an SU set. Each SU set shall comprise an "initial signal unit" (ISU) followed by a maximum of 63 "subsequent signal units" (SSUs). The first two octets of the LSDU shall be mapped into the 2-octet user data field of the ISU (Appendix 2 to Chapter 4, Figure A2-37). The remaining octets shall be mapped into the 8-octets user data fields of the SSUs ordered by sequence numbers (Appendix 3 to Chapter 4, Item 59). The number of SSUs shall depend upon the number of octets in the LSDU. The control information in each SU of the SU set shall be mapped from the information contained in the LICI and the information generated by the internal link layer protocol processes.

4.6.3.3.2 *FOR LIDU COMPRISED OF LICI*

For an LIDU containing LICI only, the SU set shall be generated by mapping the information contained in the LICI and generated by the internal link layer processes into the fields of the control information of the appropriate SU.

4.6.3.4 SU SET-TO-LIDU MAPPING

4.6.3.4.1 An SU set shall be mapped into an LIDU before being passed to the link service user.

4.6.3.4.2 For an SU set with SU(s) containing user data, the resulting LIDU shall contain LSDU and LICI. The LSDU of the resulting LIDU shall be reassembled by combining the user data field of each SU of the received complete SU set. The associated LICI shall be generated from the control information in the SUs.

4.6.3.4.3 For an SU set with SU(s) containing no user data, the resulting LIDU shall contain only LICI. The LICI shall be generated from the control information in the received SUs.

4.6.3.5 SIGNAL UNIT FORMAT

4.6.3.5.1 The formats for all SUs transmitted on the T and sub-band C channels shall be as shown in Appendix 2 to Chapter 4. The signal unit field mapping and the transmission order of the bits shall be as shown in Figure A2-1. The signal unit field coding and definitions shall be as described in Appendix 3 to Chapter 4.

4.6.3.5.2 SUs not recognized by the receiving link layer shall be ignored.

Note.— SUs not specified in Appendix 2 to Chapter 4 may be in use under mutual agreement between an AMSS service provider and an AMSS user for non-safety services.

4.6.4 T channel transmission protocol

Note.— In 4.6.4, the use of the terms "AES" and "GES" refer to the link layer functions for the T channel transmission protocol within the AES and the GES.

4.6.4.1 GENERAL

The link layer functions for the T channel transmission protocol shall be as defined in 4.6.4.2 and 4.6.4.3.

4.6.4.2 AIRCRAFT EARTH STATION (AES)

4.6.4.2.1 Upon receiving an LIDU, the AES shall generate an SU set according to 4.6.3.3.1.

Note.— LIDUs are assigned reference numbers by the T channel reservation protocol.

4.6.4.2.2 *SU transmission*. SUs shall be transmitted on the T channel in burst reservations. Among all the SUs awaiting transmission, the oldest SU of the SUs with the highest Q number shall always be transmitted first. The ISU or the RTX SU of an SU set shall always be transmitted before the SSUs, and the SSUs shall be transmitted in the descending order of their sequence numbers (Appendix 3 to Chapter 4, Item 59). A burst identifier SU (Appendix 2 to Chapter 4, Figure A2-43) shall be transmitted at the beginning of each burst (as specified in 4.4.4.3.4). Whenever, during a burst transmission, there is no SU available for transmission, a fill-in SU (Appendix 2 to Chapter 4, Figure A2-42) shall be transmitted. However, if no SUs are available at the start of a burst reservation, the AES shall inhibit the transmission of the corresponding burst.

4.6.4.2.3 *For RLS*. For each transmitted SU set the AES shall do the following:

a) respond to each T channel acknowledgement (TACK) SU sent by the destination GES via the P channel in response to the SU set as follows:

   1) when the TACK SU (Appendix 2 to Chapter 4, Figure A2-29) indicates that the SU set has been completely received at the GES, the AES shall send a transmission status indication LIDU indicating success (Table 4-25) to the link service user;

   2) when the TACK SU (Appendix 2 to Chapter 4, Figure A2-29) indicates that the entire SU set has been lost, the AES shall retransmit the entire original SU set;

   3) when the TACK SU (Appendix 2 to Chapter 4, Figure A2-29) indicates missing SUs at the GES, if no more TACK SUs indicating more missing SUs of the same SU set are expected, or if one or more TACK SUs are expected but none is received within tA5 seconds (Appendix 4 to Chapter 4) from the time the previous TACK SU was received, the AES shall retransmit the missing SUs as indicated in the received TACK SUs. A retransmission header (RTX) SU (Appendix 2 to Chapter 4, Figure A2-41) shall be transmitted before any retransmitted SU. Then, if any further TACK SU indicating missing SUs associated with the same SU set is received before the entire retransmission SU set has been retransmitted, the AES shall discard the received TACK SU.

However, the AES shall not transmit the same set, either the original SU set or a retransmission SU set, more than three times. If, after the third transmission, the AES receives a TACK SU that would result in a fourth transmission of the same SU set, the AES shall send a transmission status indication LIDU indicating the failure to the link service user and shall cease processing that SU set.

b) If an acknowledgement, associated with the SU set, is not received from the destination GES within tA4A seconds (Appendix 4 to Chapter 4) from the time the last SU in the set (either the original SU set or a retransmission set of SUs corresponding to the original SU set) was transmitted or, as specified in 4.6.5.2.6 b), discarded, the AES shall transmit a request for acknowledgement (RQA) SU (Appendix 2 to Chapter 4, Figure A2-48). Thereafter, the AES shall command the selection of an R channel frequency and then shall retransmit the RQA SU every tA4B seconds (Appendix 4 to Chapter 4) from the time the previous RQA SU was transmitted, until a corresponding TACK SU is received. However, if a corresponding TACK SU is not received within tA4B seconds from the time the fifth RQA SU was transmitted, the AES shall send a transmission status indication LIDU indicating failure (Table 4-25) to the link service user in the AES and shall cease processing that SU set.

4.6.4.3 GROUND EARTH STATION (GES)

4.6.4.3.1 The GES shall reassociate and reorder the SUs received from a logged-on AES according to their AES IDs, Q numbers, reference numbers and sequence numbers, defined in Appendix 3 to Chapter 4. A received SSU shall be discarded if the corresponding ISU or RTX SU has not been received.

Note.— The AES ID associated with a T channel burst could be determined either from the burst ID SU, if received, or any other SU, within the same burst, that contains an AES ID field.

4.6.4.3.2 Following the receipt of an ISU, the GES shall determine whether or not any more SSUs corresponding to the SU set headed by the received ISU are expected from the AES according to the following criterion:

No more SSUs corresponding to the SU set are expected if either the last SSU of the set, or an SU from the same AES but with a lower Q number, or an SU from the same AES with the same Q number but with a different reference number, or a fill-in SU with the same AES ID, is received.

4.6.4.3.3 When no more SUs corresponding to an SU set are expected, the GES shall determine whether or not there are any missing SUs in the received SU set. The GES then shall do the following:

a) if the SU set is complete, send a T channel acknowledgement (TACK) SU (Appendix 2 to Chapter 4, Figure A2-29) indicating that no SUs are missing, assemble an LIDU from the SU set according to 4.6.3.4, and pass it to the appropriate link service user;

b) if the SU set is incomplete, transmit one or more TACK SUs identifying the missing SUs to the AES, according to the following:

1) if more than 42 or less than 4 SUs of the SU set are missing, only one TACK SU (Appendix 2 to Chapter 4, Figure A2-29) shall be sent. In the first case the TACK SU shall indicate a request for the retransmission of the entire SU set, while in the second case it shall indicate a request for retransmission of all missing SUs;

2) otherwise, a maximum of 14 TACK SUs (Appendix 2 to Chapter 4, Figure A2-29) indicating all missing SUs shall be sent to the AES.

4.6.4.3.3.1 If the received SU set is a retransmission of an SU set awaiting completion at the GES, the GES shall use these sets to form a new SU set that is as complete as possible prior to sending an acknowledgement as given in 4.6.4.3.3 a) and b).

4.6.4.3.3.2 For each completed SU set, the GES shall discard all subsequent SU sets (complete or incomplete) with the same Q number, AES ID and reference number, until an SU set with the same Q number, AES ID and the paired reference number (according to the pairing scheme given in 4.6.5.2.2) is received.

4.6.4.3.4 Following the reception of an RTX SU (Appendix 2 to Chapter 4, Figure A2-41), the GES shall determine, according to the criterion described in 4.6.4.3.2, whether or not any more SUs corresponding to the retransmission set, headed by the received RTX SU, are expected from the AES. When no more SUs are still expected, the GES shall insert the retransmitted SUs into the appropriate (incomplete) SU set and shall acknowledge as specified in 4.6.4.3.3.

4.6.4.3.5 The GES shall respond to a request for acknowledgement (RQA) SU received from the AES by retransmitting the latest previously sent set of TACK SUs corresponding to the SU set indicated in the RQA SU. If the RQA SU identifies an SU set awaiting completion at the GES and for which no TACK SU has been transmitted, the GES shall send a TACK SU requesting the retransmissions of the missing SUs. If the RQA SU identifies an SU set not received at the GES, the GES shall send a TACK SU requesting the retransmission of the entire SU set.

4.6.4.3.6 If the GES receives an ISU with the same AES ID and Q number as those of an SU set awaiting completion and with a reference number equal to the reference number paired with the reference number of the SU set according to the pairing scheme given in 4.6.5.2.2, the GES shall discard the awaiting SU set.

4.6.5 T channel reservation protocol

Note.— In 4.6.5, the use of the terms "AES" and "GES" refer to the link layer functions for the T channel reservation protocol within the AES and the GES.

4.6.5.1 GENERAL

The link layer functions for the T channel reservation protocol shall be as defined in 4.6.5.2 and 4.6.5.3.

4.6.5.2 AIRCRAFT EARTH STATION (AES)

4.6.5.2.1 Upon receipt of an LIDU containing an LSDU exceeding 33 octets, the AES shall route the LIDU to the T channel protocol.

Note.— An LIDU containing an LSDU of 33 octets or less may be routed to R channel protocol or T channel protocol.

4.6.5.2.2 Before passing the LIDU to the T channel transmission protocol, the AES shall assign an available (not currently assigned) reference number (Appendix 3 to Chapter 4, Item 46) to it. If a reference number is not assigned to an LIDU, the LIDU shall be stored until one is assigned to it. Each assignment of a reference number shall be to the oldest received LIDU without a reference number. The reference numbers for assignment to T channel LIDUs shall be defined in pairs as (0,1); (2,3); (4,5); (6,7); (8,9); (10,11); (12,13); (14,15). Once released, a reference number from a pair shall not be reassigned until the other number from the pair has been assigned and released. The AES shall not assign a reference number from a pair whose other number has just been released until a reference number from each pair that was available for assignment before the release has been assigned. The assigned reference number shall be used by both the T channel transmission protocol and the T channel reservation protocol.

4.6.5.2.3 To request a reservation for the transmission of an SU set, the AES shall send a reservation request (REQ) SU to the GES indicating the reference number, Q number and the length of the SU set to be transmitted.

4.6.5.2.4 The AES shall transmit a REQ SU on the R channel (Appendix 2 to Chapter 4, Figure A2-47) or on the T channel (Appendix 2 to Chapter 4, Figure A2-7) to the GES in accordance with the following criterion:

The T channel shall be used if the AES is currently transmitting a T channel burst and there is enough room to accommodate the REQ SU or if there is a T channel burst due to start in the next 8-second time window; otherwise, the R channel shall be used.

4.6.5.2.5 When the T channel is used for transmitting a REQ SU to the GES, the requested length shall be increased by one SU.

4.6.5.2.6 After sending a REQ SU to the GES, the AES shall do the following:

a) If the T channel was used for a REQ SU transmission, and neither a corresponding reservation (RES) SU (Appendix 2 to Chapter 4, Figure A2-23) nor a corresponding reservation forthcoming (RFC) SU (Appendix 2 to Chapter 4, Figure A2-24) is received from the GES within tA6 seconds (Appendix 4 to Chapter 4) from the time the REQ SU was sent on the T channel, the AES shall send the REQ SU again on the T or R channel, in accordance with 4.6.5.2.4, with the requested transmission length equal to the length last requested or incremented by one if T channel is used. The AES shall then proceed as in 4.6.5.2.6.

b) If the R channel was used for the REQ SU transmission, and neither a corresponding RES SU nor a corresponding RFC SU is received from the GES within tA7 seconds (Appendix 4 to Chapter 4) from the time the REQ SU was sent on the R channel, the AES shall command the selection of an R channel frequency and send the REQ SU again on the T or R channel, in accordance with 4.6.5.2.4, with the requested transmission length equal to the length last requested or incremented by one if the T channel is used. The AES shall then proceed as in 4.6.5.2.6. However, if tA7 seconds elapse after the fifth consecutive transmission of a REQ SU on the R channel without receiving any corresponding RES SU or RFC SU from the GES, the AES shall abort the reservation procedure for the corresponding LIDU and shall discard the number of SUs specified in the last transmitted REQ SU. If an ISU is amongst the SUs discarded, the AES shall then discard the complete SU set headed by the discarded ISU even if this shall result in discarding more SUs than the number of SUs specified in the REQ SU. The AES shall then send a transmission status indication LIDU (Table 4-25) indicating failure to the appropriate link service user in the AES corresponding to that completely discarded SU set. If an ISU is amongst the SUs discarded, the AES shall then discard the complete SU set headed by the discarded ISU even if this shall result in discarding more SUs than the number of SUs specified in the REQ SU. The AES shall then send a transmission status indication LIDU (Table 4-25) indicating failure to the appropriate link service user in the AES corresponding to that completely discarded SU set. If an RTX SU is amongst the SUs discarded, the AES shall discard the complete SU set headed by the RTX SU. If a REQ SU is amongst the SUs discarded, the AES shall retransmit the REQ SU again on the R channel or the T channel in accordance with 4.6.5.2.4.

c) If a RES SU corresponding to a REQ SU is received from the GES, the AES shall pass the reservation information in the RES SU to the T channel transmission protocol. The starting frame number in the T channel burst reservation shall refer to either the current frame number or one of the 15 frames following the current frame number.

d) If an RFC SU corresponding to a REQ SU is received from the GES, the AES shall compute tA8 (Appendix 4 to Chapter 4), according to the delay specified in the RFC SU for the expected RES SU to arrive. The AES then shall do the following:

1) If no RES SU or RFC SU corresponding to that RFC SU set is received from the GES within tA8 seconds from the time the RFC SU was received, the AES shall send a REQ SU to the GES on the T or R channel in accordance with 4.6.5.2.4 with the requested length equal to the length associated with the corresponding RFC SU or incremented by one if the T channel is used and the AES shall then proceed as in 4.6.5.2.6.

2) If an RFC SU associated with the previously received RFC SU is received from the GES, the AES shall update the corresponding tA8 according to the new delay specified in the RFC SU.

3) If a RES SU corresponding to that RFC SU is received from the GES within tA8 seconds from the time the RFC SU was received, the AES shall pass the reservation information in the RES SU to the T channel transmission protocol in the AES.

4.6.5.2.7 After the T channel transmission protocol in the AES receives a TACK SU set requesting the retransmission of missing SUs, the AES shall compute tA8, according to the delay specified in the TACK SU for the expected RES SU to arrive. The AES then shall do the following:

a) If no RES SU or RFC SU corresponding to that TACK SU set is received from the GES within tA8 seconds from the time the complete SU set was received, the AES shall send a REQ SU to the GES on the T or R channel in accordance with 4.6.5.2.4 with the requested length equal to the number of missing SUs identified in the TACK SU set plus on if the R channel is used or incremented by one more if the T channel is used and the AES shall then proceed as in 4.6.5.2.6.

b) If an RFC SU associated with the previously received TACK SU set is received from the GES, the AES shall update the corresponding tA8 according to the new delay specified in the RFC SU.

c) If a RES SU is received from the GES within tA8 seconds from the time the complete TACK SU set was received, the AES shall pass the reservation information in the RES SU to the T channel transmission protocol in the AES.

Note.— The RFC flag field (Appendix 3 to Chapter 4, Item 50) in the RES or RFC SU to distinguish between the RES or RFC SUs associated with REQ SUs and those associated with TACK SUs or RFC SUs.

4.6.5.2.8 If a RES SU is received from the GES which does not correspond to any REQ SU sent by the AES or to RFC SU or TACK SU received by the AES, the AES shall pass the reservation information in the RES SU to the T channel transmission protocol.

4.6.5.2.9 If the AES is not able to transmit a T channel burst in the assigned T channel burst reservation, the AES shall send a REQ SU to the GES requesting a reservation for the not transmitted burst.

4.6.5.2.10 When an AES terminates communications with a GES as the result of a handover procedure (4.9), both the AES and the GES shall release all link layer resources which were allocated for data communication between them.

4.6.5.2.11 The reference number assigned to an LIDU shall be released when either all the expected reservations associated with the SU set corresponding to the LIDU have been received at the AES or the reservation procedure corresponding to that LIDU has been aborted, and after a transmission status indication LIDU (Table 4-25) indicating success or failure has been sent to the link service user in the AES.

4.6.5.3 GROUND EARTH STATION (GES)

4.6.5.3.1 Upon receipt of a REQ SU from the AES, the GES shall assign one or more burst reservations to the AES for the SU set identified in the REQ SU. When the GES transmits a TACK SU set indicating error to the AES, the GES shall assign one or more burst reservations for retransmission of the partial SU set comprised of an RTX SU followed by the missing SUs or retransmission of the complete SU set.

Note.— A TACK SU indicating error contains a field defining the preset delay to the forthcoming RES SU.

4.6.5.3.2 The GES shall send a RES SU to the AES at a time such that there is a subsequent maximum delay of 8 seconds before the intended SU set transmission time. If the start of the assigned reservation is outside the 8-second time window from the time the reservation was made, the GES shall send an RFC SU to the AES indicating the delay and then shall send the RES SU once the actual time is within 8 seconds of the scheduled reservation time. If a reservation associated with a TACK SU set indicating errors or RFC SU previously transmitted cannot be made within the delay specified in the TACK SU set or the RFC SU, the GES shall send an RFC SU to the AES before the delay period has elapsed. The RFC SU shall indicate a new delay to reservation. The GES shall send a RES SU to the AES early enough so that it arrives in time for the AES to begin sending an SU set at the start of burst reservation.

4.6.5.3.3 The GES shall not assign overlapping reservations on the same T channel. The interval between the end of one reservation and the beginning of the next reservation shall be sufficient to assure that the T channel bursts reserved by the GES do not overlap. A long SU set shall be assigned multiple bursts separated by intervals. The interval between the multiple burst reservations or between individual reservations for different SU sets shall be such as to allow for the transmission of at least one R channel burst every 8 seconds. The T channel burst length shall be chosen to allow the R channel and T channel transmissions to meet the performance requirements in 4.7. The length of each burst reservation shall be sufficient to accommodate the burst identifier SU which heads each T channel burst and the total reservation length shall be at least one SU longer than the requested one. The GES shall make reservations such that any given AES shall not be required to transmit at any time on more than one T channel belonging to the group of T channels assigned to the AES.

4.6.6 Sub-band C channel to-aircraft protocol

Note.— In this subsection, the use of the terms "AES" and "GES" refers to the link layer functions for the sub-band C channel to-aircraft protocol within the GES and the AES.

4.6.6.1 GENERAL

The link layer functions for an individual sub-band C channel in the to-aircraft direction shall be as specified in 4.6.6.2 and 4.6.6.3.

4.6.6.2 GROUND EARTH STATION (GES)

4.6.6.2.1 Upon receipt of an LIDU from the circuit-mode link service user (Table 4-38) or the GES management (Table 4-45), the GES shall generate an SU set from the LIDU. Each SU set shall comprise either a single signal unit called a "lone signal unit (LSU)" or more than one signal unit of which the first shall be an "initial signal unit (ISU)" and those that follow shall be "subsequent signal units (SSUs)". The SU set shall be generated by mapping the information contained in the LICI and generated by the internal link layer protocol processes into the fields of the control information of the appropriate SU.

4.6.6.2.2 Among all the SUs awaiting transmission, the oldest of the SUs with the highest Q number shall always be transmitted first. The SUs of an SU set comprised of multiple SUs shall be transmitted in the descending order of their sequence numbers (Appendix 3 to Chapter 4, Item 59).

Note.— The sub-band C channel link layer in the GES does not assign a reference number to the LIDU received from the circuit-mode link service user. Instead an application reference number is assigned by the circuit-mode services and is passed to the link layer in the LICI.

4.6.6.2.3 If there are no SUs to be transmitted, the GES shall transmit fill-in SUs (Appendix 2 to Chapter 4, Figure A2-42).

4.6.6.3 AIRCRAFT EARTH STATION (AES)

4.6.6.3.1 For an SU set comprised of an LSU, the AES shall form an LIDU containing only LICI and pass the LIDU to the appropriate link service user in the AES. The LICI shall be generated from the control information in the received LSU.

4.6.6.3.2 For an SU set comprised of multiple SUs, the AES shall reassociate and reorder the received SUs into an SU set according to their application reference number (Appendix 3 to Chapter 4, Item 4), sequence numbers (Appendix 3 to Chapter 4, Item 59) and Q numbers (Appendix 3 to Chapter 4, Item 43). Following receipt of an ISU, the AES shall determine whether or not any more SSUs corresponding to the SU set headed by the ISU are expected from the GES in accordance with the following criterion:

> No more SSUs corresponding to the SU set are expected if either the last SSU in the SU set or a fill-in SU is received, or if the channel is released.

If an ISU or an LSU with a Q number equal to the Q number of the SU set awaiting completion is received, the AES shall discard the incomplete SU set awaiting completion.

4.6.6.3.2.1 If no more SUs corresponding to a transmission of an SU set are expected, the AES shall determine whether or not there are any missing SUs. The AES shall then do the following:

a) if there are no missing SUs, the AES shall reassemble the SUs into an LIDU according to 4.6.3.4.3 and pass the LIDU to the appropriate link service user in the AES;

b) if there are any missing SUs, the AES shall not generate an LIDU from the received incomplete SU set; instead, the AES shall store the received SUs until the other missing SUs are received in a retransmission of the SU set, or until the channel is released.

4.6.6.3.3 *C channel crosstalk detection.* If a received SU or SU set contains an AES ID or application reference number which differs from that which prevailed when the C channel was established, the AES shall command the AES management to inhibit transmission on the C channel frequency and command the AES circuit-mode services to terminate the call.

4.6.7 Sub-band C channel from-aircraft protocol

Note.— In 4.6.7, the use of the terms "AES" and "GES" refers to the link layer functions for the sub-band C channel from-aircraft protocol within the AES and the GES.

4.6.7.1 GENERAL

The link layer functions for an individual sub-band C channel in the from-aircraft direction shall be as defined in 4.6.7.2 and 4.6.7.3.

4.6.7.2 AIRCRAFT EARTH STATION (AES)

4.6.7.2.1 Upon receipt of an LIDU from the circuit-mode link service user (Table 4-38) or the AES management (Table 4-44), the AES link layer shall generate the corresponding SU set according to 4.6.6.2.1.

4.6.7.2.2 Among all the SUs awaiting transmission, the oldest of the SUs with highest Q number shall always be transmitted first. The SUs of an SU set comprised of multiple SUs shall be transmitted in the descending order of their sequence numbers (Appendix 3 to Chapter 4, Item 59).

Note.— The sub-band C channel link layer in the AES does not assign a reference number to the LIDU received from the circuit-mode link service user. Instead an application reference number is assigned by the circuit-mode services and is passed to the link layer in the LICI.

4.6.7.2.3 If there are no SUs to be transmitted, the AES shall transmit fill-in SUs (Appendix 2 to Chapter 4, Figure A2-42).

4.6.7.3 GROUND EARTH STATION (GES)

4.6.7.3.1 For an SU set comprised of an LSU, the GES shall form an LIDU according to 4.6.6.3.1 and pass the LIDU to the appropriate link services user in the GES.

4.6.7.3.2 For an SU set comprised of multiple SUs, the GES shall reassociate and reorder the received SUs into an SU set according to their application reference number (Appendix 3 to Chapter 4, Item 4), sequence numbers (Appendix 3 to Chapter 4, Item 59) and Q numbers (Appendix 3 to Chapter 4, Item 43). Following receipt of an ISU, the GES shall determine whether or not any more SSUs corresponding to the SU set headed by the ISU are expected from the AES in accordance with the following criterion:

No more SSUs corresponding to the SU set are expected if either the last SSU in the SU set or a fill-in SU is received, or if the channel is released.

If an ISU or an LSU with a Q number equal to the Q number of the SU set awaiting completion is received, the GES shall discard the incomplete SU set awaiting completion.

4.6.7.3.2.1 If no more SUs corresponding to a transmission of an SU set are expected, the GES shall determine whether or not there are any missing SUs. The GES shall then do the following:

a) if there are no missing SUs, the GES shall reassemble the SUs into an LIDU according to 4.6.3.4.3 and pass the LIDU to the appropriate link service user in the GES;

b) if there are any missing SUs, the GES shall not generate an LIDU from the received incomplete SU set; instead, the GES shall store the received SUs until the other missing SUs are received in a retransmission of the SU set, or until the channel is released.

4.7 SATELLITE SUBNETWORK LAYER

4.7.1 General provisions

4.7.1.1 ARCHITECTURE

4.7.1.1.1 The satellite subnetwork layer (SSNL) in the AES and GES shall provide connection-oriented packet data service by establishing subnetwork connections (SNCs) between subnetwork service (SNS) users. The SSNL in the AES shall provide the additional connectivity notification service by sending connectivity notification event messages to the attached aeronautical telecommunication network (ATN) router. Both of the SSNL in the AES and GES shall contain the following three functions:

a) satellite subnetwork dependent (SSND) function;

b) subnetwork access (SNAc) function; and

c) interworking (IW) function.

The AES shall contain the additional connectivity notification (CN) function. The SSND function shall perform the SSND protocol (SSNDP) between each pair of AES and GES by exchanging subnetwork protocol data units (SNPDUs). It shall perform the SSNDP aircraft (SSNDPA) function in the AES and the SSNDP ground (SSNDPG) function in the GES. The SNAc function shall perform the ISO 8208 protocol between the AES or GES and the attached routers by exchanging ISO 8208 packets. It shall perform the ISO 8208 DCE function in the AES and the GES. The CN function shall send connectivity notification event messages to the attached ATN router through the SNAc function. The IW function (IWF) shall provide the necessary harmonization functions between the SSND, the SNAc and the CN functions. Figure 4-11 shows the SSND, IW and SNAc functions and the ATN satellite subnetwork protocol architecture.

4.7.1.1.2 The term DCE when used shall mean ISO 8208 DCE.

4.7.1.1.3 The SSNL shall interface with the link layer and the AES/GES management.

4.7.1.2 SERVICES

The SSNL shall provide the following services:

a) transparency of transferred information — provide for the transparent transfer of octet aligned SSNL user data and/or control information; and

b) quality of service selection — make available to SNS users a means to request and to agree to the quality of service for the transfer of SSNL user data.

4.7.2 Packet data performance

4.7.2.1 DEFINITIONS

4.7.2.1.1 The terms used with respect to packet data performance are based on the definitions in ISO 8348 (first edition). In applying these definitions to the AMSS subnetwork layer, the word "network" and its abbreviation "N" in ISO 8348 are replaced by the word "subnetwork" and its abbreviation "SN", respectively, wherever they appear. Additional definitions are provided as follows.

4.7.2.1.2 *Data transfer delay (95 percentile).* The 95th percentile of the statistical distribution of delays for which transit delay is the average.

4.7.2.1.3 *Subnetwork service data unit (SNSDU).* An amount of subnetwork user data, the identity of which is preserved from one end of a subnetwork connection to the other.

Note.— Subnetwork performance depends on a number of factors, including the level of communication traffic. The performance values given here apply during peak busy hours.

4.7.2.2 SPEED-OF-SERVICE

4.7.2.2.1 *CONNECTION ESTABLISHMENT DELAY*

Note.— Connection establishment delay, as defined in ISO 8348, includes a component, attributable to the called subnetwork service user, which is the time between the SN-CONNECT indication and the SN-CONNECT response. This user component is due to actions outside the boundaries of the satellite subnetwork and is therefore excluded from the AMSS specifications.

4.7.2.2.1.1 Connection establishment delay shall not exceed the following maximum values:

Minimum channel rate in use by AES (bits/s)	Maximum connection established delay (95 percentile) (seconds)
600	70
1 200	45
2 400	25
4 800	25
10 500	25

4.7.2.2.2 *Transit delay*

Note. — In accordance with ISO 8348, transit delay values are based on a fixed SNSDU length of 128 octets. Transit delays are defined as average values.

4.7.2.2.2.1 Transit delay shall not exceed the following maximum values:

Minimum channel rate in use by AES (bits/s)	Maximum transit delay (seconds)		
	To-aircraft		From-aircraft
	Highest priority service	Lowest priority service	Highest priority service
600	12	40	40
1 200	8	25	30
2 400	5	12	15
4 800	4	7	13
10 500	4	5	13

Note. — In any particular AES, lower priority from-aircraft traffic may be subject to additional delay, depending on the amount and rate of from-aircraft traffic loading.

4.7.2.2.3 *DATA TRANSFER DELAY (95 PERCENTILE)*

Data transfer delay (95 percentile) shall not exceed the following maximum values:

Minimum channel rate in use by AES (bits/s)	Maximum data transfer delay (95 percentile) (seconds)		
	To-aircraft		From-aircraft
	Highest priority service	Lowest priority service	Highest priority service
600	15	110	80
1 200	9	60	65
2 400	6	30	35
4 800	5	20	30
10 500	4	10	30

Note.— In any particular AES, lower priority from-aircraft traffic may be subject to additional delay, depending on the amount and rate of from-aircraft traffic loading.

4.7.2.2.4 *CONNECTION RELEASE DELAY*

The connection release delay (95 percentile) shall not exceed 30 seconds.

4.7.2.3 RELIABILITY OF SERVICE

4.7.2.3.1 *RESIDUAL ERROR RATE*

The residual error rate in the from-aircraft direction shall not exceed 10^{-4} per SNSDU. The residual error rate in the to-aircraft direction shall not exceed 10^{-6} per SNSDU.

Note.— Residual error rate includes the probability of undetected error, the probability of losing an SNSDU, and the probability of duplicating an SNSDU.

4.7.2.3.2 *CONNECTION RESILIENCE*

4.7.2.3.2.1 The probability of an SNC provider-invoked SNC release shall not exceed 10^{-4} over any one-hour interval.

Note.— Connection release resulting from either GES-to-GES handover or AES log-off or VC pre-emption are excluded from this specification.

4.7.2.3.2.2 The probability of an SNC provider-invoked reset shall not exceed 10^{-1} over any one-hour interval.

4.7.3 Satellite subnetwork-dependent protocol services and operations

4.7.3.1 GENERAL PROVISIONS

Since the functional differences between the SSNDPA and SSNDPG are minimal, their operations shall be described in terms of SSNDPX where X shall stand for either A or G. Where differences do occur, the SSNDPA and SSNDPG functions shall be described individually.

4.7.3.2 SATELLITE SUBNETWORK-DEPENDENT PROTOCOL ENTITIES

Note.— At least one pair of SSNDPA and SSNDPG entities exists between each pair of AES and GES. Figure 4-12 shows two pairs of SSNDPA and SSNDPG entities between two AESs and a GES.

4.7.3.2.1 The SSNDPX defined in this section shall pertain to each SSNDPX entity.

4.7.3.3 LOGICAL CHANNELS

Note.— The connections between SSNDPAs and SSNDPGs are established through logical channels. Up to 255 logical *channels may be established between each pair of SSNDPX entities. Each logical channel is identified by its own logical channel number (LCN) ranging from 1 through 255. LCN 0 is reserved.*

4.7.3.3.1 For a new ground-to-air connection establishment, the SSNDPG shall allocate a logical channel number in the range 1 to 127, by choosing the lowest numbered logical channel in the ready state in that range. For a new air-to-ground connection setup, the SSNDPA shall allocate a logical channel number in the range 128 to 255, by choosing the highest numbered logical channel in the ready state in that range.

4.7.3.4 OPERATIONS

The SSNDPX virtual call (VC) service shall proceed through three distinct phases:

a) connection establishment;

b) data transfer; and

c) connection release.

Note.— The SSNDPX is specified in terms of locally originated, or remotely originated operations. Locally originated specifies the procedure at the SSNDPX for handling operations originating from a local SNS user, while remotely originated specifies the procedure at the SSNDPX for handling operations originating from a remote SNS user.

4.7.3.5 CONNECTION ESTABLISHMENT

Note.— Up to 128 octets of user data may be transferred during connection establishment.

4.7.3.5.1 The connection establishment procedure shall apply independently to each establishment request.

4.7.3.5.2 User data shall be transparently forwarded in both directions.

4.7.3.5.3 *LOCALLY ORIGINATED*

4.7.3.5.3.1 *Normal operation*

4.7.3.5.3.1.1 When the SSNDPX receives a call request packet from the IWF, it shall allocate a logical channel which is in the ready state, forward the call request packet to the remote SSNDPX by means of a connection request SNPDU and place the logical channel into the IWF call request state.

4.7.3.5.3.1.2 If the call is accepted at the remote SSNDPX, a connection confirm SNPDU is received. The SSNDPX shall then place the logical channel in the data transfer/flow control state (flow control ready/no remote or local interrupt pending) and forward a call connected packet to the IWF. The call connected packet shall use default values (if any) for the facilities which are not transmitted over the satellite subnetwork, according to the SNPDU to packet mapping rules defined in 4.7.3.16.

4.7.3.5.3.1.3 If the SSNDPX does not receive either a connection confirm or connection released SNPDU from the remote SSNDPX before the timer (*see* tN1, Table 4-18) expires, it shall initiate a connection release procedure.

4.7.3.5.3.2 *Other operation*

If resources are not available, or a requested facility value is not allowed, then the originating SSNDPX shall send a clear indication packet to the IWF.

4.7.3.5.4 *REMOTELY ORIGINATED*

4.7.3.5.4.1 *Normal operation*

4.7.3.5.4.1.1 When the SSNDPX receives a connection request SNPDU from the remote SSNDPX, it shall place the logical channel selected in the incoming call state. The SSNDPX shall forward an incoming call packet to the IWF using default values for any facilities which are not transmitted over the satellite subnetwork (see 4.7.3.16).

4.7.3.5.4.1.2 When the SSNDPX receives a call accepted packet from the IWF, it shall forward a connection confirm SNPDU to the remote SSNDPX and place the logical channel in the data transfer/flow control state (flow control ready/no remote or local interrupt pending) when it receives from the interfacing link layer the information that the connection confirm SNPDU has been processed (receipt of fail/success LIDU).

4.7.3.5.4.2 *Other operation*

4.7.3.5.4.2.1 If the receiving SSNDPX cannot support the request, then it shall transmit a connection released SNPDU to the originating SSNDPX.

4.7.3.5.4.2.2 If a selected facility value is not allowed, then the receiving SSNDPX shall initiate a connection release procedure.

4.7.3.6 CONNECTION RELEASE

Note.— A subnetwork connection may be released at any time by any party once the logical channel is in the data transfer, IWF call request, or incoming call states. The connection released SNPDU may contain user data (128 octets maximum) provided by the IWF.

4.7.3.6.1 User data shall be transparently forwarded in both directions.

4.7.3.6.2 The SSNDPX shall guarantee in-sequence transmission between data/ interrupt SNPDUs already forwarded to the link layer and a subsequently transmitted connection released or connection release complete SNPDU.

4.7.3.6.3 *LOCALLY ORIGINATED*

4.7.3.6.3.1 When the SSNDPX receives a clear request packet from the IWF, it shall place the logical channel in the local clear request state, generate a connection released SNPDU, and forward it to the remote SSNDPX. The only SNPDUs it shall then accept, are a connection released SNPDU or a connection release complete SNPDU. It shall discard all other SNPDUs. The SSNDPX shall also consider the receipt of any packet other than a clear request packet as an error, and shall discard it.

4.7.3.6.3.2 When the SSNDPX receives a connection release complete after the connection released has been successfully sent, it shall return the logical channel to the ready state. If the SSNDPX receives a connection released SNPDU from the remote SSNDPX, it shall not expect to receive a connection release complete SNPDU.

4.7.3.6.3.3 If the SSNDPX does not receive a response from the remote SSNDPX before the associated timer (*see* tN6, Table 4-18) expires, it shall return the logical channel to the ready state.

4.7.3.6.4 *REMOTELY ORIGINATED*

When the SSNDPX receives a connection released SNPDU, it shall enter the remote clear request state, and forward a clear indication packet to the IWF. It shall also construct a connection release complete SNPDU, send it to the remote SSNDPX, and return the logical channel to the ready state.

4.7.3.6.5 *SSNDPX ORIGINATED*

If the SSNDPX entity needs to disconnect a connection, it shall place the logical channel in the local clear request state, send a clear indication packet to the IWF and transmit a connection released SNPDU to the remote SSNDPX. It expects to receive as a response from the remote SSNDPX a connection release complete SNPDU or connection released SNPDU, and shall return the logical channel to the ready state when the expected response is received or timing supervision expires (*see* tN6, Table 4-20).

4.7.3.7 DATA TRANSFER

4.7.3.7.1 The data transfer procedure shall apply independently to each logical channel which is in the data transfer/flow control state.

4.7.3.7.2 *DATA TRANSFER PROCEDURE*

4.7.3.7.2.1 Data shall be forwarded transparently and in sequence between the SNS users.

4.7.3.7.2.2 An M-bit SNPDU sequence shall consist of a sequence of one or more data SNPDUs. Each data SNPDU except the last one, shall contain the maximum 503 octets of user data and its M-bit shall be set to 1. The user data field of the last SNPDU which belongs to the sequence may have less than the maximum length and shall have its M-bit set to 0.

4.7.3.7.2.3 *Locally originated*

4.7.3.7.2.3.1 An M-bit packet sequence received from the IWF shall be forwarded as an M-bit SNPDU sequence to the remote SSNDPX.

4.7.3.7.2.3.2 Upon receipt from the IWF of one or more data packets belonging to one M-bit packet sequence, the SSNDPX shall generate one or more data SNPDUs, using the M-bit to indicate a following data SNPDU of the same sequence of data SNPDUs and shall forward them to the remote SSNDPX.

Note.— The number of data SNPDUs needed in the sequence depends on the amount of user data in the data packets which belong to the M-bit packet sequence.

4.7.3.7.2.3.3 The SSNDPX shall also assign an SNPDU number to each data SNPDU. SNPDU numbers shall be consecutive over a given connection. The sequence numbering of data SNPDUs shall be performed modulo 256 and the SNPDU numbers shall cycle through the entire range from 0 through 255. The first data SNPDU to be transmitted over the satellite link, when the logical channel has just entered the flow control ready state, shall have an SNPDU number equal to 0.

4.7.3.7.2.4 *Remotely originated*

4.7.3.7.2.4.1 An M-bit SNPDU sequence received from the remote SSNDPX shall be forwarded as an M-bit packet sequence to the IWF.

4.7.3.7.2.4.2 Upon receipt of an M-bit SNPDU sequence, the SSNDPX shall generate an M-bit packet sequence, using the M-bit to indicate a following packet of the same sequence as required and forward it to the IWF.

Note.— The number of data packets needed in the M-bit packet sequence depends on the amount of user data in the M-bit SNPDU sequence and the packet size.

4.7.3.7.2.4.3 If a data SNPDU is received which contains less than the maximum size and with M-bit = 1 and D-bit = 0, then the SSNDPX shall initiate a reset procedure (*see* 4.7.3.8.2.1).

4.7.3.7.3 *FLOW CONTROL*

4.7.3.7.3.1 Flow control shall be provided within the SSNDPX to prevent the overflow of data buffers.

4.7.3.7.3.2 To interrupt the flow of data, the receiving SSNDPX shall generate a flow control SNPDU with its flow control reason field set to suspend and transmit it to the remote SSNDPX. The SNPDU number in the flow control (suspend) SNPDU shall be set to the SNPDU number of the last received and accepted data SNPDU. If there are any out-of-sequence data SNPDUs in the SSNDPG, the SNPDU number in the flow control SNPDU with its reason field set to suspend shall be set to the SNPDU number of the SNPDU received and accepted before the out-of-sequence SNPDU. When subsequently the receiving SNDPX is able to resume the data transfer, it shall transmit a flow control SNPDU with its flow control reason field set to resume.

4.7.3.7.3.3 When the SSNDPX receives a flow control SNPDU with its flow control field set to suspend, it shall stop transmitting data SNPDUs on the indicated logical channel. If the SNPDU number in the flow control (suspend) SNPDU is other than that of the last data SNPDU transmitted and the data SNPDU with SNPDU number equal to the SNPDU number in the flow control (suspend) SNPDU plus one modulo 256 is no longer in the data buffer, the SSNDPX shall initiate a reset of the logical channel. When the SSNDPX receives a flow control SNPDU with its control field set to resume, it shall restart transmitting data SNPDUs on the indicated logical channel. The first (re)transmitted data SNPDU shall have its SNPDU number equal to the SNPDU number of the previously received flow control SNPDU (suspend) plus one modulo 256, unless a reset procedure has been invoked.

4.7.3.7.3.4 If the receiving SSNDPX is not able to resume data transfer before the associated timer (*see* tN7 in Table 4-18 and Table 4-20) expires, it shall initiate a reset of the logical channel.

4.7.3.7.4 *EXPEDITED DATA TRANSFER*

Note.— The expedited data transfer allows an SSNDPX to transmit user data contained in an interrupt packet to the remote SSNDPX, bypassing any flow control that may have been applied by subnetwork layer entities.

4.7.3.7.4.1 The expedited data transfer procedure shall apply independently to each logical channel which is in the data transfer state and shall not be initiated when a release or reset procedure is in process.

4.7.3.7.4.2 Only one interrupt SNPDU at a time, with a maximum user data length of 32 octets, shall be permitted in each direction.

4.7.3.7.4.3 *Locally originated*

4.7.3.7.4.3.1 When the originating SSNDPX receives an interrupt packet from the IWF and provided there is no pre-existing interrupt SNPDU awaiting interrupt confirm SNPDU, the SSNDPX shall then generate an interrupt SNPDU and forward it to the remote SSNDPX, and await an interrupt confirm SNPDU; otherwise, the SSNDPX shall discard the interrupt packet.

4.7.3.7.4.3.2 Upon receipt of an interrupt confirm SNPDU, the SSNDPX shall generate an interrupt confirmation packet and forward it to the IWF.

4.7.3.7.4.3.3 If the SSNDPX does not receive the interrupt confirm SNPDU before the associated timer (*see* tN4 in Table 4-18 and Table 4-20) expires, it shall initiate a reset of the logical channel.

4.7.3.7.4.4 *Remotely originated*

4.7.3.7.4.4.1 When the SSNDPX receives an interrupt SNPDU, it shall forward an interrupt packet to the IWF.

4.7.3.7.4.4.2 When the SSNDPX receives an interrupt confirmation packet from the IWF, it shall construct an interrupt confirm SNPDU, and send it to the remote SSNPDX.

4.7.3.8 *CONNECTION RESET*

4.7.3.8.1 When the SSNDPX detects an error in the SSNDPX operation for which its action is to reset the virtual circuit (*see* Table 4-24), then it shall place the logical channel into the local reset state, carry out the reset procedure and transmit a reset SNPDU to the remote SSNDPX.

Note.— The cause and diagnostic codes indicate whether the reset should be carried out within the satellite subnetwork alone or should be extended to the IWF.

4.7.3.8.2 *RESET ACTION*

During the reset process, the following actions shall be taken by the SSNDPX with respect to its data transfer operation:

a) the SNPDUs which have not yet been passed to the link layer shall be discarded;

b) the SNPDUs that have been received prior to receiving/transmitting a reset SNPDU but which do not constitute an M-bit SNPDU sequence shall be flushed from the reassembly area;

c) the expected (data) SNPDU number shall be reset to 0 and subsequently transmitted data SNPDUs shall be numbered starting from 0; and

d) any outstanding interrupt SNPDU to or from the remote SSNDPX remains unconfirmed and tN4 is stopped.

4.7.3.8.3 *RESET PROCEDURES*

4.7.3.8.3.1 The reset procedures shall apply only to logical channels that are in the data transfer state.

4.7.3.8.3.2 The SSNDPX shall guarantee in sequence transmission between data/interrupt SNPDUs already forwarded to the link layer and a subsequently transmitted reset or reset confirm SNPDU.

4.7.3.8.3.3 *Locally/SSNDPX originated*

4.7.3.8.3.3.1 When the originating SSNDPX receives a reset request packet from the IWF or when it has detected an error for which its action is to reset the SVC, it shall place the logical channel into the local reset state, execute the reset action, transmit a reset SNPDU to the remote SSNDPX, and start a timer tN3 (*see* Table 4-18). If required by the error procedures in 4.7.3.9, the SSNDPX shall forward a reset indication packet to the IWF.

4.7.3.8.3.3.2 Upon receipt of the reset confirm SNPDU from the remote SSNDPX, it shall return the logical channel to the data transfer/flow control state.

4.7.3.8.3.3.3 If the SSNDPX does not receive a response from the SSNDPX before the associated timer (*see* tN3 in Table 4-18) expires, it shall initiate a connection release procedure.

4.7.3.8.3.4 *Remotely originated*

4.7.3.8.3.4.1 When the SSNDPX receives a reset SNPDU, it shall place the logical channel into the remote reset state, execute the reset action and transmit a reset indication packet to the IWF as required (*see* Table 4-24).

4.7.3.8.3.4.2 The SSNDPX shall transmit a reset confirm SNPDU to its remote SSNDPX and shall return the logical channel to the data transfer state when it has received from the link layer the information that the reset confirm SNPDU has been successfully transmitted.

4.7.3.8.3.5 *Simultaneous reset*

If the SSNDPX sends a reset SNPDU and subsequently receives a reset SNPDU it shall:

a) not send a reset confirm SNPDU; and

b) not expect to receive a reset confirm SNPDU.

4.7.3.9 ERROR PROCEDURES

Note.— Errors which are recognized by the SSNDPX may be the result of the following events:

- *channel degradation or loss of synchronization*
- *AES log-off*
- *a GES-to-GES handover*
- *link congestion*
- *an uncorrected transmission error*
- *a remote SSNDPX protocol error*
- *a protocol error in the IWF/SSNDPX interface procedure*

4.7.3.9.1 When an error as noted in Tables 4-22 to 4-24 is detected, the SSNDPX shall initiate either reset or release of the relevant connection.

4.7.3.9.2 Errors shall be notified to the IWF by means of cause and diagnostic parameters within the relevant packet. Errors shall be notified to the remote SSNDPX by using the corresponding fields of the SNPDUs, i.e. reset or release cause and diagnostic code.

4.7.3.9.3 The coding of the cause fields which are generated by the SSNDPX and passed to the remote SSNDPX shall be as defined in Table 4-16.

4.7.3.9.4 The coding of the corresponding SSNDPX generated diagnostic code field shall be as defined in Table 4-17.

4.7.3.9.5 *LOG-ON/LOG-OFF*

Note.— The procedures for log-on and log-off are covered in 4.7.6.

4.7.3.9.6 *ORIGINATING SSNDPX ERROR RECOVERY*

4.7.3.9.6.1 Transmission error resulting from the loss or delay of SNPDUs shall be detected either by time-out when a response is expected or by the fail LIDU reported by the link layer.

4.7.3.9.6.2 The actions the SSNDPX follows upon time-out shall be as summarized in Table 4-18.

4.7.3.9.6.3 The actions the SSNDPX shall follow when it is informed by the link layer that the transmission of an SNPDU has failed shall be as summarized in Table 4-19. Receipt of a fail (data/interrupt) LIDU while the relevant LCN is either in local/remote reset state or local/remote clear request state, shall not cause the SSND sub-layer entity to generate a (further) connection reset.

4.7.3.9.7 *PROTOCOL ERROR*

Note.— Two types of protocol error may occur at the SSNDPX. These are:

a) a syntactical error which occurs when a received SNPDU does not conform to the format specifications over the satellite subnetwork; and

b) a logical error which occurs when the SSNDPX receives from its peer entity an SNPDU that is not an acceptable input to the current state of the logical channel.

4.7.3.9.7.1 When the SSNDPX detects a protocol error, it shall respond as indicated in Tables 4-21 to 4-24. These tables are depicted for each logical channel state.

4.7.3.9.8 *OUT-OF-SEQUENCE DATA SNPDU PROCEDURE*

4.7.3.9.8.1 The SSNDPX shall process received data SNPDUs in proper sequence, according to SNPDU number to construct data packets to be forwarded to the IWF. The SSNDPX shall discard duplicate SNPDUs.

Note.— The receiving link layer at the GES may deliver SNPDUs to the SSNDPG in altered sequence. The SSNDPG assembles data SNPDUs in proper sequence before forwarding them to the IWF.

4.7.3.9.8.2 *SSNDPG actions for out-of-sequence data SNPDUs*

A data SNPDU shall be defined as out of sequence if and only if its SNPDU number does not immediately follow the SNPDU number of the last received data SNPDU that has been used in creating the last data packet.

Note.— SNPDU numbers are incremented modulo 256. Thus, SNPDU number 0 follows SNPDU number 255.

4.7.3.9.8.2.1 If an out-of-sequence data SNPDU is not a duplicate, the SSNDPG shall store the out-of-sequence data SNPDU. If no more storage is available, the SSNDPG shall place the logical channel in the reset state and extend the reset to the IWF.

4.7.3.9.8.2.2 Stored data SNPDUs shall be processed to create data packets whenever this can be done without creating an out-of-sequence condition. Data packets shall be forwarded to the IWF as soon as possible.

4.7.3.9.8.3 *SSNDPA actions for out-of-sequence SNPDUs*

If a data SNPDU is received which is not a duplicate but has an SNPDU number not immediately following the SNPDU number of the data SNPDU last received, the SSNDPA shall initiate a reset of the connection.

4.7.3.10 SNPDU FORMATS

4.7.3.10.1 *GENERAL SNPDU FORMAT*

4.7.3.10.1.1 An SNPDU shall consist of at least two octets. Octet 1 shall contain the D- and M-bits and the SNPDU type identifier field. Octet 2 shall contain the logical channel number field; depending on the particular SNPDU type, additional octets may be required. The general SNPDU format shall be as defined in Figure 4-13.

4.7.3.10.1.2 The D- and M-bits shall be bits 7 and 8, respectively, in octet 1.

4.7.3.10.1.3 The M-bit shall be used in an M-bit SNPDU sequence consisting of a sequence of data SNPDUs; it shall be set to 0 in all other SNPDUs.

Note.— The D-bit may be used for end-to-end acknowledgement (receipt confirmation).

4.7.3.10.1.4 The SNPDU type identifier field shall be bits 1-6 in octet 1. The coding of the SNPDU type identifier field shall be as defined in Table 4-15.

4.7.3.10.1.5 Octet 2 shall contain the logical channel number field.

Note.— In the following sections, fields are defined in the order they may appear in the relevant SNPDU.

4.7.3.10.2 *CONNECTION REQUEST SNPDU*

4.7.3.10.2.1 The format of connection request SNPDU shall be as defined in Figure 4-14.

4.7.3.10.2.2 *SNPDU type identifier field*

4.7.3.10.2.2.1 Bits 1, 2, 3 and 6 shall be the following indicator bits:

a) bit 1, facilities field present;

b) bit 2, called NSAP address present;

c) bit 3, calling NSAP address present; and

d) bit 6, fast select with restriction on response.

4.7.3.10.2.2.2 Bits 1, 2 and 3 shall be set to 1 if the corresponding fields are present in the connection request SNPDU; otherwise, they shall be set to 0. Bit 6 shall be set to 1 if fast select with restriction on response applies; otherwise, it shall be set to 0.

4.7.3.10.2.3 *DTE address length field*

Octet 3 shall consist of the calling- and called-DTE address length fields. Bits 8 to 5 shall specify the length of the calling-DTE address in semi-octets. Bits 4 to 1 shall specify the length of the called-DTE address in semi-octets. Each address-length field shall be binary coded, where bit 5 or 1 shall be the low-order bit of the indicator.

4.7.3.10.2.4 *Calling- and called-DTE fields*

4.7.3.10.2.4.1 When indicated by the DTE addresses length field, the octets following the DTE addresses length field shall contain the called-DTE address followed by the calling-DTE address.

4.7.3.10.2.4.2 Each digit of an address shall be coded in a semi-octet in binary-coded decimal, where bit 5 or bit 1 shall be the low-order bit of the digit.

4.7.3.10.2.4.3 Starting from the high-order digit, a DTE address shall be coded in consecutive octets, with two digits per octet. In each octet, the higher-order digit shall be coded in bits 8 to 5. When the total number of digits in the called-plus calling-DTE fields is odd, the combined fields shall be rounded up to an integral number of octets by inserting zeros in bits 4 to 1 of the last octet of the combined fields.

4.7.3.10.2.5 *Called- and calling-NSAP address fields*

When indicated by the called- and calling-NSAP address present indicator bits, the octets following the calling- and called-DTE fields shall contain the called-NSAP address field, then the calling-NSAP address field.

4.7.3.10.2.6 *Facility field length field*

When indicated by the facilities field present indicator bit, the next octet shall contain the length of the facilities field in octets. The facility field length field shall be binary-coded, where bit 1 shall be the low-order bit of the field.

4.7.3.10.2.7 *Facilities field*

When indicated by the facilities field present indicator bit, the octets following the facility field length field shall contain the codes and parameters for the facilities.

4.7.3.10.2.8 *Call user data field*

The next octets shall be used to carry the call user data, if any. If fast select facility is not used, not more than 16 octets of data shall be present. If fast select facility is used, not more than 128 octets of data shall be present.

4.7.3.10.3 CONNECTION CONFIRM *SNPDU*

4.7.3.10.3.1 The format of the connection confirm SNPDU shall be as specified in Figure 4-15.

4.7.3.10.3.2 *SNPDU type identifier field*

4.7.3.10.3.2.1 Bits 1 and 2 shall be the following indicator bits:

a) bit 1: facilities field present; and

b) bit 2: NSAP address present.

4.7.3.10.3.2.2 These bits shall be set to 1 if the corresponding fields are present; otherwise, they shall be set to 0.

4.7.3.10.3.3 *Called-NSAP address field*

When indicated by the NSAP address present indicator bit, the octets following the logical channel number field shall consist of the called-NSAP address.

4.7.3.10.3.4 *Facility length field*

When indicated by the facilities field present indicator bit, the next octet shall contain the length of the facilities field in octets. The facility length indicator shall be binary-coded, where bit 1 shall be the low-order bit of the field.

4.7.3.10.3.5 *Facilities field*

When indicated by the facilities field present indicator bit, the octets following the facilities field shall contain the codes and parameters for the facilities.

4.7.3.10.3.6 *Called user data field*

The next octets shall be used to carry the called user data, if any. If fast select facility is used, not more than 128 octets of data shall be present.

4.7.3.10.4 *CONNECTION RELEASED SNPDU*

4.7.3.10.4.1 The connection released SNPDU format shall be as defined in Figure 4-16.

4.7.3.10.4.2 *SNPDU type identifier field*

4.7.3.10.4.2.1 Bit 2 shall be the NSAP address present indicator bit.

4.7.3.10.4.2.2 This bit shall be set to 1 if the called-NSAP address field is present; otherwise, it shall be set to 0.

4.7.3.10.4.3 *Called-NSAP address field*

This field shall have the same coding as 4.7.3.10.3.3.

4.7.3.10.4.4 *Clearing cause field*

4.7.3.10.4.4.1 The next octet shall be the clearing cause field. It shall contain the clearing cause for the release of the connection.

4.7.3.10.4.4.2 The coding of the clearing cause which may be generated by the SSNDPX shall be as given in Table 4-16.

4.7.3.10.4.5 *Diagnostic code field*

The octet following the clearing cause field shall be the diagnostic code field. It shall contain additional information on the reason for the release of the connection. The coding of the diagnostic code field shall be dependent on the clearing cause as in Table 4-16. The diagnostic code field codings when connection release has been initiated by the SSNDPX shall be as defined in Table 4-17.

4.7.3.10.4.6 *Clear user data field*

The field following the diagnostic code field shall be the user data field. If present, this field shall contain not more than 128 octets of user data.

4.7.3.10.5 *CONNECTION RELEASE COMPLETE SNPDU*

The connection release complete SNPDU format shall be as defined in Figure 4-17.

4.7.3.10.6 *DATA SNPDU*

4.7.3.10.6.1 The data SNPDU format shall be as defined in Figure 4-18.

4.7.3.10.6.2 *M-bit*

The M-bit shall be set to 1 if the SNPDU is not the last in an M-bit sequence of data SNPDUs; otherwise, it shall be set to 0.

4.7.3.10.6.3 *SNPDU number field*

Octet 3 shall contain the 8-bit SNPDU number.

4.7.3.10.6.4 *User data field*

The field following the SNPDU number field shall contain the user data. This field shall contain up to a maximum of 503 octets.

4.7.3.10.7 *INTERRUPT DATA SNPDU*

4.7.3.10.7.1 The interrupt data SNPDU format shall be as defined in Figure 4-19.

4.7.3.10.7.2 *Interrupt user data field*

The field following the logical channel number field shall be the interrupt user data field. This field shall contain up to a maximum of 32 octets.

4.7.3.10.8 *INTERRUPT CONFIRM SNPDU*

The interrupt confirm SNPDU format shall be as defined in Figure 4-20.

4.7.3.10.9 *RESET SNPDU*

4.7.3.10.9.1 The reset SNPDU format shall be as defined in Figure 4-21.

4.7.3.10.9.2 *Resetting cause*

Octet 3 shall be the resetting cause field and shall contain the reason for the reset. When the reset has been initiated by the SSNDPX, the coding of the resetting cause field in a reset SNPDU shall be as given in Table 4-16.

4.7.3.10.9.3 *Diagnostic code*

4.7.3.10.9.3.1 Octet 4 shall be the diagnostic code field and shall contain additional information on the reason for the reset. The coding of the diagnostic code field shall be dependent on the resetting cause as given in Table 4-16. The diagnostic code field codings when the reset has been initiated by the SSNDPX shall be as defined in Table 4-17.

4.7.3.10.9.3.2 If the resetting cause field indicates "IWF originated", the diagnostic code field shall have been passed unchanged from the IWF as a result of its having initiated a resetting procedure.

4.7.3.10.10 *RESET CONFIRM SNPDU*

The reset confirm SNPDU format shall be as defined in Figure 4-22.

4.7.3.10.11 *FLOW CONTROL (SUSPEND) SNPDU*

4.7.3.10.11.1 The flow control (suspend) SNPDU format shall be as defined in Figure 4-23.

4.7.3.10.11.2 *Flow control reason field*

Octet 3 shall contain the flow control reason field. This field shall be set to 11001001 (suspend).

4.7.3.10.11.3 *SNPDU number field*

Octet 4 shall contain the 8-bit SNPDU number of the last in-sequence received and accepted data SNPDU.

4.7.3.10.12 *FLOW CONTROL (RESUME) SNPDU*

4.7.3.10.12.1 The flow control (resume) SNPDU format shall be as defined in Figure 4-24.

4.7.3.10.12.2 *Flow control field*

Octet 3 shall contain the flow control reason field. This field shall be set to 11001011 (resume) to resume transmission from the peer.

4.7.3.10.13 *CONNECTION REQUEST/CONFIRM SNPDU FACILITIES FIELD*

4.7.3.10.13.1 The facilities field shall be present only when the facility field present indicator bit is set to one in the connection request, and connection confirm SNPDUs.

4.7.3.10.13.2 The facilities field shall contain one facility element for each facility or group of facilities requested. The first octet of each facility element shall be the facility code field, which shall indicate the code for the facility or facilities requested. The remaining octets of a facility element shall contain the facility parameter field.

4.7.3.10.13.3 *Recommended facilities*

Recommendation.— *The following facilities should be supported by the SSNDPX:*

a) throughput class negotiation;

b) transit delay selection and indication; and

c) fast select.

4.7.3.10.13.4 *Throughput class negotiation (TCN) facility format*

The format of the throughput class negotiation (TCN) facility field shall be as defined in Figure 4-25.

4.7.3.10.13.5 *Transit delay selection and indication (TDSAI) facility format*

The format of the transit delay selection and indication facility field shall be as defined in Figure 4-26.

4.7.3.10.13.6 *Fast select facility format*

The fast select facility format shall be as defined in Figure 4-27.

4.7.3.10.13.7 *Expedited data negotiation*

The expedited data negotiation facility format shall be as defined in Figure 4-28.

4.7.3.10.14 *DIAGNOSTIC CODES*

When connection release/reset is initiated by the SSNDPX, the coding of the diagnostic code field in the connection released and reset SNPDUs shall be as defined in Table 4-17.

4.7.3.11 TIMER VALUES

The timer values shall be as defined in Table 4-20.

4.7.3.12 STATE DIAGRAMS

State diagrams for the following states shall be given below:

a) The state diagram for connection establishment/release of a logical channel shall be as defined in Figure 4-29.

b) The state diagram for reset and flow control states within the data transfer state shall be as defined in Figure 4-30.

4.7.3.13 STATE TABLES

4.7.3.13.1 Action taken in any state of the SSNDPX shall be given by Tables 4-21 to 4-24.

4.7.3.13.2 The following conventions shall be used in the state tables:

a) action taken, which could be:

— normal, as defined in 4.7.3.5 to 4.7.3.8;

— discard the received SNPDU and take no subsequent action as a result of receiving that SNPDU;

— error, as defined in the table;

b) D = the diagnostic code contained in the diagnostic code field of the appropriate SNPDU (connection released, or reset) issued upon the detection of the indicated error.

4.7.3.14 SATELLITE SUBNETWORK DEPENDENT TO LINK LAYER INTERFACE FUNCTIONS

4.7.3.14.1 The interface functions to the link layer shall include the following:

a) generation and reception of link interface data units (LIDUs);

b) routing of received SNPDUs according to connection;

c) selection of further SNPDUs for transmission according to a cyclic order of selecting among the logical channels at a given Q number and giving precedence to interrupt SNPDUs over data SNPDUs of the same Q number; and

d) routing of local acknowledgement (success/fail) for RLS transmission status indication LIDUs.

4.7.3.14.2 The LIDUs passed between the SSNDPX and the link layer shall include the LIDUs defined in Table 4-25.

4.7.3.15 PACKET TO SNPDU MAPPING RULES

4.7.3.15.1 The rules for mapping the ISO 8208 packet fields into the corresponding fields in SNPDU shall be as specified in this section.

4.7.3.15.2 *DTE ADDRESSES*

4.7.3.15.2.1 The called-DTE address and the calling-DTE address fields in the ISO 8208 call request packet shall be directly mapped into the called-DTE address and the calling-DTE address fields in the connection request SNPDU.

4.7.3.15.2.2 The calling and called DTE addresses in the ISO 8208 call accepted packet shall not be transmitted across the satellite link.

4.7.3.15.3 *NSAP ADDRESS*

4.7.3.15.3.1 The called address extension and the calling address extension parameter fields in the ISO 8208 call request packet shall be directly mapped into the called NSAP address and the calling NSAP address fields in the connection request SNPDU.

4.7.3.15.3.2 If the called address extension parameter in either the ISO 8208 call accepted packet or clear request packet is equal to the called NSAP address of the corresponding connection request SNPDU, then the called address extension shall not be transmitted across the satellite link; otherwise, it shall be directly mapped into the relevant SNPDU.

4.7.3.15.4 *SUBNETWORK CONNECTION PRIORITY*

4.7.3.15.4.1 The target value for the priority of data on a connection in the ISO 8208 call request packet shall be mapped to the LIDU Q number passed to the link layer as defined in Table 4-26. This value shall be used as long as the connection setup procedure has not been completed.

4.7.3.15.4.2 The selected value for the priority of data on a connection in the ISO 8208 call accepted packet shall be mapped to the LIDU Q number passed to the link layer as defined in Table 4-26. This value shall be used for the remainder of the SNC.

4.7.3.15.4.3 If an invalid priority value is provided in the call request or call accepted packet, the SSNDPX shall reject the call. The diagnostic code in the clear indication packet shall be set to "connection rejection — requested quality of service not available — (permanent condition)".

4.7.3.15.4.4 If priority of data on a connection is not indicated in the call request packet, a default value (SNC priority = 0) shall be used.

4.7.3.15.5 *THROUGHPUT CLASS NEGOTIATION*

4.7.3.15.5.1 The throughput class negotiation shall apply independently for each direction of transfer.

4.7.3.15.5.2 *Throughput*

The throughput subparameter shall be defined as one of the values (unspecified, 75, 150, 300, 600, 1 200, 2 400, 4 800, 9 600, 19 200, 48 000, 64 000 bits/s).

4.7.3.15.6 *TRANSIT DELAY*

4.7.3.15.6.1 The negotiated transit delay shall apply to both directions of transfer.

4.7.3.15.6.2 *Aircraft-originated connection establishment*

4.7.3.15.6.2.1 The SSNDPA shall map directly the transit delay selection and indication (TDSAI) facility in the call request packet to the same facility in the connection request SNPDU.

4.7.3.15.6.2.2 If the SSNDPG receives a call accepted packet from the IWF in response to an incoming call packet with TDSAI facility, it shall forward the same facility in the connection confirm SNPDU to the SSNDPA.

4.7.3.15.6.3 *Ground-originated connection establishment*

If the SSNDPG receives a call request packet with the TDSAI facility from the IWF, the SSNDPG shall forward to the SSNDPA a mean value for the satellite subnetwork transit delay of a data SNPDU of 131 octets in the connection request SNPDU.

4.7.3.15.7 *FAST SELECT*

The fast select facility shall be treated as follows:

a) a call request packet without the fast select facility shall be mapped to a connection request with no restriction on response SNPDU with the fast select (use not permitted) facility;

b) a call request packet with the fast select facility indicating fast select requested with no restriction on response shall be mapped to a connection request with no restriction on response SNPDU without the fast select (use not permitted) facility; and

c) a call request packet with the fast select facility indicating fast select request with restriction on response shall be mapped to a connection request with restriction on response SNPDU without the fast select (use not permitted) facility.

4.7.3.15.8 *EXPEDITED DATA NEGOTIATION*

The expedited data negotiation facility in the call request or call accepted packet shall not be mapped to the corresponding connection request or connection confirm SNPDU unless the facility parameter is set to "no use of expedited data".

4.7.3.15.9 *CAUSE AND DIAGNOSTIC CODES*

4.7.3.15.9.1 Clearing cause, resetting cause and diagnostic code fields shall be transferred without modification from the packets to the corresponding SNPDUs.

4.7.3.15.9.2 If the SSNDPX has initiated the clear or reset procedure, then the clearing cause, the resetting cause and the diagnostic code fields shall be set as defined in Tables 4-16 and 4-17.

4.7.3.15.10 *DATA*

4.7.3.15.10.1 If the user data field in the data packets of an M-bit packet sequence is less than the default data SNPDU maximum user data field length, then these fields shall be concatenated to form an M-bit SNPDU sequence.

4.7.3.15.10.2 If the user data field in the data packets of an M-bit packet sequence is greater than the default data SNPDU maximum user data field length, then these fields shall be segmented to form an M-bit SNPDU sequence.

4.7.3.16 SNPDU TO PACKET MAPPING RULES

4.7.3.16.1 This section shall specify the rules for mapping the SNPDU fields into the corresponding fields in ISO 8208 packet.

4.7.3.16.2 *DTE ADDRESS*

4.7.3.16.2.1 The called DTE address and the calling DTE address fields in the connection request SNPDU shall be directly mapped into the called DTE address and the calling DTE address fields in the incoming call packet.

4.7.3.16.2.2 Both the calling and called DTE address fields shall be regenerated when forwarding a call connected packet, if they were present in the corresponding call request packet.

4.7.3.16.3 *NSAP ADDRESS*

4.7.3.16.3.1 The called NSAP address and the calling NSAP address fields in the connection request SNPDU shall be directly mapped into the called address extension and calling address extension parameter fields in the incoming call packet.

4.7.3.16.3.2 The called NSAP address field in the connection confirm or connection released SNPDU shall be mapped into the called address extension field in the call connected or clear indication packet.

4.7.3.16.4 *PRIORITY*

The Q number associated with the connection request and connection confirm SNPDUs shall be mapped into the target and selected values of the priority of data on a connection field in the priority facility in the ISO 8208 incoming call and call connected packets.

4.7.3.16.5 *THROUGHPUT CLASS NEGOTIATION*

4.7.3.16.5.1 The throughput class negotiation shall apply independently for each direction of transfer.

4.7.3.16.5.2 *Throughput*

The throughput sub-parameter shall be defined as one of the values (unspecified, 75, 150, 300, 600, 1 200, 2 400, 4 800, 9 600, 19 200, 48 000, 64 000 bits/s).

4.7.3.16.6 *TRANSIT DELAY*

4.7.3.16.6.1 The negotiated transit delay shall apply to both directions of transfer.

4.7.3.16.6.2 *Aircraft-originated connection establishment*

4.7.3.16.6.2.1 If the SSNDPG receives a connection request SNPDU from an SSNDPA with TDSAI facility, the SSNDPG shall forward to the IWF a mean value for satellite subnetwork transit delay of a data SNPDU of 131 octets in the incoming call packet.

4.7.3.16.6.2.2 The SSNDPA shall map directly the TDSAI facility in the connection confirm SNPDU to the same facility in the call connected packet.

4.7.3.16.6.3 *Ground-originated connection establishment*

4.7.3.16.6.3.1 The SSNDPA shall map directly the TDSAI facility in the connection request SNPDU to the same facility in the incoming call packet.

4.7.3.16.6.3.2 If the SSNDPG receives a connection confirm SNPDU from the SSNDPA in response to a connection request SNPDU with TDSAI facility, it shall forward the same facility in the call connected packet to the IWF.

4.7.3.16.7 *FAST SELECT*

The fast select facility shall be treated as follows:

a) a connection request with no restriction on response SNPDU with the fast select (use not permitted) facility shall be mapped into an incoming call packet without the fast select facility;

b) a connection request with no restriction on response SNPDU without the fast select (use not permitted) facility shall be mapped into an incoming call packet with the fast select facility with the "no restriction on response" parameter;

c) a connection request with restriction on response SNPDU without the fast select (use not permitted) facility shall be mapped into an incoming call packet with the fast select facility with the "restriction on response" parameter.

4.7.3.16.8 *EXPEDITED DATA NEGOTIATION*

If the expedited data negotiation facility is not present in the connection request or connection confirm SNPDU, this facility with its parameter set to "use of expedited data" shall be added to the corresponding incoming call or call connected packet; otherwise, this facility shall be mapped to the corresponding packet.

4.7.3.16.9 *CAUSE AND DIAGNOSTIC CODES*

Clearing cause, resetting cause and diagnostic code fields shall be transferred without modification from the SNPDUs to the corresponding packets.

4.7.3.16.10 *DATA*

4.7.3.16.10.1 If the user data field in the data SNPDUs of an M-bit SNPDU sequence is less than the default data packet maximum user data field length, then these fields shall be concatenated to form an M-bit packet sequence.

4.7.3.16.10.2 If the user data field in the data SNPDUs of an M-bit SNPDU sequence is greater than the default data packet maximum user data field length, then these fields shall be segmented to form an M-bit packet sequence.

4.7.3.17 CAPACITY

The SSNDPA shall support at least eight simultaneous, independent logical channels.

4.7.4 ISO 8208 DCE protocol operations

4.7.4.1 GENERAL PROVISIONS

4.7.4.1.1 The protocol between the ISO 8208 DCE and the ISO 8208 DTE shall comply with the ISO 8208 second edition.

4.7.4.1.2 *PACKET LAYER ENTITY*

Note.— Within the ISO 8208 DCE there may be more than one DCE/DTE interface, e.g. a GES may be connected to more than one ground ATN router. One such entity exists in the DCE for each DCE/DTE interface. Deciding which entity to use to reach a particular destination is a function performed external to the protocol described here. The protocol defined in 4.7.4 pertains to each packet layer entity in the DCE.

4.7.4.2 CONFORMANCE REQUIREMENTS

4.7.4.2.1 *SUPPORTED SERVICES AND CAPABILITIES*

The following services and capabilities shall be supported:

a) virtual call service;

b) a user data field of up to 128 octets in data packets; and

c) expedited data delivery, i.e. the use of interrupt packets with a user data field of up to 32 octets.

4.7.4.2.2 *SUPPORTED FACILITIES*

The following facilities shall be supported:

a) calling address extension and called address extension; and

b) priority.

Note.— The target and lowest acceptable values for the priority to gain a connection and keep a connection, and the lowest acceptable value for data on a connection, need not be supported.

4.7.4.2.3 *RECOMMENDED FACILITIES*

Recommendation.— *The following facilities should be supported:*

a) throughput class negotiation;

b) transit delay selection and indication;

c) fast select;

d) fast select acceptance.

4.7.4.3 OPERATIONS

4.7.4.3.1 *EXTERNAL INTERACTIONS*

Note.— The initiation of certain DCE procedures is directed by elements outside the ISO 8208 DCE. Likewise, the occurrence of certain ISO 8208 DCE events are to be reported appropriately. These external interactions include:

a) requesting of the link layer, transmission of outgoing packets;

b) receiving, from the link layer, incoming packets;

c) accepting requests from the IWF to initiate certain ISO 8208 protocol procedures including:

1) originate a virtual call,

2) accept a virtual call,

3) terminate a virtual call,

4) transfer data and interrupt information, and

5) re-initialize a logical channel.

d) reporting to the IWF the occurrence of certain ISO 8208 protocol events including:

1) receipt of an incoming request to set up a virtual call,

2) receipt of the acceptance of a virtual call setup,

3) termination of a virtual call,

4) receipt of data and interrupt information, and

5) re-initialization of a logical channel.

4.7.4.3.1.1 The ISO 8208 DCE shall accept all ISO 8208 packets from the ISO 8208 DTE without failure.

4.7.4.3.2 *LOGICAL CHANNELS*

Note.— Each virtual call and permanent virtual circuit is assigned a logical channel identifier which is a number in the range from 1 through 4 095. For each virtual call, a logical channel identifier is assigned during the call setup phase from a range of previously agreed-upon logical channel identifiers. For each permanent virtual circuit, a logical channel identifier is assigned in agreement with the DTE. A DCE's use of logical channels is agreed upon for a period of time with the DTE.

4.7.4.3.3 *STATE TRANSITIONS*

4.7.4.3.3.1 The specifications and definitions in ISO 8208 shall apply for format definitions, diagnostic and cause codes, facility registration protocols (if used), and flow control on the ISO 8208 interface.

Note 1.— The ISO 8208 DCE is defined as a state machine. An ISO 8208 packet received from the DTE can cause state transitions, as can a packet received from IWF. The next state transition (if any) that occurs when the DCE receives a packet from the DTE is specified by Tables 4-29 to 4-34. These tables are organized according to the hierarchy in Figure 4-31.

Note 2.— Upon receiving a packet, the action is classified as normal or erroneous under the entry "A =". The resulting state is shown under the entry, "S =".

4.7.4.3.3.2 If a state transition is specified, the action taken shall be as specified in Tables 4-29 to 4-34.

4.7.4.3.4 *DISPOSITION OF PACKETS*

When a packet is received from the DTE, the expressions in parentheses in Tables 4-29 to 4-34 specify whether the packet shall be forwarded or not forwarded to the IWF. If no remark in parentheses is listed or listed as not forwarded, then the packet shall be discarded. The ISO 8208 DCE shall either forward or not forward a packet from the IWF to the DTE in a manner that is compatible with ISO 8208.

4.7.4.3.5 *DIAGNOSTIC AND CAUSE CODES*

For certain conditions, Tables 4-29 to 4-34 indicate a diagnostic code that shall be included in the packet generated when entering the state indicated. The term, "D =", shall define the diagnostic code. When "A = DIAG", the action taken shall be to generate an ISO 8208 diagnostic packet and transfer it to the DTE: the diagnostic code indicated shall define the entry in the diagnostic field of the packet. In the cause field of any packet type, bit 8 of the cause field shall always be set to 0, indicating that the condition was recognized by the ISO 8208 interface.

Note.— The state Tables 4-29 to 4-34 are defined so that the SSNDPX and ISO 8208 DCE functions can operate simultaneously. While asynchronous operation is a suitable implementation strategy, it is not a requirement for the SSNDPX and ISO 8208 DCE operations.

4.7.4.3.6 *DCE TIMER*

Note.— Under certain circumstances, the DTE must respond to a packet issued from the DCE within a given time.

4.7.4.3.6.1 Table 4-35 covers these circumstances and the action that the DCE shall initiate upon the expiration of that time.

4.7.4.4 CAPACITY

The AES DCE shall support at least eight simultaneous, independent logical channels.

4.7.4.5 VC PRE-EMPTION

A logical channel of the lowest priority and the associated virtual call shall be cleared as necessary to accept a request for higher priority service.

Note.— Logical channels and virtual calls have a priority level of 0 unless the ISO 8208 priority facility was invoked during call set up.

4.7.5 Interworking function

4.7.5.1 SSNDPX/IWF INTERFACE

4.7.5.1.1 The ISO 8208 packets exchanged between the IWF and the SSNDPX shall be as defined in Table 4-36.

4.7.5.1.2 *INCOMING CALL PACKET HANDLING*

The IWF shall forward the incoming call packet with the expedited data negotiation facility and "use of expedited data" parameter to the appropriate ISO 8208 DCE entity.

Note.— If the facility parameter is "no use of expedited data", the IWF forwards the incoming call packet with or without this facility.

4.7.5.1.3 *CALL CONNECTED PACKET HANDLING*

If the parameter of the expedited data negotiation facility is set to "use of expedited data" in the call connected packet, the IWF shall forward this facility and its parameter with the packet to the appropriate ISO 8208 DCE entity. For each virtual call, the IWF shall associate the SSNDPX logical channel with the corresponding ISO 8208 DCE logical channel.

Note.— If the expedited data negotiation facility parameter is set to "no use of expedited data", the IWF forwards the call connected packet with or without this facility.

4.7.5.1.4 *CLEAR INDICATION PACKET HANDLING*

4.7.5.1.4.1 The IWF shall disassociate the SSNDPX logical channel with the corresponding ISO 8208 DCE logical channel and forward the packet to the ISO 8208 DCE entity.

4.7.5.1.5 *DATA, INTERRUPT, INTERRUPT CONFIRMATION AND RESET INDICATION PACKET HANDLING*

4.7.5.1.5.1 Data, interrupt, interrupt confirmation and reset indication packets shall be forwarded to the appropriate ISO 8208 DCE entity based on the logical channel association established after the completion of a connection establishment.

4.7.5.2 ISO 8208 DCE/IWF INTERFACE

4.7.5.2.1 The ISO 8208 packets exchanged between the IWF and the ISO 8208 DCE shall be as defined in Table 4-37.

4.7.5.2.2 *CALL REQUEST PACKET HANDLING*

If the call request packet does not contain the expedited data negotiation facility, the IWF shall add this facility with its parameter set to "no use of expedited data" to the packet and shall forward it to the appropriate SSNDPX entity; otherwise, the IWF shall forward the call request packet with this facility and parameter. If the optional called DTE address is invalid, then the IWF shall return a clear indication packet to the ISO 8208 DCE entity.

4.7.5.2.3 *CALL ACCEPTED PACKET HANDLING*

If the call accepted packet does not contain the expedited data negotiation facility, the IWF shall add this facility with its parameter set to "no use of expedited data" to the packet and shall forward it to the appropriate SSNDPX entity; otherwise, the IWF shall forward the call accepted packet with this facility and parameter. For each virtual call, the IWF shall associate the ISO 8208 DCE logical channel with the corresponding SSNDPX logical channel.

4.7.5.2.4 *CLEAR REQUEST PACKET HANDLING*

The IWF shall disassociate the ISO 8208 DCE logical channel with the corresponding SSNDPX logical channel and forward the packet to the SSNDPX entity.

4.7.5.2.5 *DATA, INTERRUPT, INTERRUPT CONFIRMATION AND RESET REQUEST PACKET HANDLING*

Data, interrupt, interrupt confirmation and reset request packets shall be forwarded to the appropriate SSNDPX entity based on the logical channel association established after the completion of a connection establishment.

4.7.5.3 IWF/CN INTERFACE

The IWF shall forward the connectivity notification event messages to the appropriate ISO 8208 DCE logical channel.

4.7.5.4 ISO 8208 LOGICAL CHANNEL AND SSNDPX LOGICAL CHANNEL ASSOCIATION

Note.— ISO 8208 DCE logical channel identifier and the SSNDPX logical channel number of an SNC need not be identical.

4.7.5.5 DATA TRANSFER PROCEDURES

4.7.5.5.1 *FLOW CONTROL*

Flow control shall be applied between the SSNDPX and the ISO 8208 DCE to prevent storage overflow.

4.7.5.6 CAUSE AND DIAGNOSTIC CODE

4.7.5.6.1 The IWF shall replace the cause "local procedure error" in ISO 8208 packets received from the DCE, by the cause "remote procedure error" before forwarding them to the SSNDPX. The IWF shall replace the cause "local link error" in an SNPDU received from the SSNDPX by the cause "network congestion" before forwarding them to the DCE. All other causes shall be transferred without modification.

4.7.5.6.2 Diagnostic codes shall be transferred without modification.

4.7.6 Management interface

4.7.6.1 AES MANAGEMENT INTERFACE

4.7.6.1.1 The changes in log-on status conveyed from the AES management to the SSNL shall be as defined in 4.9.2.1.1.

4.7.6.1.2 When the AES either logs-off or otherwise terminates communication with a GES, the AES SSNL shall clear all connections with this GES.

4.7.6.1.3 *CONNECTIVITY NOTIFICATION EVENT*

4.7.6.1.3.1 The CN function shall be performed by the CN entity.

4.7.6.1.3.2 *Log-on to a GES*

When the AES logs-on to a GES, the AES shall send a join event message to the attached ATN router on the aircraft. This message shall include sufficient information for the attached ATN router to determine the address(es) of the DTE(s) attached to the GES.

Note.— The attached ATN router, on receiving the join event message, will have sufficient information to establish the SVCs.

4.7.6.1.3.3 *Log-off from a GES*

When the AES logs-off from a GES, the CN shall forward to the IWF a leave event message indicating AES log-off from the GES.

4.7.6.2 GES MANAGEMENT INTERFACE

4.7.6.2.1 The changes in log-on status conveyed from the GES management to the SSNL shall be as defined in 4.10.3.2.

4.7.6.2.2 When the AES logs-off from the GES, the SSNL shall clear all connections associated with the AES, and shall release all resources associated with these SNCs. In addition, the GES shall provide to the attached ATN ground routers a leave event indication referencing the 24-bit ICAO aircraft identifier.

4.8 CIRCUIT-MODE SERVICES

4.8.1 AMS(R)S circuit-mode general requirements

Note.— The AMS(R)S circuit-mode service is a communications service between aircraft and ground facilities using satellite links as one of the connecting media. The AMS(R)S circuit-mode service provides a means to establish and maintain a non-shared switched circuit between aircraft and ground users on demand. The primary purpose of the circuit-mode service is to provide for safety voice communications. A switched circuit is held for the duration of the call unless automatically pre-empted in order to reassign resources for a higher priority call attempt. AMS(R)S switched circuits may be interconnected with one or more terrestrial communications facilities in tandem with the AMS(R)S subnetwork. These facilities may include safety circuit-switched networks or dedicated circuits.

4.8.1.1 *AMS(R)S circuit-mode services.* Circuit-mode AMS(R)S communications services shall be provided to Level 3 and 4 AESs and shall consist of distress, urgency, flight safety and other messages related to meteorology and flight regularity.

Note.— Non-AMS(R)S circuit switched voice and data service for non-safety communications may be supported by AMS(R)S on a not-to-interfere basis provided that the provisions of 4.8.3.2 are complied with.

4.8.1.2 *Order of importance.* AMS(R)S services for ATS communications shall have precedence over non-AMS(R)S communications.

4.8.1.3 *Non-AMS(R)S communications.* Non-AMS(R)S communications shall not interfere with AMS(R)S communications.

4.8.2 Circuit-mode system architecture

AES circuit-mode services shall be able to specify a particular GES to be used in air-origination calls and shall not be restricted to its log-on GES. Conversely, a ground originated call arriving from the terrestrial network of any GES which has current log-on information of the AES shall be completed by that GES rather than the GES to which the AES is logged on.

4.8.2.1 *Circuit-mode link layer signalling interface.* The AES and GES circuit-mode service procedures shall use the AMS(R)S link layer to exchange signalling information. This information shall be conveyed in circuit-mode — link interface data units (CM-LIDU). As a link service user, the AMS(R)S circuit-mode procedures shall use the services of the link layer interface defined in 4.5 and 4.6. Each CM-LIDU shall be comprised of specific link interface control information (LICI) parameters required by the link layer service. The CM-LIDUs and their relevant LICI parameters are defined in Table 4-38.

4.8.2.2 CIRCUIT-MODE TELEPHONY INTERWORKING INTERFACE

Note.— Guidance material on the circuit-mode telephony interworking interface is contained in Attachment A to Part I.

4.8.2.2.1 The AES and GES circuit-mode service procedures shall interwork with external telephony networks through an interworking interface comprising a standardized set of interworking telephony events which conform to ITU CCITT Recommendations Q.601 to Q.608. The set of interworking telephony events used by the circuit-mode procedures, and the requirements for mapping parameters between the events and corresponding CM-LIDUs, shall be as defined in Tables 4-39 to 4-42.

Note.— Details of ITU CCITT Recommendations Q.601 to Q.608 are contained in CCITT Blue Book, Volume VI — Fascicle VI.6.

4.8.2.3 OTHER AES CIRCUIT-MODE SYSTEM INTERFACES

4.8.2.3.1 *AES management interface.* The specific information exchanged between AES circuit-mode services and AES management shall be as defined in 4.9.

4.8.2.3.2 *AES voice codec external interface.* The AES external voice interface shall convey bi-directional voice information in a form compatible with aircraft-specific audio systems.

4.8.2.4 OTHER GES CIRCUIT-MODE SYSTEM INTERFACES

4.8.2.4.1 *GES management interface.* The specific information exchanged between GES circuit-mode services and GES management shall be as defined in 4.10.

4.8.2.4.2 *Voice codec external interface.* The GES external voice interface shall convey bi-directional voice information in a form compatible with terrestrial network audio channels.

4.8.3 AMS(R)S service requirements

4.8.3.1 *Connectivity.* The AMS(R)S service shall support the on-demand establishment of switched circuits between any aircraft within the service area of a GES and the terrestrial networks serving the GES. The AMS(R)S service shall allow a circuit switched transaction to be established between an aircraft and a terrestrial network via a GES other than the GES to which the aircraft is logged on.

4.8.3.2 *Priority and pre-emption.* AMS(R)S calls shall have priority over all non-AMS(R)S calls and shall be capable of pre-empting non-AMS(R)S calls if required to gain immediate access to the circuit-mode service. AMS(R)S calls shall be established and maintained in accordance with the priority levels defined in Table 4-43. An AMS(R)S call with a higher service priority than an AMS(R)S call in progress shall be able to preempt the lower service priority call if necessary to gain immediate access to circuit-mode service. All AMS(R)S call attempts crossing the interface between a GES and a terrestrial network shall be identified as to the associated priority category.

4.8.3.3 *Grade-of-service.* The GES shall have available sufficient C channel resources such that an air or ground-originated call attempt received at the GES shall experience a probability of blockage within the GES of no more than 0.01. Available GES C channel resources shall include all pre-emptable resources (e.g. those in use by non-safety users).

4.8.4 AMS(R)S performance requirements

4.8.4.1 CALL PROCESSING DELAYS

Note.— Guidance material on access delay performance requirements for the AMS(R)S subnetwork and how they impact planning of ATS terrestrial networks is contained in Attachment A to Part I.

4.8.4.1.1 *AIR-ORIGINATIONS*

4.8.4.1.1.1 *GES signalling transit delay.* The maximum time delay for a GES to present a call origination event (FITE 18, *see* Table 4-42) to the terrestrial network interworking interface after the first arrival of all AES call information at the GES link layer shall be 1.0 second (95th percentile).

Note.— All AES call information is contained within the "abbreviated access request" CM-LIDU received via the R channel.

4.8.4.1.1.2 *GES C channel assignment delay.* The maximum time delay for a GES to enqueue a "C channel assignment" CM-LIDU for service by the P channel link layer after an "abbreviated access request" CM-LIDU has arrived at the GES link layer shall be 1.5 seconds (95th percentile).

4.8.4.1.1.3 *AES C channel assignment response delay.* The maximum time delay for an AES to begin transmitting a C channel carrier after a "C channel assignment" CM-LIDU has arrived at the AES link layer shall be 1.0 second (95th percentile).

4.8.4.1.2 *GROUND-ORIGINATIONS*

4.8.4.1.2.1 *GES C channel assignment delay.* The maximum time delay for a GES to enqueue a "C channel assignment" CM-LIDU for service by the P channel link layer after a call origination event (FITE 18, see Table 4-41) has arrived at the terrestrial network interworking interface shall be 1.5 seconds (95th percentile).

4.8.4.1.2.2 *AES C channel assignment response delay.* The maximum time delay for an AES to begin transmitting a C channel carrier after both a "call announcement" CM-LIDU and a "C channel assignment" CM-LIDU have arrived at the AES link layer shall be 1.0 second (95th percentile).

Note.— The AES procedures for ground-originated calls require an AES to await the successful receipt of both CM-LIDUs before C channel transmission can begin. These procedures include error-recovery logic to handle their potential receipt out of normal order.

4.8.4.2 TRANSFER DELAY

The total allowable transfer delay within the AMS(R)S subnetwork on a C channel operating at 21.0 kbits/s shall be no more than 0.485 second.

4.8.4.2.1 The maximum transfer delay component that can be attributed to the AES or GES shall be 0.080 second for each.

Note 1.— Fixed transfer delay components of 0.285 second and 0.040 second are allotted to RF propagation delay (worst case path geometry) and vocoder frame emission delay respectively. Allocating 0.040 second for vocoder frame emission delay provides for worst case synchronization where the first 0.020 second vocoder speech frame is delayed by an additional C channel interleaver block.

Note 2.— Total transfer delay for the AMS(R)S subnetwork is defined as the elapsed time commencing at the instant that speech is presented to the AES or GES and concluding at the instant that the speech enters the interconnecting network of the counterpart GES or AES. This delay includes vocoder processing time, physical layer delay, RF propagation delay and any other delays within the AMS(R)S subnetwork.

4.8.4.3 MISROUTING

The probability of misrouting caused by internal processing or signalling errors within the GES shall not exceed 1 in 10^6.

Note.— Misrouting can occur if the GES misinterprets (1) the network-ID or ground address digits contained in an "abbreviated access request — telephone" CM-LIDU (for air-originations) or (2) the AES-ID or terminal-ID contained in a FITE 18 received from the interworking interface with the terrestrial network (for ground-originations).

4.8.5 Circuit-mode voice encoding algorithm

All AES and GES implementations shall provide circuit-mode voice communications using the voice encoding/decoding algorithm defined in Appendix 7 to Chapter 4. All such voice communications shall be conducted over a 21 kbits/s C channel as defined in 4.4.5.

4.8.6 AMS(R)S circuit-mode procedures

The AMS(R)S circuit-mode procedures comprise the following four functional areas:

a) For the AES circuit-mode services:

   i) AES outgoing logic procedure (for air-originations); and

   ii) AES incoming logic procedure (for ground-originations).

b) For the GES circuit-mode services:

   i) GES outgoing logic procedure (for ground-originations); and

   ii) GES incoming logic procedure (for air-originations).

4.8.6.1 AMS(R)S CIRCUIT-MODE PROCEDURES

Note 1.— It is assumed that an AMS(R)S circuit-mode service procedure will encode or interpret the relevant parameters of any CM-LIDU being transmitted or received without specifically stating the exact code values in the procedures contained herein. Specific requirements for parameter encoding can be found in the interworking telephony events mapping requirements defined in Appendix 5 to Chapter 4.

Note 2.— The term "C channel resources" includes all required C channel hardware and sufficient transmitter power to maintain a C channel.

4.8.6.1.1 *AES CIRCUIT-MODE LOGIC*

Note.— The requirements for mapping between interworking telephony events and CM-LIDUs by the AES outgoing and incoming procedures are defined in Appendix 5 to Chapter 4, Figures A5-1 to A5-11 and A5-12 to A5-18, respectively. Circuit-mode configuration parameters (e.g. those used in 4.8.6.1.1.1) are defined in Appendix 6 to Chapter 4.

4.8.6.1.1.1 *AES outgoing circuit-mode procedure.* Receipt of an "AMS(R)S call origination" event (FITE 18) at the interworking interface shall cause AES circuit-mode services to assign a unique application reference number to the call. AES circuit-mode services shall then do the following:

a) if sufficient AES C channel resources are not available and the blockage is attributable to calls operating at a C channel priority equal to or greater than the current call attempt, AES circuit-mode services shall return a "call unsuccessful — network congestion" event (BITE 12) to the interworking interface and terminate all activities for the call; or

b) if sufficient C channel resources are available or if at least one of the calls causing the blockage is operating at a C channel priority less than the current call attempt, AES circuit-mode services shall do the following and then await a C channel assignment from GES circuit-mode services:

1) if the call priority is distress/urgency, AES circuit-mode services shall forward to the link layer nA21 "abbreviated access request — telephone" CM-LIDUs; or

2) if the call priority is flight safety, AES circuit-mode services shall forward to the link layer nA22 "abbreviated access request — telephone" CM-LIDUs; or

3) if the call priority is regularity/meteorological, the AES circuit-mode services shall forward to the link layer nA23 "abbreviated access request — telephone" CM-LIDUs.

4.8.6.1.1.1.1 AES circuit-mode services shall do the following while awaiting a response from GES circuit-mode services:

a) if a response is not received from GES circuit-mode services within tA50 seconds after the transmission of the latest "abbreviated access request — telephony" CM-LIDU, the AES shall command the selection of an R channel frequency and then shall transmit the original quantity of CM-LIDUs; provided that the total number of retransmissions of the CM-LIDU series does not exceed four. If, tA50 seconds after the fourth retransmission of the CM-LIDU series, no response has been received, AES circuit-mode services shall return a "call unsuccessful — line out of service" event (BITE 17) to the interworking interface and terminate all activities for the call; or

b) if a "clear forward" event (FITE 22) is received at the interworking interface, AES circuit-mode services shall forward to the link layer a "call progress — channel release" CM-LIDU via the R channel and terminate all activities for the call; or

c) if the call attempt is to be pre-empted by a higher priority call, AES circuit-mode services shall forward a "clear back" event (BITE 25) to the interworking interface, forward to the link layer a "call progress — channel release" CM-LIDU via the R channel, and then terminate all activities for the call; or

d) if any of the following responses are received, AES circuit-mode services shall do the following:

1) if either a "call progress — call attempt result" CM-LIDU or a "call progress — channel release" CM-LIDU are received, AES circuit-mode services shall forward a "clear back" event (BITE 25) or an appropriate "call unsuccessful" event (BITE 14, 15, 16, 17, or 20) to the interworking interface as determined by the cause location, cause class, and cause value parameters received in the CM-LIDU. AES circuit-mode services shall then terminate all activities for the call; or

2) if a "C channel assignment" CM-LIDU is received, AES circuit-mode services shall request AES management to allocate C'channel resources and activate a C channel unit on the assigned frequency at the C channel Q number value as per Table 4-43.

Note.— This is to say that the Q number of the C channel is inferred from the Q number used in the initial circuit-mode call signalling at the link layer.

AES circuit-mode services shall then forward to the link layer a "call information — service address" CM-LIDU every tA29 seconds indefinitely and interconnect the C channel audio interface with that of the calling terminal.

Note.— The call information conveyed by the "call information — service address" CM-LIDU is redundant with that conveyed by the "abbreviated access request" CM-LIDU. This information is used to maintain compatibility with the circuit continuity test procedure in use by those GESs which are providing AMSS services to non-AMS(R)S users; and it will not be submitted to digit analysis by a GES.

4.8.6.1.1.1.2 If no response is received from GES circuit-mode services within tA28 seconds after C channel unit activation, AES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, return a "call unsuccessful — line out of service" event (BITE 17) to the interworking interface, and terminate all activities for the call; otherwise, AES circuit-mode services shall do the following:

a) if one or more "call progress — test" CM-LIDUs are received, AES circuit-mode services shall ignore them; or

b) if one or more "call progress — channel release" CM-LIDUs are received, or if a "clear forward" event

(FITE 22) is received at the interworking interface, then AES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, return an appropriate telephony event (BITE 14, 15, 16, 17, 20, or 25) to the interworking interface, and terminate all activities for the call; or

c) if a "call progress — connect" CM-LIDU is received, or if the CM-LIDU arrives preceded by either a "call progress — test" CM-LIDU or a "call progress — call attempt result" CM-LIDU which was previously received within tA28 seconds after C channel unit activation, AES circuit-mode services shall do the following:

1) ensure that the repetitive transmission of the "call information — service address" CM-LIDU has ceased; and

2) forward an "answer" event (BITE 22) to the interworking interface and forward to the link layer a positive "telephony acknowledge" CM-LIDU via the C channel sub-band. If any additional "call progress — connect" CM-LIDUs are received subsequent to the initial "call progress — connect" CM-LIDU, AES circuit-mode services shall respond to each by forwarding to the link layer a positive "telephony acknowledge" CM-LIDU to GES circuit-mode services; or

Note.— At this point the end-to-end call is established.

d) if a "call progress — call attempt result" CM-LIDU (encoded to indicate an "address complete" event) is received, or if it arrives preceded by a "call progress — test" CM-LIDU which was previously received within tA28 seconds after C channel unit activation, AES circuit-mode services shall do the following:

1) ensure that the repetitive transmission of the "call information — service address" CM-LIDU has ceased; and

2) forward an "address complete" event (BITE 5) to the interworking interface and forward to the link layer a positive "telephony acknowledge" CM-LIDU via the C channel sub-band. If any additional "call progress — call attempt result" CM-LIDUs are received subsequent to the initial "call progress — call attempt result" CM-LIDU, AES circuit-mode services shall respond to each by forwarding to the link layer a positive "telephony acknowledge" CM-LIDU to GES circuit-mode services; or

e) if C channel resources are pre-empted for a higher priority call, AES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, return a "clear back" event (BITE 25) to the interworking interface, and terminate all activities for the call; or

f) if the C channel sub-band link layer commands the call be terminated, AES circuit-mode services shall forward a "clear back" event (BITE 25) to the interworking interface and terminate all activities for the call.

4.8.6.1.1.2 *AES incoming circuit-mode procedure*. This procedure shall be defined by the following interrelated procedures:

a) AES incoming circuit-mode call initiation — 4.8.6.1.1.2.1;

b) AES incoming C channel continuity check — 4.8.6.1.1.2.2;

c) AES incoming aircraft completion — 4.8.6.1.1.2.3; and

d) AES incoming C channel maintenance — 4.8.6.1.1.2.4.

4.8.6.1.1.2.1 *AES incoming circuit-mode call initiation*. Upon receipt of either a "call announcement" or "C channel assignment" CM-LIDU with a unique application reference number, AES circuit-mode services shall do the following:

a) if a "C channel assignment" was received, AES circuit-mode services shall forward to the link layer a negative "telephony acknowledge" CM-LIDU (encoded to indicate that the "call announcement" CM-LIDU is missing) via the R channel and do the following:

1) if neither a related "call announcement" CM-LIDU or a "call progress — channel release" CM-LIDU are received within tA27 seconds of the transmission of the latest negative "telephony acknowledge" CM-LIDU, AES circuit-mode services shall forward to the link layer the negative "telephony acknowledge" CM-LIDU via the R channel and await their arrival for an additional tA27 seconds; provided that the total number of repetitions of the "telephony acknowledge" CM-LIDU does not exceed four. If neither of the aforementioned CM-LIDUs are received within tA27 seconds after the fourth repetition of the "telephony acknowledge" CM-LIDU, AES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

2) if a "call progress — channel release" CM-LIDU is received within tA27 seconds after the latest transmission of the "telephony acknowledge" CM-LIDU, AES circuit-mode services shall terminate all activities for the call; or

3) if the call attempt is to be preempted for a higher priority call, AES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

4) if the related "call announcement" CM-LIDU is received within tA27 seconds after the latest transmission of the "telephony acknowledge" CM-LIDU, AES circuit-mode services shall do the following:

i) if the called terminal is occupied with a call at a priority higher than or equal to the current call attempt, or if C channel resources are not available, AES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

ii) if the called terminal and C channel resources are both available, AES circuit-mode services shall request AES management to allocate C channel resources and activate a C channel unit on the assigned frequency at the C channel Q number value as per Table 4-43.

Note.— This is to say that the Q number of the C channel shall be inferred from the Q number used in the initial circuit-mode call signalling at the link layer.

AES circuit-mode services shall then forward to the link layer a "call progress — test" CM-LIDU and perform the AES incoming C channel continuity check procedure in 4.8.6.1.1.2.2; or

b) if a "call announcement" CM-LIDU was received, AES circuit-mode services shall do the following:

1) if a "call progress — channel release" CM-LIDU is received within tA25 seconds after receipt of the "call announcement" CM-LIDU, AES circuit-mode services shall terminate all activities for the call; or

2) if neither a "C channel assignment" CM-LIDU or a "call progress — channel release" CM-LIDU are received within tA25 seconds after receipt of the "call announcement" CM-LIDU, AES circuit-mode services shall forward to the link layer a negative "telephony acknowledge" CM-LIDU (encoded to indicate that the "C channel assignment" CM-LIDU is missing) via the R channel and await their arrival for an additional tA27 seconds. If neither of the CM-LIDUs arrive after tA27 seconds, AES circuit-mode services shall again forward to the link layer the negative "telephony acknowledge" CM-LIDU and await an additional tA27 seconds; provided that the total number of repetitions of the negative "telephony acknowledge" CM-LIDU does not exceed four. If neither of the CM-LIDUs are received within tA27 seconds after the fourth repetition of the negative "telephony acknowledge" CM-LIDU, AES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

3) if the call attempt is to be pre-empted for a higher priority call, AES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

4) if a "C channel assignment" CM-LIDU is received within either tA25 seconds after receipt of the "call announcement" CM-LIDU or tA27 seconds after receipt of the transmission of the latest negative "telephony acknowledge" CM-LIDU, AES circuit-mode services shall do the following:

i) if the called terminal is occupied with a call at a priority higher than or equal to the current call attempt, or if C channel resources are not available, AES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

ii) If the called terminal and C channel resources are both available, AES circuit-mode services shall request AES management to allocate the resources at a C channel Q number value as per Table 4-43 and activate a C channel unit on the assigned frequency. AES circuit-mode services shall then forward to the link layer a "call progress — test" CM-LIDU and perform the AES incoming C channel continuity check procedure in 4.8.6.1.1.2.2.

4.8.6.1.1.2.2 *AES incoming C channel continuity check.* Where required elsewhere in 4.8, AES circuit-mode services shall perform a C channel continuity check by doing the following:

a) if neither a "call progress — test" CM-LIDU or a "call progress — channel release" CM-LIDU are received within tA26 seconds after the most recent "call progress — test" CM-LIDU has been forwarded, AES circuit-mode services shall forward to the link layer another "call progress — test" CM-LIDU until any of the following occur:

1) if neither a "call progress — test" CM-LIDU or a "call progress — channel release" CM-LIDU are received within tA41 seconds after activation of the C channel unit, AES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs, shall then forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

2) if a "call progress — channel release" CM-LIDU is received within tA41 seconds after activation of the C channel unit, AES circuit-mode services shall terminate all activities for the call; or

3) if the C channel is to be pre-empted for a higher priority call, AES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the R channel and terminate all activities for the call; or

4) if a "call progress — test" CM-LIDU is received within tA41 seconds after C channel unit activation, AES circuit-mode services shall enable the circuit path between the C channel unit and the forward circuit of the aircraft network. AES circuit-mode services shall then forward to the link layer a positive "telephony acknowledge" CM-LIDU via the C channel sub-band, forward an "AMS(R)S call origination" event (FITE 18) to the interworking interface and await completion of the call to the called terminal as per the AES incoming aircraft completion procedure defined in 4.8.6.1.1.2.3.

4.8.6.1.1.2.3 *AES incoming aircraft completion.* Where required elsewhere in 4.8, AES circuit-mode services shall do the following in order to complete a call across the aircraft network to the called terminal:

a) if one or more "call progress — test" CM-LIDUs are received, AES circuit-mode services shall forward to the link layer a positive "telephony acknowledge" CM-LIDU via the C channel sub-band; or

b) if an "answer" event (BITE 22) is not received from the interworking interface within tA42 seconds after forwarding the "AMS(R)S call origination" event (FITE 18), AES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and terminate all activities for the call; or

c) if a "call progress — channel release" CM-LIDU is received within tA42 seconds after forwarding the "AMS(R)S call origination" event (FITE 18), or if the C channel is to be pre-empted for a higher priority call, then AES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and terminate all activities for the call; or

d) if an "answer" event (BITE 22) is received from the interworking interface within tA42 seconds after forwarding the "AMS(R)S call origination" event (FITE 18), AES circuit-mode services shall forward to the link layer a "call progress — connect" CM-LIDU and perform the AES incoming C channel maintenance procedure defined in 4.8.6.1.1.2.4.

4.8.6.1.1.2.4 *AES incoming C channel maintenance.* Where required elsewhere in 4.8, AES circuit-mode services shall allow the end-to-end connection to continue while doing the following to maintain a C channel:

a) if, within tA26 seconds after transmission of the latest "call progress — connect" CM-LIDU, neither a positive "telephony acknowledge" CM-LIDU is received or a "clear back" event (BITE 25) is received from the interworking interface, AES circuit-mode services shall again forward to the link layer the "call progress — connect" CM-LIDU via the C channel sub-band; or

b) if, within tA30 seconds after transmission of the first "call progress — connect" CM-LIDU, neither a positive "telephony acknowledge" CM-LIDU is received or a "clear back" event (BITE 25) is received from the interworking interface, AES circuit-mode services shall stop forwarding the "call progress — connect" CM-LIDU, forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and terminate all activities for the call; or

c) if, within tA30 seconds after transmission of the first "call progress — connect" CM-LIDU, a "call progress — channel release" CM-LIDU is received, AES circuit-mode services shall stop forwarding the "call progress — connect" CM-LIDU, forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and terminate all activities for the call; or

d) if the C channel is to be pre-empted for a higher priority call, AES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, and terminate all activities for the call; or

e) if one or more positive "telephony acknowledge" CM-LIDUs are received, AES circuit-mode services shall stop forwarding the "call progress — connect" CM-LIDU and do the following while allowing the C channel to function:

Note.— This is the location in the logic procedure at which the end-to-end voice channel is ready for use and the air and ground users can begin conversation.

1) if a "clear back" event (BITE 25) is received from the interworking interface, AES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and terminate all activities for the call; or

2) if a "call progress — channel release" CM-LIDU is received, AES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and terminate all activities for the call; or

3) if the C channel is to be pre-empted for a higher priority call, AES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and terminate all activities for the call; or

Note.— The above logic transitions monitor for call clearing via either a normal call clearing action or an AES-initiated C channel pre-emption.

f) if the C channel sub-band link layer commands the call be terminated, AES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface and terminate all activities for the call.

4.8.6.1.2 *GES CIRCUIT-MODE LOGIC*

Note.— The requirements for mapping between interworking telephony events and CM-LIDUs by the GES outgoing and incoming procedures are defined in Appendix 5 to Chapter 4, Figures A5-19 to A5-27 and A5-28 to A5-40, respectively.

4.8.6.1.2.1 *GES outgoing circuit-mode procedure.* This procedure shall be defined by the following interrelated procedures:

a) GES outgoing circuit-mode call initiation — 4.8.6.1.2.1.1;

b) GES outgoing C channel establishment — 4.8.6.1.2.1.2;

c) GES outgoing C channel continuity check — 4.8.6.1.2.1.3;

d) GES outgoing C channel maintenance — 4.8.6.1.2.1.4; and

e) GES outgoing C channel release guard — 4.8.6.1.2.1.5.

4.8.6.1.2.1.1 *GES outgoing circuit-mode call initiation.* Receipt of an "AMS(R)S call origination" event (FITE 18) at the interworking interface shall cause GES circuit-mode services to assign a unique application reference number to the call. If the AES is not logged on, GES circuit-mode services shall forward a "call unsuccessful — send error indication" event (BITE 20) to the interworking interface and terminate all activities for the call; otherwise, GES circuit-mode services shall request GES management to assign C channel resources to the call at the C channel Q number value as per Table 4-43.

Note.— This is to say that the Q number of the C channel shall be inferred from the Q number used in the initial circuit-mode call signalling at the link layer.

GES circuit-mode services shall then do the following:

a) if a "clear forward" event (FITE 22) is received at the interworking interface, GES circuit-mode services shall terminate all activities for the call; or

b) if C channel resources are not available, GES circuit-mode services shall forward a "call unsuccessful — network congestion" event (BITE 12) to the interworking interface and terminate all activities for the call; or

c) if C channel resources are available, GES circuit-mode services shall forward to the link layer a "call announcement" CM-LIDU followed immediately by a "C channel assignment" CM-LIDU. GES circuit-mode services shall then request GES management to activate the previously assigned C channel unit on the assigned frequency and then establish the C channel as per 4.8.6.1.2.1.2.

4.8.6.1.2.1.2 *GES outgoing C channel establishment.* Where required elsewhere in 4.8, GES circuit-mode services shall do the following to establish a C channel for use in a ground-origination:

a) if, within tG16 seconds after the latest transmission of either the "call announcement" or "C channel assignment" CM-LIDUs, a negative "telephony acknowledge" CM-LIDU is received, GES circuit-mode services shall again forward to the link layer the missing CM-LIDU indicated in the received CM-LIDU and await an additional tG16 seconds; or

b) if nothing is received from AES circuit-mode services within tG16 seconds after the latest transmission of either the "call announcement" or "C channel assignment" CM-LIDU, GES circuit-mode services shall again forward to the link layer both of the CM-LIDUs and await an additional tG16 seconds. If, after the additional tG16 second period, nothing is received, GES circuit-mode services shall forward a "call unsuccessful — line out of service" event (BITE 17) to the interworking interface and forward to the link layer a "call progress — channel release" CM-LIDU via the P channel. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier does not terminate within tG23 seconds after the first "call progress — channel release" CM-LIDU was forwarded, GES circuit-mode services shall again forward the CM-LIDU. If the from-aircraft carrier terminates during either tG23 second period, GES circuit-mode services shall terminate all activities for the call. If the from-aircraft carrier does not terminate by the expiry of the second tG23 second period, GES circuit-mode services shall terminate all activities for the call; or

Note. — The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

c) if a "call progress — call attempt result" CM-LIDU is received, GES circuit-mode services shall forward an appropriate "call unsuccessful" event (BITES 12, 16, or 17) to the interworking interface. Also, GES circuit-mode services shall wait tG23 seconds for the C channel from-aircraft carrier to terminate. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the from-aircraft carrier terminates by the end of the period, GES circuit-mode services shall terminate all activities for the call. If the from-aircraft carrier does not terminate within the same period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

d) if a "clear forward" event (FITE 22) is received at the interworking interface, GES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band followed by a "call progress — channel release" CM-LIDU via the P channel. GES circuit-mode services shall then perform the GES outgoing C channel release guard procedure defined in 4.8.6.1.2.1.5; or

e) if a "call progress — test" CM-LIDU is received, GES circuit-mode services shall forward to the link layer a "call progress — test" CM-LIDU and then perform the GES outgoing C channel continuity check procedure defined in 4.8.6.1.2.1.3.

4.8.6.1.2.1.3 *GES outgoing C channel continuity check.* When checking the circuit continuity of a C channel which is to be used for a ground-origination, GES circuit-mode services shall do the following:

a) if tG34 seconds have elapsed from the time that the first "call progress — test" CM-LIDU was sent to AES circuit-mode services, GES circuit-mode services shall forward a "call unsuccessful — line out of service" event (BITE 17) to the interworking interface and forward to the link layer a "call progress — channel release" CM-LIDU via the P channel. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier does not terminate within tG23 seconds after the first transmission of the "call progress — channel release" CM-LIDU, GES circuit-mode services shall again forward the CM-LIDU via the P channel and await an additional tG23 seconds. If the from-aircraft carrier terminates during either period, GES circuit-mode services shall terminate all activities for the call. If the from-aircraft carrier does not terminate by expiry of the second period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

b) if tG34 seconds have not elapsed since the time that the first "call progress — test" CM-LIDU was sent to AES circuit-mode services, GES circuit-mode services shall do the following while simultaneously forwarding to the link layer a "call progress — test" CM-LIDU to AES circuit-mode services every tG35 seconds:

1) if a "call progress — call attempt result" CM-LIDU is received, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs to AES circuit-mode services. GES circuit-mode

services shall then forward an appropriate "call unsuccessful" event (BITE 12, 16 or 17) to the interworking interface and await tG23 seconds for the C channel from-aircraft carrier to terminate. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the from-aircraft carrier terminates by the end of the period, GES circuit-mode services shall terminate all activities for the call. If the from-aircraft carrier does not terminate by the expiry of this period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

2) if a "clear forward" event (FITE 22) is received at the interworking interface, GES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, stop forwarding "call progress — test" CM-LIDUs and then perform the GES outgoing C channel release guard procedure defined in 4.8.6.1.2.1.5; or

3) if a "call progress — channel release" CM-LIDU is received from AES circuit-mode services, GES circuit-mode services shall forward a "clear back" event (BITE 25) to the interworking interface and stop forwarding "call progress — test" CM-LIDUs. GES circuit-mode services shall then wait tG23 seconds for the C channel from-aircraft carrier to terminate. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the from-aircraft carrier terminates during the period, GES circuit-mode services shall terminate all activities for the call. If the from-aircraft carrier does not terminate within this period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

4) if a positive "telephony acknowledge" CM-LIDU is received, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs. GES circuit-mode services shall then forward an "address complete" event (BITE 5) to the interworking interface and perform the GES outgoing C channel maintenance procedure defined in 4.8.6.1.2.1.4; or

5) if a "call progress — connect" CM-CIDU is received, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs. GES circuit-mode services shall then forward an "address complete" event (BITE 5) and an "answer" event (BITE 22) to the interworking interface, forward to the link layer a positive "telephony acknowledge" CM-LIDU via the C channel sub-band, and perform the GES outgoing C channel maintenance procedure defined in 4.8.6.1.2.1.4.

4.8.6.1.2.1.4 *GES outgoing C channel maintenance.* Where required elsewhere in 4.8, GES circuit-mode services shall enable the circuit path between the forward circuit of the terrestrial network and the C channel unit, and then do the following to maintain the C channel:

a) if a "call progress — connect" CM-LIDU is received, GES circuit-mode services shall forward to the link layer a positive "telephony acknowledge" CM-LIDU via the C channel sub-band. If an identical CM-LIDU was not received previously during the GES outgoing C channel establishment procedure defined in 4.8.6.1.2.1.2, GES circuit-mode services shall also forward an "answer" event (BITE 22) to the interworking interface; or

b) if a "clear forward" event is received at the interworking interface, GES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band. GES circuit-mode services shall then perform the GES outgoing C channel release guard procedure defined in 4.8.6.1.2.1.5; or

c) if the C channel from-aircraft carrier drops for more than tG19 seconds, GES circuit-mode services shall forward a "clear back" event (BITE 25) to the interworking interface. GES circuit-mode services shall then forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and perform the GES outgoing C channel release guard procedure defined in 4.8.6.1.2.1.5; or

d) if the C channel is to be pre-empted for a higher priority call, GES circuit-mode services shall forward a "clear back" event (BITE 25) to the interworking interface. GES circuit-mode services shall then forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and perform the GES outgoing C channel release guard procedure defined in 4.8.6.1.2.1.5; or

e) if a "call progress — channel release" CM-LIDU is received, GES circuit-mode services shall forward a "clear back" event (BITE 25) to the interworking interface and terminate all activities for the call.

4.8.6.1.2.1.5 *GES outgoing C channel release guard.* When releasing a C channel which is in use for a ground-origination, GES circuit-mode services shall do the following when required elsewhere in 4.8:

a) if the C channel from-aircraft carrier terminates within tG17 seconds after the last of the six "call progress — channel release" CM-LIDUs has been forwarded, GES circuit-mode services shall terminate all activities for the call; or

b) if the C channel from-aircraft carrier does not terminate within tG17 seconds after the last of the six "call progress — channel release" CM-LIDUs has been forwarded, GES circuit-mode services shall forward to the link layer twelve "call progress — channel release" CM-LIDUs via the C channel sub-band and one "call progress — channel release" CM-LIDU via the P channel. If the from-aircraft carrier is not present, terminate all activities for the call. Otherwise, if the C channel from-aircraft carrier terminates within tG18 seconds after the transmission of the "call progress — channel release" CM-LIDU via the P channel, GES circuit-mode services shall terminate all activities for the call. If the C channel from-aircraft carrier does not terminate within the same tG18 second period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

c) if a "call progress — channel release" CM-LIDU is received, GES circuit-mode services shall await the termination of the C channel from-aircraft carrier. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier terminates within tG18 seconds after receipt of the "call progress — channel release" CM-LIDU, GES circuit-mode services shall terminate all activities for the call. If the C channel from-aircraft carrier does not terminate within this same period, GES circuit-mode services shall terminate all activities for the call at the end of the period.

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

4.8.6.1.2.2 *GES incoming circuit-mode procedure.* This procedure shall be defined by the following interrelated procedures:

a) GES incoming circuit-mode call initiation — 4.8.6.1.2.2.1;

b) GES incoming bi-directional setup — 4.8.6.1.2.2.2;

c) GES incoming C channel establishment — 4.8.6.1.2.2.3;

d) GES incoming terrestrial completion — 4.8.6.1.2.2.4;

e) GES incoming C channel maintenance — 4.8.6.1.2.2.5; and

f) GES incoming C channel release guard — 4.8.6.1.2.2.6.

4.8.6.1.2.2.1 *GES incoming circuit-mode call initiation.* Upon receipt from an AES of an "abbreviated access request — telephone" CM-LIDU with a unique application reference number, GES circuit-mode services shall request GES management to assign C channel resources at the C channel Q number value as per Table 4-43.

Note.— This is to say that the Q number of the C channel shall be inferred from the Q number used in the initial circuit-mode call signalling at the link layer.

GES circuit-mode services shall then do the following:

a) if a "call progress — channel release" CM-LIDU is received prior to GES management assigning C channel resources, GES circuit-mode services shall terminate all activities for the call; or

b) if C channel resources are not available, then GES circuit-mode services shall forward to the link layer a "call progress — call attempt result" CM-LIDU via the P channel. GES circuit-mode services shall then await tG9 seconds for the potential receipt of a repetition of the original "abbreviated access request — telephone" CM-LIDU at the current application reference number. If such an additional CM-LIDU is received from AES circuit-mode services, GES circuit-mode services shall again forward the "call progress — call attempt result" CM-LIDU; otherwise, GES circuit-mode services shall terminate all activities for the call after expiry of the initial tG9 second period.

Otherwise, GES circuit-mode services shall forward to the link layer a "C channel assignment" CM-LIDU. Simultaneously, GES circuit-mode services shall request GES management to activate the previously assigned C channel unit. Any redundant "abbreviated access request — telephone" CM-LIDUs (with an identical application reference number) received prior to C channel unit activation shall be ignored. GES circuit-mode services shall then perform the GES incoming bi-directional setup procedure defined in 4.8.6.1.2.2.2.

Note.— Redundant "abbreviated access request — telephone" CM-LIDUs might be received, prior to C channel unit *activation, as a result of the series transmission of several such CM-LIDUs by the AES. The redundant CM-LIDUs can be ignored without effect.*

4.8.6.1.2.2.2 *GES incoming bi-directional setup.* Where required elsewhere in 4.8, GES circuit-mode services shall perform routing analysis of the network-ID specified in the "abbreviated access request — telephone" CM-LIDU while simultaneously performing the following:

Note 1.— Routing analysis is considered to be a GES-specific procedure wherein the network-ID parameter is used to identify the specific group of voice circuits which interconnect the GES with the desired terrestrial circuit-switched voice network.

Note 2.— The logic in this subsection initiates terrestrial call completion while simultaneously initiating the establishment of the C channel.

a) if an additional "abbreviated access request — telephone" CM-LIDU at the current application reference number is received from AES circuit-mode services within tG11 seconds after the latest "C channel assignment" CM-LIDU has been forwarded to the link layer, GES circuit-mode services shall again forward the "C channel assignment" CM-LIDU to AES circuit-mode services; or

b) if a "call information — service address" CM-LIDU is not received within tG11 seconds after the latest "C channel assignment" CM-LIDU has been forwarded to the link layer, GES circuit-mode services shall perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; or

c) if a "call progress — channel release" CM-LIDU is received, GES circuit-mode services shall await the termination of the C channel from-aircraft carrier. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier terminates within tG24 seconds after receipt of the "call progress — channel release" CM-LIDU, GES circuit-mode services shall terminate all activities for the call. If the carrier does not terminate within the same tG24 second period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

d) if a "call information — service address" CM-LIDU is received within tG11 seconds after C channel unit activation, GES circuit-mode services shall send "call progress — test" CM-LIDUs every tG10 seconds indefinitely; or

e) if routing analysis indicates that completion of the call is blocked due to congestion in either the GES switching equipment or the forward circuit group leading to the terrestrial network, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs and then forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band. GES circuit-mode services shall then perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; or

f) if routing analysis is successful in obtaining a forward circuit to the terrestrial network, GES circuit-mode services shall forward an "AMS(R)S call origination" event (FITE 18) to the interworking interface with the terrestrial network. If a "call information — service address" CM-LIDU has already been received, GES circuit-mode services shall then perform the GES incoming terrestrial completion procedure defined in 4.8.6.1.2.2.4; otherwise GES circuit-mode services shall await establishment of the C channel by performing the GES incoming C channel establishment procedure defined in 4.8.6.1.2.2.3.

4.8.6.1.2.2.3 *GES incoming C channel establishment.* Where required elsewhere in 4.8, GES circuit-mode services shall do the following while awaiting the establishment of the C channel:

Note.— Within this subsection, it is possible that signalling events might be received from the terrestrial network. Therefore, if any telephony interworking events are received at the interworking interface with the terrestrial network, they should be held in queue for interpretation by logic specified in subsequent subsections.

a) if an additional "abbreviated access request — telephone" CM-LIDU at the current application reference number is received from AES circuit-mode services within tG11 seconds after the latest "C channel assignment" CM-LIDU has been forwarded to the link layer, GES circuit-mode services shall again forward the "C channel assignment" CM-LIDU to AES circuit-mode services; or

b) if a "call progress — channel release" CM-LIDU is received within tG11 seconds of C channel unit activation, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs and forward a "clear forward" event (FITE 22) to the interworking interface. (If additional "call progress — channel release" CM-LIDUs are received, GES circuit-mode services shall ignore them.) GES circuit-mode services shall then wait tG24 seconds after receipt of the "call progress — channel release" CM-LIDU for the C channel from-aircraft carrier to terminate. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier terminates within the tG24 second period, GES circuit-mode services shall terminate all activities for the call. If the C channel from-aircraft carrier does not terminate within the same period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of the unterminated from-aircraft carrier should be posted to a monitoring function.

c) if a "call information — service address" CM-LIDU is not received within tG11 seconds after the latest "C channel assignment" CM-LIDU has been forwarded to the link layer, GES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface and perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; or

d) if a "call information — service address" CM-LIDU is received within tG11 seconds after C channel unit activation, GES circuit-mode services shall send "call progress — test" CM-LIDUs every tG10 seconds indefinitely and perform the GES incoming terrestrial completion procedure defined in 4.8.6.1.2.2.4.

4.8.6.1.2.2.4 *GES incoming terrestrial completion.* While GES circuit-mode services is awaiting completion of the call across the terrestrial network it shall enable the circuit path between the C channel unit and the forward circuit of the terrestrial network while simultaneously forwarding to the link layer a "call progress — test" CM-LIDU every tG10 seconds indefinitely. It shall also do the following:

Note.— At this point, circuit continuity is established through the GES between the C channel and the terrestrial network circuit. Call completion across the terrestrial network is still under way and call progress tones from that network may be audible to the on-aircraft party. If the called party answers the call attempt, this will be indicated by receipt from the terrestrial network of an "answer" event (BITE 22) at the interworking interface.

a) if the C channel from-aircraft carrier terminates for more than tG13 seconds, GES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface. After the FITE 22 event has been forwarded, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs. GES circuit-mode services shall then forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band. GES circuit-mode services shall then perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; or

b) if either a "release incoming side" event (BITE 29) or a "call unsuccessful" event (BITE 12, 14, 15, 16, 17 or 20) were received from the interworking interface, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs. GES circuit-mode services shall then forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band. GES circuit-mode services shall then perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; or

c) if a "call progress — channel release" CM-LIDU is received, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs and shall forward a "clear forward" event (FITE 22) to the interworking interface. (If additional "call progress — channel release" CM-LIDUs are received, GES circuit-mode services shall ignore them.) If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier terminates within tG14 seconds, GES circuit-mode services shall terminate all activities for the call. If the C channel from-aircraft carrier does not terminate within the same period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

d) if an "address complete" event (BITE 5) or "sending finished" event (BITE 27) are received at the interworking interface, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs. It shall then forward to the link layer a "call progress — call attempt result" CM-LIDU every tG10 seconds until a positive "telephony acknowledge" CM-LIDU is received. If a positive "telephony acknowledge" CM-LIDU is not received within tG11 seconds of the transmission of the first "call progress — call attempt result" CM-LIDU, GES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, and perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; otherwise, GES circuit-mode services shall perform the GES incoming C channel maintenance procedure defined in 4.8.6.1.2.2.5; or

e) if an "answer" event (BITE 22) is received at the interworking interface, GES circuit-mode services shall stop forwarding "call progress — test" CM-LIDUs. It shall then forward to the link layer a "call progress — connect" CM-LIDU every tG10 seconds until a positive "telephony acknowledge" CM-LIDU is received. If a positive "telephony acknowledge" CM-LIDU is not received within tG11 seconds after the first "call progress — connect" CM-LIDU was forwarded, GES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, and perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; otherwise, GES circuit-mode services shall perform the GES incoming C channel maintenance procedure defined in 4.8.6.1.2.2.5.

4.8.6.1.2.2.5 *GES incoming C channel maintenance.* GES circuit-mode services shall then allow the end-to-end circuit-mode connection to continue until any of the following occur:

a) if an "answer" event (BITE 22) is received at the interworking interface, GES circuit-mode services shall forward to the link layer a "call progress — connect" CM-LIDU every tG10 seconds until a positive "telephony acknowledge" CM-LIDU is received. If a positive "telephony acknowledge" CM-LIDU is not received within tG11 seconds after the first "call progress — connect" CM-LIDU was forwarded, GES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface, forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band, and perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6. Otherwise, GES circuit-mode services shall allow the end-to-end circuit-mode connection to continue; or

b) if a "clear back" event (BITE 25) is received at the interworking interface, GES circuit-mode services shall forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band. GES circuit-mode services shall then perform the GES incoming release guard procedure defined in 4.8.6.1.2.2.6; or

c) if the C channel from-aircraft carrier terminates for more than tG13 seconds, GES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface. GES circuit-mode services shall then forward to the link layer six "call progress — channel release" CM-LIDUs via the C channel sub-band and then perform the GES incoming release guard procedure defined in 4.8.2.1.2.2.6; or

d) if a "call progress — channel release" CM-LIDU is received, GES circuit-mode services shall forward a "clear forward" event (FITE 22) to the interworking interface. (If additional "call progress — channel release" CM-LIDUs are received, GES circuit-mode services shall ignore them.) If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier does not terminate within tG14 seconds after the receipt of the "call progress — channel release" CM-LIDU, GES circuit-mode services shall terminate all activities for the call. If the C channel from-aircraft carrier terminates within the same tG14 second period, GES circuit-mode services shall terminate all activities for the call at the end of the period.

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

4.8.6.1.2.2.6 *GES incoming release guard.* When releasing a C channel which is in use for an air-origination, GES circuit-mode services shall do the following when required elsewhere in 4.8:

a) if the C channel from-aircraft carrier terminates within tG12 seconds after the last of the six "call progress — channel release" CM-LIDUs was forwarded, GES circuit-mode services shall terminate all activities for the call; or

b) if the C channel from-aircraft carrier does not terminate within tG12 seconds after the last of the six "call progress — channel release" CM-LIDUs was forwarded, GES circuit-mode services shall forward to the link layer twelve "call progress — channel release" CM-LIDUs via the C channel sub-band followed by one "call progress — channel release" CM-LIDU via the P channel. If the from-aircraft carrier is not present, terminate all activities for the call. Otherwise, if the C channel from-aircraft carrier terminates within tG14 seconds after the transmission of the "call progress — channel release" CM-LIDU sent via the P channel, GES circuit-mode services shall terminate all activities for the call. If the C channel from-aircraft carrier does not terminate within the same tG14 second period, GES circuit-mode services shall terminate all activities for the call at the end of the period; or

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

c) if a "call progress — channel release" CM-LIDU is received, GES circuit-mode services shall await the termination of the C channel from-aircraft carrier. If the from-aircraft carrier is not present, terminate all activities for the call; otherwise, if the C channel from-aircraft carrier terminates within tG14 seconds after receipt of the "call progress — channel release" CM-LIDU, GES circuit-mode services shall terminate all activities for the call. If the C channel from-aircraft carrier does not terminate within the same tG14 second period, GES circuit-mode services shall terminate all activities for the call at the end of the period.

Note.— The status of an unterminated from-aircraft carrier should be posted to a monitoring function.

4.8.7 ATS-specific terrestrial network standards

Note.— Guidance material on aeronautical speech circuit switching and signalling is contained in ICAO Circular 183 — ATS Speech Circuits — Guidance Material on Switched Network Planning *and in Attachment A to Part I.*

4.8.7.1 *Closed user group.* The AMS(R)S voice service inclusive of interconnecting aircraft and terrestrial networks shall be considered a closed user group to the extent that it is a non-public safety service to be accessible only by ATS and AOC users and used strictly for the conveyance of safety information.

Note.— The definition of a closed user group implies that a private numbering plan is also in effect. A telephony numbering plan for the safety service need not conform to that of the international public switched telephone network (PSTN) as defined in CCITT Recommendation E.163.

4.8.7.2 *Safety terrestrial private networks.* The GES shall interwork in tandem with private ground networks that may be implemented by ATS administrations and aircraft operators. These networks shall provide connectivity between the GES facilities and the relevant ATS or aircraft operator facilities and shall interwork with the GES circuit-mode procedures defined herein.

4.8.7.2.1 The application of aeronautical speech circuit switching and signalling interfaces between the GES and an administration or aircraft operator shall be made on the basis of individual agreements.

4.8.7.2.1.1 **Recommendation.—** *Terrestrial networks should provide:*

a) priority access to the ground party without adversely impacting any existing communications by the ground party;

b) automatic call-back in those instances where a call is blocked by an engaged condition at a ground party;

c) the capability of alternate routing, when necessary and feasible;

d) identification of originator of incoming air-originated calls, when feasible; and

e) call forwarding, when necessary and feasible.

Note.— Call forwarding ensures that calls to operating positions which are temporarily not manned will be rerouted automatically to an appropriate operating position.

4.8.7.2.2 The characteristics of the ringing tone, the busy tone and the congestion tone used by the terrestrial network shall conform to ITU CCITT Recommendation E.180.

Note.— Details of ITU CCITT Recommendation E.180 are contained in CCITT Blue Book, Volume II — Fascicle II-2.

4.8.7.3 *Registration of air-originated attempts to a busy ground party.* All call attempts offered to a terrestrial network or a ground destination shall be afforded the priority and pre-emption services defined in 4.8.3.2.

4.8.7.3.1 **Recommendation.—** *If an air-originated call attempt is blocked due to an engaged condition at the ground party, a record of the call attempt should be maintained by the ground user or terrestrial network for a subsequent ground-originated return call to the original aircraft. A GES should not be required to provide specific functions that allow a blocked call attempt to be held in a GES-managed internal queue for later service.*

4.8.8 Telephony numbering plan

4.8.8.1 *General.* A universal telephony numbering plan for AMS(R)S circuit-mode services shall be established so as to facilitate universal interoperability with terrestrial networks.

4.8.8.2 AIRCRAFT NUMBERING

4.8.8.2.1 *Specific requirements.* A fixed address length of 10 address digits shall be allotted to the aircraft numbering plan. All assigned addresses shall be of the same length.

4.8.8.2.2 *Address analysis.* Numbering of individual aircraft destinations shall consist of the AES ID of the aircraft expressed as eight octal digits to which is appended the two-digit decimal ID of the calling or called terminal on the aircraft numbered from 00 to 99 decimal. The first 10 terminal addresses (00-09) shall be reserved for ATS application.

4.8.8.2.2.1 AES circuit-mode services shall maintain a private, 100 entry terminal ID address space specific to all AMS(R)S safety terminals on an aircraft. Use of this address space, as opposed to the parallel address space for non-safety services, shall be inferred by AES circuit-mode services by the associated priority of the call attempt.

4.8.8.2.2.2 **Recommendation.—** *Subsequent mutual agreement by aircraft manufacturers and ATS administrations should provide for the assignment of aircraft terminal ID "00" as the default destination for all ground-originated safety voice calls to an aircraft. Flight deck audio management systems should associate any incoming call directed to this terminal ID with an appropriate available audio channel on the flight deck (e.g. "SATCOM 1" or "SATCOM 2" on a flight deck audio panel). Terminal IDs "05" to "09" should be reserved for the future application of facsimile devices or other types of digital terminals.*

4.8.8.3 TERRESTRIAL NUMBERING

4.8.8.3.1 *Ground destination address.* All terrestrial addresses shall be 10 digits in length so as to simplify address analysis in the GES and intervening terrestrial networks.

4.8.8.3.1.1 *Address analysis.* Numbering of individual ground destinations shall consist of the following digit sequence:

a) a digit "8";

b) a three digit country code signifying the destination State;

c) a three digit facility code signifying the destination facility within the destination State. The code values to be assigned to individual facilities within a State shall be determined and published by the administration of the destination State; and

d) a three digit agent code signifying the destination agent within the destination facility. The code values to be assigned to individual agents within a facility shall be determined and published by the organizational entity controlling the facility.

Note 1.— A GES is not required to convert any ground address received during an air-originated AMS(R)S call. The terrestrial network may convert any such address, if necessary, to that which is required for that particular network.

Note 2.— GES operators may convert a ground address to that which is required by a particular terrestrial network upon mutual agreement with that network operator.

Note 3.— Country codes are based on the International Telecommunication Union (ITU) country code shown in Table 1 of Appendix 43 of the ITU Radio Regulations. However, only one code per country should be used in the AMS(R)S service for safety and regulatory communications.

4.8.8.3.2 *Network ID.* Network ID "10" shall be used in all air-originated safety calls.

Note.— Additional network IDs may be used for safety communications upon prior arrangement between GES operators and the affected ATS administrations and aircraft operators.

4.9 AIRCRAFT EARTH STATION (AES) MANAGEMENT

4.9.1 General

AES management functions shall include the functions performed in the AES to initiate and carry out a log-on process, to maintain a logged-on status, to initiate and carry out a log-off process, and to manage the data and voice communications with a GES.

4.9.2 AES management interfaces

4.9.2.1 The AES management shall provide for interfaces to the following AES entities:

a) subnetwork layer;

b) link layer;

c) physical layer;

d) circuit-mode services.

4.9.2.1.1 *SUBNETWORK LAYER*

The information exchanged between the AES management and the subnetwork layer shall include the following:

a) to the subnetwork layer:

1) log-on status: logged on initial or renewal/logged off;

2) log-on GES ID (if logged on);

3) AES ID.

4.9.2.1.2 *LINK LAYER*

The information exchanged between the AES management and the link layer shall be in the form of the link interface data units (LIDUs) described in 4.5.2. All LIDUs exchanged across this interface shall be as specified in Table 4-44 except that the information sent to the AES management shall also include interface control information commanding the AES management to randomly select an R channel frequency.

Note.— The link layer assembles SUs in accordance with the information in the received LIDUs. LIDU formats are not prescribed. SU formats are given in Appendix 2 to Chapter 4.

4.9.2.1.3 *PHYSICAL LAYER*

The information exchanged between the AES management and the physical layer shall include the following:

a) to the physical layer:

1) frequencies for the transmit and receive channel units;

2) channel unit mode selection (R, T or C channel);

3) channel rates;

4) transmitter power settings;

5) channel unit number;

b) from the physical layer:

1) P channel loss/degradation indication;

2) P channel synchronization indication;

3) estimated bit error rate on each channel unit receiving a C channel.

4.9.2.1.4 *CIRCUIT-MODE SERVICES*

The information exchanged between the AES management and the circuit-mode services shall include the following:

a) to circuit-mode services:

1) log-on status, (i.e. logged on/logged off);

2) log-on GES ID;

3) channel unit number in response to each request for a channel unit assignment;

b) from circuit-mode services:

1) request for assignment of a transmit channel unit and associated Q number, application reference number, frequency, channel rate and initial EIRP;

2) request for assignment of a receive channel unit and associated Q number, application reference number, frequency and channel rate;

3) command to randomly select an R channel frequency.

4.9.3 AES management functions

4.9.3.1 AES management shall carry out the following functions:

a) AES table management;

b) AES log-status management;

c) AES channel management.

4.9.3.2 AES TABLE MANAGEMENT

4.9.3.2.1 AES management shall maintain the following two tables:

a) system table;

b) log-on confirm table.

4.9.3.2.2 *SYSTEM TABLE*

The content of this table for each beam in a satellite service area shall be as provided by the GES (see 4.10.4.2.2).

4.9.3.2.3 *AES SYSTEM TABLE UPDATE*

For updating the contents of the system tables, the AES management shall use the following procedures:

a) *Prior to log-on.* Once the AES management receives a broadcast sequence on a satellite/beam-identifying P_{smc} channel frequency, it shall determine whether the received sequence is a partial sequence or a complete sequence (see 4.10.4.5.2) and then do the following:

1) if it is a partial sequence, the AES management shall compare the revision number specified in the received partial sequence with the revision number of the corresponding current data segment in the system table. If the received revision number is one higher than the current number, the AES shall update its system table according to the received sequence. If the received revision number differs

from the current number by more than one, the AES management shall wait for the following complete sequence and update its system table accordingly.

2) if the received sequence is a complete sequence, the AES shall update its system table accordingly.

b) *After log-on.* When the AES management receives a partial sequence from the log-on GES, it shall update its system table accordingly.

4.9.3.2.4 *LOG-ON CONFIRM TABLE*

This table shall include the following:

a) satellite ID;

b) beam ID;

c) log-on GES ID;

d) initial EIRP for R channels;

e) P_d channel frequency and channel rate;

f) R_d channel frequencies and channel rate;

g) T channel frequencies and channel rate;

h) number of C channels supportable by the AES simultaneously (including a C channel that utilizes a transmitter that is shared by the C, R and T channels for Level 3 AES).

4.9.3.2.5 *LOG-ON CONFIRM TABLE UPDATE*

The content of the log-on confirm table, except for item h), shall be updated whenever the AES management logs on, renews its log-on or completes a data channel reassignment procedure with the GES (4.9.3.3.4.1 f)).

4.9.3.3 AES LOG-STATUS MANAGEMENT

4.9.3.3.1 Before an AES begins providing user communication services, the AES management shall successfully complete the log-on procedure, given in 4.9.3.3.4, with a selected GES. Prior to initiating the log-on procedure, the AES management shall select a suitable satellite, beam and GES combination as specified in 4.9.3.3.2.

4.9.3.3.2 *SATELLITE, BEAM AND GES SELECTIONS*

The satellite, beam and GES selections shall be made such that the AES is capable of receiving an adequate signal level on a P_{smc} channel of the selected GES. The adequacy of the signal level shall be based on receiving a P channel synchronization indication (4.9.2.1.3 b)) from the physical layer. The information used to make these selections shall be as specified in the most current version of the system table. The currency of the system table shall be determined by comparing the revision number (Appendix 3 to Chapter 4, Item 49) of the system table currently held at the AES with the revision number of the system table broadcast received on the satellite/beam-identifying P_{smc} channel. If necessary, the system table shall be updated in accordance with 4.9.3.2.3.

4.9.3.3.3 *LOG-ON PROCEDURE*

4.9.3.3.3.1 Initiation of a log-on procedure with the selected GES shall be either automatic or in response to a received command. The AES management shall initiate the log-on procedure immediately following the selection of a log-on GES.

4.9.3.3.3.2 To log on to the selected GES, the AES management shall transmit a log-on request LIDU to the GES on an R_{smc} channel frequency randomly selected from the GES R_{smc} channel frequencies given in the system table. The log-on request LIDU shall indicate a distress condition (by setting "Q number of application" = 15 in the log-on request LIDU, Table 4-44), if such a condition is declared at the aircraft. The AES management shall then do the following:

a) If tA11 seconds (Appendix 4 to Chapter 4) elapses without receiving a response from the GES as specified in b) to e) below, the AES management shall command the selection of an R_{smc} channel frequency and then retransmit the log-on request LIDU to the selected GES. The AES management shall command the selection of an R_{smc} channel frequency and then retransmit the log-on request LIDU every tA11 seconds until a response is received, except that the number of transmissions of the log-on request LIDU shall not exceed 5. If, after the fifth transmission, a response is not received within tA11 seconds, the AES management shall abort the log-on procedure to the current selected GES, select a GES according to 4.9.3.3.2 and then shall log-on to the selected GES in accordance with 4.9.3.3.3.

b) If within tA11 seconds the AES management receives a log-on confirm LIDU, and the channel control LIDUs (P/R and T channel control LIDUs) indicated in the log-on confirm LIDU, the AES management shall command the selection of an R_d channel frequency and then shall transmit a log-on acknowledgement LIDU indicating the correct receipt of all expected LIDUs to the GES. If, after tA12 seconds from sending a log-on acknowledgement LIDU, the AES management does not receive a log-on acknowledgement LIDU from the GES on the assigned P_d channel, it shall command the selection of an R_d

channel frequency and then shall retransmit the log-on acknowledgement LIDU. The AES management shall command the selection of an R_d channel frequency and then shall retransmit the same LIDU every tA12 seconds until a log-on acknowledgement LIDU is received from the GES, except that the total number of transmissions of the log-on acknowledgement LIDU shall not exceed four. If, after tA12 seconds from the fourth transmission, a log-on acknowledgement LIDU is not yet received from the GES, the AES management shall abort the log-on procedure to the current selected GES, select a GES according to 4.9.3.3.2 and then shall log-on to the selected GES in accordance with 4.9.3.3.3; otherwise, when a log-on acknowledgement LIDU is received, the AES shall be considered logged on. The AES management shall then relay this information on the various interfaces, where applicable, and update its log-on confirm table.

c) If some, but not all, of the expected LIDUs are received within tA11 seconds, the AES management shall transmit a log-on acknowledgement LIDU to the GES indicating the missing LIDUs. If, after tA11 seconds from the time the AES log-on acknowledgement LIDU was transmitted, the AES management still has r·· received all expected LIDUs, it shall command the selection of an R_{smc} channel frequency and then retransmit another log-on acknowledgement LIDU indicating all missing LIDUs to the same GES. The AES management shall command the selection of an R_{smc} channel frequency and then shall repeat the transmission of a log-on acknowledgement LIDU, indicating all missing LIDUs, every tA11 seconds until all expected LIDUs are received, except that the total number of transmitted log-on request LIDUs (in a) above) and log-on acknowledgement LIDUs shall not exceed five. If, after tA11 seconds from the fifth transmission, all expected LIDUs have not been received, the AES management shall abort the log-on procedure to the current selected GES, select a GES according to 4.9.3.3.2 and then shall log-on to the selected GES in accordance with 4.9.3.3.3. If, and when, within the required time the AES management receives all the expected LIDUs, it shall transmit a log-on acknowledgement LIDU indicating no errors to the GES and shall then proceed as given in b).

d) If a log-on reject LIDU is received, the AES management shall respond according to the rejection reason (Appendix 3 to Chapter 4, item 44) indicated in the LIDU.

e) If a log-off request LIDU is received from the GES, the AES management shall refrain from any attempt to log-on to this GES for the duration of time specified in the LIDU, starting at the time of receipt of the LIDU, except for distress/urgency log-on.

f) If a selective release broadcast LIDU is received from the GES, the AES shall immediately inhibit any transmission on the frequency specified in the LIDU.

4.9.3.3.3.2.1 If during the log-on procedure the AES management receives a P channel loss/degradation indication (defined in Appendix 1 to Chapter 4), it shall abort the log-on procedure to the current selected GES, select a GES according to 4.9.3.3.2 and log on to the selected GES in accordance with 4.9.3.3.3.

4.9.3.3.4 *PROCEDURES AFTER LOG-ON*

4.9.3.3.4.1 The AES shall attempt to log-off before terminating communication with the log-on GES.

Note.— Loss or degradation of the P channel precludes any log-off attempt (4.9.3.3.4.4 refers).

4.9.3.3.4.2 The AES management shall respond to the LIDUs received from its log-on GES as follows:

a) *partial sequence of system table broadcast LIDUs:* the AES management shall update its system table as indicated in 4.9.3.2.3;

b) *log-on prompt LIDU:* the AES management shall initiate the log-on procedure (4.9.3.3.3) with the selected GES being the one specified in the log-on prompt LIDU;

c) *log-on interrogation LIDU:* if the AES management has indicated the capability of responding to a log-on interrogation LIDU (by setting LOV = 0 in the log-on request LIDU, Table 4-44), it shall respond by sending a log-on acknowledgement LIDU to the GES;

d) *selective release broadcast LIDU:* the AES shall immediately inhibit any transmission on the frequency specified in the LIDU.

Note.— A selective release broadcast LIDU may be sent by a GES to its logged-on AESs at any time.

e) *GES channel status report LIDU:* the AES management shall respond by sending an AES channel report LIDU corresponding to the C channel indicated in the received LIDU. Any transmit channel EIRP adjustment indicated in the received LIDU shall be made in accordance with 4.9.3.4.1.3.2.

f) *log control/data channel reassignment LIDU:* the AES management shall respond with a log control/ready for reassignment LIDU, then shall do the following:

1) if within tA11 seconds (Appendix 4 to Chapter 4) the AES management does not receive all of the expected LIDUs (a log-on confirm LIDU and,

either a P/R channel control LIDU or a T channel control LIDU or both), the AES management shall send a log control/reassignment reject LIDU to the GES;

2) if all the expected LIDUs are received, the AES management shall command the selection of an R_d channel frequency and then shall send a log-on acknowledgement LIDU to the GES. If the AES management does not receive a return log-on acknowledgement LIDU from the GES within tA12 (Appendix 4 to Chapter 4) seconds from the time the log-on acknowledgement LIDU was sent to the GES, it shall command the selection of an R_d channel frequency and then shall retransmit the same LIDU. The AES management shall command the selection of an R_d channel frequency and then shall repeat the retransmission of the same LIDU every tA12 seconds until a log-on acknowledgement is received from the GES, except that the number of transmissions of the log-on acknowledgement LIDU shall not exceed four. If, after the fourth transmission, a log-on acknowledgement LIDU is not received from the GES within tA12 seconds, the AES management shall initiate the log-on procedure (4.9.3.3.3) with the current log-on GES if an adequate signal level is received on the log-on GES P_{smc} channel; otherwise, with a different GES selected according to the GES selection procedure (4.9.3.3.2). If a log-on acknowledgement LIDU is received from the GES, the AES management shall update its log-on confirm table.

g) *log-off request LIDU:* the AES management shall consider the AES logged-off and immediately inhibit its transmissions on the R and T channels to the GES. The AES shall refrain from any attempt to log-on to this GES for the duration of time specified in the LIDU starting at the time of receipt of the LIDU, except for distress/urgency log-on.

4.9.3.3.4.2.1 **Recommendation.—** *Upon receipt of a universal time broadcast LIDU from the GES, the AES should make the time information in the LIDU available to the appropriate application processes within the aircraft. The time information in the LIDU should be considered correct at the instant of reception of the first bit of the next P channel superframe (4.4.2).*

4.9.3.3.4.3 The AES management shall respond to received commands as follows:

a) *log-off command:* the AES management shall transmit a log-off request LIDU to the GES, relay the log-off status on the AES management interfaces as specified in 4.9.2, and then do the following:

1) if a log-off acknowledgement LIDU from the GES is not received within tA10 seconds (Appendix 4 to Chapter 4) from the time the log-off request LIDU was transmitted, the AES management shall retransmit another log-off request LIDU. The AES management shall retransmit the same LIDU every tA10 seconds until a log-off acknowledgement LIDU from the GES is received, except that the number of transmissions of the log-off request LIDU shall not exceed five. If, within tA10 seconds from the time of the fifth transmission, a log-off acknowledgement LIDU is not received, the AES management shall consider the AES logged off;

2) when a log-off acknowledgement LIDU is received from the log-on GES, the AES management shall consider the AES logged off;

b) *GES-to-GES handover command:* the AES management shall log on to the specified GES within the same satellite service area as the current log-on GES using the procedure in 4.9.3.3.3. However, for a Level-3 AES, if the AES transmit channel unit is being used for a circuit-mode call, the AES management shall initiate the log-on procedure after the circuit-mode call is terminated;

c) *satellite-to-satellite handover command:* the AES management shall first maintain all previously established circuit-mode calls for three minutes or until all calls are cleared, whichever comes first. After three minutes, the AES management shall clear any remaining circuit-mode calls. After all calls are cleared, the AES management shall select a suitable beam in the service area of the specified satellite. If a suitable beam cannot be found, the AES management shall select a different satellite and a beam within its service area according to 4.9.3.3.2. The AES management shall then select, according to 4.9.3.3.2, a GES that supports the selected beam and shall automatically log on to the selected GES using the procedure in 4.9.3.3.3.

4.9.3.3.4.4 The AES management shall respond to the indications relayed to it via the AES physical layer interface as follows:

P_d channel loss/degradation indication: the AES management shall either attempt to (1) reacquire an adequate signal level on the same P_d channel and resume normal operation, or (2) renew its log-on to the same GES by re-initiating the log-on procedure to the same GES, or (3) re-initiate the satellite, beam and GES selection and the log-on process as specified in 4.9.3.3.2 and 4.9.3.3.3 respectively. All R and T channel transmissions shall be inhibited if there is a loss or degradation of the P_d channel. C channel transmissions for an existing circuit-mode call shall be allowed to continue

provided the bit error rate of received C channel transmissions does not exceed its nominal value for any subsequent period of more than 40 seconds.

4.9.3.4 AES CHANNEL MANAGEMENT

4.9.3.4.1 *CHANNEL UNIT CONTROL*

4.9.3.4.1.1 The AES management shall control all of the AES transmit and receive channel units via the interface with the AES physical layer.

4.9.3.4.1.2 *Channel unit frequency and channel rate control.* The AES management shall control the frequencies and channel rate settings of all the AES receive and transmit channel units. The frequencies and the channel rates for the P_{smc} and R_{smc} channels shall be as provided in the system table. The frequencies and channel rates for the P_d, R_d and T channels shall be as instructed by the GES in the log-on confirm LIDU and the P/R channel control and the T channel control LIDUs. When the AES management receives from the circuit-mode services a request for assignment of transmit and receive channel units with certain settings of frequencies and channel rates, it shall accomplish these assignments and settings by communication with the physical layer and shall relay these assignments and settings back to the circuit-mode services. However, the AES management shall ensure that no assigned frequencies are used for transmission that could generate intermodulation products that produce harmful interference to on-aircraft satellite navigation receiver operation and shall pre-empt a lower priority call if necessary.

4.9.3.4.1.2.1 The AES management shall carry out the randomized selection of R channel frequencies in response to commands generated by protocols in the link layer, circuit-mode services and the AES management itself. Every selection shall persist until another such random selection is made.

4.9.3.4.1.3 *Channel unit power control.* The AES management shall control the EIRP settings of each of the AES transmit channels via the AES management-physical layer interface.

4.9.3.4.1.3.1 The AES management shall use the EIRP setting in 4.2.3.5.5 for transmission of the log-on request LIDU on the R_{smc} channel. Thereafter, the AES management shall set the EIRP on the R_d channel to the initial EIRP setting value communicated to it by the GES via the log-on confirm LIDU. The T channel initial EIRP setting shall be computed according to the ratio of R_d channel and T channel channel rates and the assigned R_d channel initial EIRP.

Note.— The log-on GES is responsible for determining the amount of the adjustments of the values of the EIRP settings for the R_d and T channels.

4.9.3.4.1.3.2 For a C channel, the AES management shall relay from the circuit-mode services to the physical layer the initial EIRP setting of the transmit channel unit. Subsequent adjustments to the EIRP setting shall be made according to the EIRP adjustment values received from the GES in the GES channel status report LIDUs.

Note.— All decisions about the power control and the adjustments required for a C channel are made at the GES through which the call is established and relayed to the AES circuit-mode services on the C channel sub-band.

4.9.3.4.1.4 *Level-3 AES channel unit switching.* In the case of a level-3 AES, the single transmit channel unit shall be shared between the R/T channel mode and the C channel mode of transmission.

4.9.3.4.1.4.1 The transmit channel unit shall be switched to the R/T channel mode whenever not doing so would inhibit the transmission of:

a) any packet-mode data SU with precedence higher than the precedence of the circuit-mode call-in-progress; or

b) any link layer signalling SU associated with packet-mode data SUs of a precedence higher than the precedence of the circuit-mode call-in-progress; or

c) any call setup signalling SU associated with a circuit-mode call of a precedence higher than the precedence of the circuit-mode call-in-progress.

4.9.3.4.1.4.2 The transmit channel unit shall be switched to the C channel mode whenever not doing so would inhibit the establishment or the continuation of a circuit-mode call having a precedence higher than the precedences of all packet-mode data SUs in the link layer and the precedences of the packet-mode data SUs associated with all signalling SUs in the link layer.

4.10 GROUND EARTH STATION (GES) MANAGEMENT

4.10.1 General

Note.— This section defines the management functions required at the GES to initiate and execute the log-on process and to manage the data and voice communications between the AES and the GES.

4.10.1.1 The GES shall perform the set of functions described in this section in order to establish and maintain communications channels with its logged-on AESs and shall share the information about the status of each of its logged-on AESs with all the other GESs supporting AMS(R)S services through the same satellite.

4.10.2 GES management architecture

4.10.2.1 GROUND-TO-AIR

Anywhere within a satellite service area, an AES shall have at least one unique P_{smc} channel available at 600 bits/s for identification of the satellite and the beam supporting the P_{smc} channel.

4.10.2.2 GROUND-TO-GROUND

There shall be communication between the GESs in the same satellite service area to exchange information as required for carrying out the GES management functions specified in 4.10.4.

4.10.3 GES management interfaces

4.10.3.1 The GES management shall interface with the subnetwork layer, circuit-mode services, link layer and physical layer in order to exchange control information required for GES table management, log status management and channel management.

4.10.3.2 SUBNETWORK LAYER

The following control information shall be exchanged between the GES management and the subnetwork layer in the GES:

a) to subnetwork layer:

1) log status information:

i) logged-on/logged-off;

ii) AES ID;

iii) GES ID;

2) minimum channel rate of T channel;

3) channel rate of P_d and R_d channels.

4.10.3.3 CIRCUIT-MODE SERVICES

The following control information shall be exchanged between the GES management and the circuit-mode services in the GES:

a) to circuit-mode services:

1) log status information:

i) logged-on/logged-off;

ii) AES ID;

iii) GES ID;

2) EIRP value;

3) frequency assigned (Q number, application reference number);

4) voice channel characteristics;

5) channel unit assigned (Q, number, application reference number);

6) channel unit pre-empted (Q number, application reference number);

b) from circuit-mode services:

1) voice channel characteristics;

2) request for frequency (Q number, application reference number);

3) request for channel unit (Q number, application reference number).

4.10.3.4 LINK LAYER

4.10.3.4.1 The control information exchanged between the GES management and the link layer in the GES shall be as in Table 4-45.

4.10.3.4.2 The information shall be exchanged in the form of link interface data units (LIDUs). The LIDU shall contain link interface control information (LICI) only.

Note.— Each LIDU received from the GES management is mapped into a corresponding SU set in the link layer according to 4.5.3.2.3.

4.10.3.5 PHYSICAL LAYER

The following control information shall be exchanged between the GES management and the physical layer in the GES:

a) to physical layer (for each channel):

1) frequency;

2) channel rate setting (if selectable);

3) power setting;

4) mode (T, or R, or C, if selectable);

5) channel unit number;

b) from physical layer (for each channel):

1) estimated C channel bit error rate;

2) channel unit number;

3) mode.

4.10.4 GES management functions

4.10.4.1 The GES management shall carry out the following functions:

a) GES table management;

b) GES log status management;

c) GES channel management;

d) GES system broadcast.

4.10.4.2 GES TABLE MANAGEMENT

4.10.4.2.1 The GES management shall maintain the following tables:

a) AES system table;

b) AES log-on status table.

4.10.4.2.2 *AES SYSTEM TABLE*

4.10.4.2.2.1 The AES system table for a satellite service area shall include initial search data (search frequencies for satellite and beam identification) and regional data (information about each GES in the satellite service area).

4.10.4.2.2.2 Each GES in a satellite service area shall maintain both the initial search data and regional data content of the AES system table for that satellite service area in addition to maintaining the initial search data for all the other satellite service areas.

4.10.4.2.2.3 The initial search data for a satellite service area shall include the following satellite/beam identifying information for each beam that supports a satellite/beam-identifying P_{smc} channel in the satellite service area:

a) primary satellite/beam-identifying P_{smc} channel frequency at 600 bits/s;

b) secondary satellite/beam-identifying P_{smc} channel frequency at 600 bits/s;

c) satellite ID;

d) satellite location, orbit inclination and right ascension epoch;

e) beam ID (for spot-beam-only satellites).

4.10.4.2.2.4 The regional data for a satellite service area shall include the following information:

a) system table revision number;

b) satellite ID;

c) for a satellite with a global beam, for each GES supporting the global beam:

1) GES ID;

2) P_{smc} channel and R_{smc} channel frequencies; and

3) P_{smc} channel and R_{smc} channel rates;

d) for a satellite with spot beams only:

1) beam ID (same as in e) of initial search);

2) GES spot beam support table indicating in which spot beam the GES radiates; and

3) for each GES supporting a spot beam:

i) GES ID;

ii) P_{smc} channel and R_{smc} channel frequencies; and

iii) P_{smc} channel and R_{smc} channel rates.

4.10.4.2.3 *AES LOG-ON STATUS TABLE*

4.10.4.2.3.1 Each GES shall maintain an AES log-on status table, which shall include the information specified in 4.10.4.2.3.2 and 4.10.4.2.3.3.

4.10.4.2.3.2 The GES shall include in its AES log-on status table, for every AES logged-on to it or to any other GES in the same satellite service area, the following information:

a) AES ID;

b) satellite ID;

c) beam ID;

d) log-on GES ID.

4.10.4.2.3.3 For each AES logged-on to the GES, the AES log-on status table at the GES shall contain the following information in addition to the information specified in 4.10.4.2.3.2:

a) P channel frequency assigned to the AES;

b) R channel frequencies assigned to the AES;

c) T channel frequencies assigned to the AES;

d) channel rate capabilities of P, R, T and C channels;

e) AES activity indicator (active or inactive).

4.10.4.2.3.4 *AES log-on status table update*

The GES shall update the AES log-on status table when an AES logs on (initial or renewal) or logs off from this GES or when the GES receives log-on or log-off information corresponding to an AES from another GES.

4.10.4.3 GES LOG STATUS MANAGEMENT

4.10.4.3.1 The GES log status management function shall manage the AES log-on/log-off, verify the activity of each of its log-on AESs, renew the log-on (when required), and reassign data channels to the AESs (when required).

4.10.4.3.2 *LOG-ON*

Note.— The AES initiates a log-on by sending a log-on request LIDU to the GES (4.9.3.3.3) after the AES has selected a satellite, a beam and a GES.

4.10.4.3.2.1 To reject the log-on request of an AES, the GES management shall reply to the log-on request LIDU by sending a log-on reject LIDU to the AES indicating the reason for rejection. The GES shall always accept the log-on request of an AES indicating that the AES is in distress.

Note.— Several rejection reasons have been identified for an AES log-on request. Refer to Appendix 3 to Chapter 4, Item 44 "Reason" for the listing of the identified rejection reasons and their corresponding codes. The "Reason" is a field of the log-on reject LIDU.

Note.— The "Q number of the application" parameter in the log-on request LIDU will indicate whether the aircraft is in distress or not. The "Q number of application" parameter will be set to 15 for an aircraft in distress.

4.10.4.3.2.2 To accept the log-on request of an AES, the GES management shall reply to the log-on request LIDU by sending a log-on confirm LIDU followed by a P/R channel control LIDU and a T channel control LIDU to the AES, as required to assign new P_d, R_d and T channels to the AES.

4.10.4.3.2.3 After transmitting the log-on confirm LIDU followed by the channel control LIDUs (P/R and T channel control LIDUs) as indicated in the log-on confirm LIDU to the AES or after transmitting the missing LIDUs identified in the log-on acknowledgement LIDU received from the AES, the GES management shall do the following:

a) If no response is received from the AES within tG26 seconds (Appendix 4 to Chapter 4) from the time the log-on confirm LIDU followed by channel control LIDUs were sent or the missing LIDUs indicated in the log-on acknowledgement LIDU received from the AES were retransmitted, the GES management shall send another log-on confirm LIDU followed by the required channel control LIDUs to the AES. The GES management shall send the log-on confirm LIDU followed by channel control LIDUs to the AES every tG26 seconds until a response is received or the number of times the log-on confirm LIDU followed by channel control LIDUs have been sent equals four. If no response is received within tG26 seconds from the time the fourth log-on confirm LIDU followed by the channel control LIDUs were sent, the GES management shall delete the requesting AES from its AES log-on status table and then transmit log-off information to other GESs in the same satellite service area if the AES is identified as logged on to this GES in the AES log-on status table.

b) If a log-on acknowledgement LIDU indicating no error is received from the AES, the GES management shall send a log-on acknowledgement LIDU to the AES on the newly assigned P_d channel. Thereafter, the GES management shall, each time another log-on acknowledgement LIDU is received from the AES within tG27 seconds (Appendix 4 to Chapter 4) from the time the last log-on acknowledgement LIDU was sent to the AES, send another log-on acknowledgement LIDU to the AES. The GES management shall repeat the above procedure until one of the following occurs:

1) no log-on acknowledgement LIDU is received from the AES within tG27 seconds from the time the last log-on acknowledgement LIDU was sent to the AES; or

2) an R channel SU that is not a log-on request LIDU or a log-on acknowledgement LIDU is received from the AES, after which, the GES management shall update its AES log-on status table as specified in 4.10.4.2.3, and send log-on information to the other GESs in the same satellite service area.

c) If a log-on acknowledgement LIDU identifying the missing LIDUs is received from the AES, the GES management shall retransmit the missing LIDUs to the AES and shall proceed as in 4.10.4.3.2.3.

4.10.4.3.2.4 If another log-on request LIDU is received from the AES before the GES management has finished responding to the previously received log-on request LIDU, the GES management shall discard the last received log-on request LIDU.

4.10.4.3.3 *LOG-OFF*

Note.— An AES log-off may be initiated by the AES by sending a log-off request LIDU to the GES or by the GES by sending a log-off request LIDU to the AES. The GES initiated log-off is intended to provide the GES with the capability to shut down undesired AES transmissions.

4.10.4.3.3.1 Upon receipt of a log-off request LIDU from an AES, the GES management shall do the following:

a) if the AES is identified as logged on to this GES in the AES log-on status table, delete the AES from its AES log-on status table, transmit log-off information to other GESs in the same satellite service area and then transmit log-off acknowledgement LIDU to the AES; or

b) if the AES is not identified as logged-on to this GES in the AES log-on status table but is in the process of logging on, transmit log-off acknowledgement LIDU to the AES.

4.10.4.3.3.2 After sending a log-off request LIDU to an AES, the GES management shall not be required to respond to any transmission from the identified AES for the duration of the time specified in the LIDU, except, as specified in 4.10.4.3.2.1, to a log-on request LIDU indicating that the AES is in distress.

4.10.4.3.4 *LOG-ON VERIFICATION*

Note.— The AES log-on status table in the GES management contains an activity indicator for each AES logged on to the GES. The activity indicator for the AES is set to "active" whenever any data/signalling is received from the AES. The activity indicator is set to "inactive" if no data or signalling is received from the AES within tG6 seconds (Appendix 4 to Chapter 4) from the time the activity indicator was last set to "active".

4.10.4.3.4.1 The GES management shall verify the AES activity status by either of the following two methods:

a) direct verification; or

b) indirect verification.

Note.— The log-on verification of the AES is the responsibility of its log-on GES only.

4.10.4.3.4.2 *Direct verification*

If no data/signalling is received at the log-on GES or at another GES in the same satellite service area as the log-on GES from an AES capable of responding to log-on interrogation LIDU within tG6 seconds (Appendix 4 to Chapter 4) from the time the activity indicator for the AES was last set to inactive, the GES management shall send a log-on interrogation LIDU to the AES. The GES management shall then do the following:

a) If no log-on acknowledgement LIDU is received from the AES within tG8 seconds (Appendix 4 to Chapter 4) from the time the log-on interrogation LIDU was sent, the GES management shall send another log-on interrogation LIDU to the AES. The GES management shall retransmit the log-on interrogation LIDU to the AES every tG8 seconds until a log-on acknowledgement LIDU is received or the total number of times the log-on interrogation LIDU has been sent equals five. When tG8 seconds has elapsed after the transmission of the fifth log-on interrogation LIDU without receiving a log-on acknowledgement LIDU from the AES, the GES management shall delete the AES from its AES log-on status table and shall send log-off information to the other GESs in the same satellite service area.

b) If a log-on acknowledgement LIDU is received from the AES, the GES management shall set the activity indicator for the AES in the AES log-on status table to "active".

4.10.4.3.4.3 *Indirect verification*

The AES shall remain inactive for twelve hours before the GES management considers it logged off.

4.10.4.3.5 *LOG-ON PROMPT*

Upon receipt of an R channel SU (ISU or a C channel access request SU) by the GES link layer from an AES which is not in its AES log-on status table, the GES management shall send a log-on prompt LIDU to the AES.

4.10.4.3.6 *CHANNEL REASSIGNMENT*

4.10.4.3.6.1 The GES management shall have the capability to reassign the data channels to a logged-on AES.

4.10.4.3.6.2 Upon receipt of a data channel reassignment request, the GES management shall forward a log control/data channel reassignment LIDU to the AES. The GES management shall then do the following:

a) If no response is received from the AES within tG31 seconds (Appendix 4 to Chapter 4) from the time the log control/data channel reassignment LIDU was sent to the AES, the GES management shall send another log control/data channel reassignment LIDU to the AES. If no response is received again within the tG31 seconds, the GES management shall abort the data channel reassignment procedure.

b) If data channel reassignment reject LIDU is received from the AES, the GES management shall abort the data channel reassignment procedure.

c) If a log control/ready for assignment LIDU is received from the AES, the GES management shall transmit a log-on confirm LIDU followed by a P/R channel control LIDU and a T channel control LIDU, as required, containing the reassigned channel information to the AES. The GES management shall then do the following:

1) If no response is received from the AES within tG32 seconds (Appendix 4 to Chapter 4) from the time the log-on confirm LIDU followed by the channel control LIDUs were sent, the GES management shall send another log-on confirm LIDU on the previous P_d channel followed by a P/R channel control and T channel control LIDUs as appropriate. If no response is received again within tG32 seconds, the GES management shall abort the data channel reassignment procedure.

2) If a log-on acknowledgement LIDU indicating no error is received from the AES on the newly assigned R_d channel, the GES management shall send a log-on acknowledgement LIDU to the AES on the newly assigned P_d channel. The GES management shall, if another log-on acknowledgement LIDU is received within tG33 seconds (Appendix 4 to Chapter 4) from the time the last log-on acknowledgement LIDU was sent, send another log-on acknowledgement LIDU to the AES on the new P_d channel. The GES management shall repeat the above procedure until no response has been received from the AES within tG33 seconds from the time the last log-on acknowledgement was sent by the GES, after which the GES management shall update the AES log-on status table with the new channel frequencies assigned to the AES.

3) If a data channel reassignment reject LIDU is received from the AES, the GES management shall abort the data channel reassignment procedure.

4.10.4.4 GES CHANNEL MANAGEMENT

4.10.4.4.1 The GES channel management shall control the AES/GES channel configuration, channel power and channel frequency.

4.10.4.4.2 *CHANNEL CONFIGURATION MANAGEMENT*

4.10.4.4.2.1 *GES channel configuration for management communication*

For each beam supported by a satellite, each GES supporting the beam shall provide:

a) at least one transmit P_{smc} channel, and

b) at least four receive R_{smc} channels

for management communications.

4.10.4.4.2.2 *AES channel configuration assignment and adjustment*

4.10.4.4.2.2.1 During log-on, the GES management shall assign a P_d channel to an AES in a manner which ensures that the performance requirements in 4.7 and 4.8 are met.

4.10.4.4.2.2.2 During log-on, the GES management shall assign a group of R channels and one or more T channels to an AES, in a manner which ensures that the performance requirements in 4.7 and 4.8 are met.

4.10.4.4.2.2.3 For the C channel(s), the GES management shall assign C channel(s) on a per-call basis.

4.10.4.4.2.2.4 After log-on, the GES management shall adjust an AES channel configuration, if required, by initiating channel reassignment as described in 4.10.4.3.6.

4.10.4.4.3 *CHANNEL POWER MANAGEMENT*

4.10.4.4.3.1 *AES power setting*

Note.— Prior to log-on, the AES will use its default power setting to transmit the log-on request LIDU to the GES management.

4.10.4.4.3.1.1 For the R and T channels, during the log-on process the GES management shall assign an initial power setting to the AES as the "initial EIRP" value in the log-on confirm LIDU sent to the AES. The initial EIRP value shall be determined so that the estimated bit error rate at the GES shall not exceed 10^{-5}.

Note.— The AES will adjust its channel unit power levels according to the EIRP value received in the log-on confirm LIDU.

4.10.4.4.3.1.2 For the C channel, the initial EIRP value shall be assigned by the GES management on a per-call basis and shall be sent to the AES via the circuit-mode services in the C channel assignment LIDU.

4.10.4.4.3.2 *C channel power adjustment*

4.10.4.4.3.2.1 For the to-aircraft C channel, the GES management shall adjust the GES EIRP according to the BER value received from the AES management in the channel status report LIDU. The adjustment EIRP shall be required to maintain a BER of no more than 10^{-3}.

4.10.4.4.3.2.2 For the from-aircraft C channel, the GES management shall determine the AES EIRP adjustment required to maintain a BER of no more than 10^{-3} based on the BER value measured at the GES. The adjustment shall be sent to the AES management in the channel status report LIDU.

4.10.4.4.4 *CHANNEL FREQUENCY MANAGEMENT*

4.10.4.4.4.1 *AES frequency setting*

Note.— Prior to log-on, the AES will use the R_{smc} channel frequency from the system table to send the log-on request LIDU to the GES management.

4.10.4.4.4.1.1 For the P, R and T channels, the GES management shall assign the initial P, R and T channel frequencies to the AES (if the P_d/R_d frequency is different from the P_{smc}/R_{smc} frequencies) by sending P/R channel control LIDU and T channel control LIDU to the AES after the log-on confirm LIDU in response to the received log-on request LIDU.

4.10.4.4.4.1.2 For a C channel, the GES management shall assign the AES C channel transmit/receive frequency by passing the assigned frequencies to the AES in the C channel assignment LIDU transmitted by the circuit-mode services in the GES.

4.10.4.4.4.2 *AES channel frequency reassignment*

4.10.4.4.4.2.1 For the P and R channels, the GES management shall adjust the P/R channel frequencies previously assigned to the AES by initiating channel reassignment procedure as described in 4.10.4.3.6 and sending the newly assigned frequencies in the P/R channel control LIDUs following the log-on confirm LIDU.

4.10.4.4.4.2.2 For the T channel, the GES management shall adjust the T channel frequencies by initiating channel reassignment procedure and transmitting the T channel control LIDU, following the log-on confirm LIDU, to the AES.

4.10.4.4.5 *CHANNEL INTERFERENCE MANAGEMENT*

The GES management shall maintain one or more reserve frequencies for each GES in each beam it supports to be used as P_{smc} channel and as R_{smc} channel frequencies, in the event of interference to the previously assigned P_{smc} channel and R_{smc} channel frequencies. In the event that changeover is required, the GES management shall update the system table accordingly.

4.10.4.4.6 *PRE-EMPTION MANAGEMENT*

4.10.4.4.6.1 *Voice versus voice pre-emption*

After the circuit-mode services in the GES transmits a C channel assignment LIDU to the AES, the GES management shall immediately make available a channel unit serving the lowest precedence call for the new call, when no channel units are available, and indicate the availability of the channel unit to the circuit-mode services in the GES.

4.10.4.4.6.2 *Data versus voice pre-emption*

The GES shall have the capability to reassign spectrum and power resources from circuit-mode services to packet-mode services in order to meet packet data service requirements.

4.10.4.5 GES SYSTEM BROADCAST

4.10.4.5.1 The GES management shall transmit the system table and time data to the AES in order to maintain the currency of the data and time in the AES.

4.10.4.5.2 *SYSTEM TABLE BROADCAST*

4.10.4.5.2.1 The GES management shall transmit the system table data to the AES by means of one or more of the following broadcast LIDUs:

a) broadcast index;

b) GES P/R channel advice;

c) satellite identification and beam identification channel advice:

d) GES beam support advice.

4.10.4.5.2.2 The system table data shall be transmitted in the following two forms:

a) partial sequence containing the most recent updates; and

b) complete sequence containing the full initial search and regional data update.

4.10.4.5.2.3 A partial sequence shall comprise one or more broadcast LIDUs described in 4.10.4.5.2.1.

4.10.4.5.2.4 The complete sequence shall include all the broadcast LIDUs in 4.10.4.5.2.1. There shall be a complete sequence for each beam in the satellite service area supporting a satellite/beam-identifying P_{smc} channel.

4.10.4.5.2.5 The partial and complete sequence shall each include one broadcast index LIDU.

Note 1.— The broadcast index LIDU provides an existence flag for each LIDU in the complete sequence.

Note 2.— The GES P_{smc} and R_{smc} channel series of the complete sequence can contain up to 64 LIDUs because of the size of the "initial sequence number" field in the broadcast index LIDU. In case more LIDUs are included in the series, the second series of the GES P_{smc} and R_{smc} channel series is used.

4.10.4.5.2.6 The GES shall transmit the partial sequence on all the P channels it supports. In addition, the GES shall transmit the complete sequence on each satellite/beam-identifying P_{smc} channel it supports. Each GES in a satellite service area shall transmit to each of its logged-on AESs all partial sequences due to any update made by any GES in the satellite service area.

4.10.4.5.2.7 The partial sequence shall be transmitted twice as often as the complete sequence.

4.10.4.5.3 *SELECTIVE RELEASE BROADCAST*

Note.— The selective release broadcast LIDU is used to command all logged-on AESs to cease transmission on specified L-band frequency(ies).

4.10.4.5.3.1 The GES management shall send one or more selective release broadcast LIDUs to the AES upon occurrence of either of the following events:

a) request to release certain channels;

b) for circuit-mode calls, if the in-band channel clearing facilities (such as the channel release signalling facility on the sub-band C channel) are ineffective.

4.10.4.5.4 **Recommendation.—** *The GES management should broadcast the system time to the AES following an AES log-on by transmitting the system time broadcast LIDU on all P channels. The time in the system time broadcast LIDU should be the predicted time of reception at an AES of the first bit of the next superframe of the relevant P channel.*

4.10.5 Satellite system management

At least one satellite/beam-identifying P_{smc} channel shall be active at all times for each beam that supports a satellite/beam-identifying P_{smc} channel.

TABLES FOR CHAPTER 4

Table 4-1. Received phase noise mask

Offset from carrier (Hz)	Phase noise (dBc)
10	−34
100	−65
1 000	−73
3 000	−77
10 000	−79
35 000	−79

1. Phase noise is measured single sideband relative to carrier.
2. The mask shall be defined by drawing straight lines through the above points on a graph which is logarithmic in frequency.

Note.— This mask is illustrated in the guidance material contained in Attachment A to Part I of Annex 10, Volume III.

Table 4-2. P channel acquisition carrier-to-noise levels

Channel rates (bits/s)	C/No (dB-Hz)	Nominal channel spacing (kHz)
600	31.9	5
1 200	35.0	5
2 400	38.0	5
4 800	39.5	5
10 500	42.9	10
10 500	43.3	7.5

Table 4-3. Maximum out-of-band EIRP density levels

Frequency (MHz)	EIRP density
0.01 to 1 525	−135 dBc/4 kHz
1 525 to 1 559	−203 dBc/4 kHz
1 559 to 1 565	−135 dBc/4 kHz
1 565 to 1 585	−155 dBc/1 MHz
1 585 to 1 598	−105 dBc/4 kHz
1 598 to 1 605	−105 dBc/1 MHz
1 605 to 1 610	−85 dBc/1 MHz
1 610 to 1 626.5	−55 dBc/4 kHz
1 660.5 to 1 735	−55 dBc/4 kHz
1 735 to 12 000	−105 dBc/4 kHz
12 000 to 18 000	−70 dBc/4 kHz

Table 4-4. Transmitted phase noise mask

Offset from carrier (Hz)	Phase noise (dBc)
10	−40
100	−67
500	−72
1 100	−80
X	−80

1. Phase noise is measured single sideband relative to carrier.
2. The mask shall be defined by drawing straight lines through the above points on a graph which is logarithmic in frequency.
3. X is equal to 35 kHz or four times the symbol rate, whichever is less.
4. Where discrete spectral components exist, the sum of the discrete phase noise components and continuous spectral component averaged over a bandwidth of ±10 Hz on either side of the discrete component shall not exceed the phase noise mask.

Note.— This mask is illustrated in the guidance material contained in Attachment A to Part I of Annex 10, Volume III.

Table 4-5. Required spectrum limits for AES transmissions

Frequency offset	Attenuation (dB) (relative to maximum envelope level)
±0.75 SR	0
±1.40 SR	20
±2.80 SR	40
35 kHz	40

1. The mask shall be defined by drawing straight lines through the above points.
2. The symbol rate, SR, is equal to the channel rate for A-BPSK, and is half the channel rate for A-QPSK.

Table 4-6. Required spectral limits for A-BPSK received by AES

Upper bound		Lower bound	
Normalized frequency	Amplitude response (dB)	Normalized frequency	Amplitude response (dB)
–X	–40	—	—
–0.75	–40	—	—
–0.66	–12	—	—
–0.56	–3.5	—	—
–0.4	0.25	–0.1	–3
0.4	0.25	0.1	–3
0.56	–3.5	—	—
0.66	–12	—	—
0.75	–40	—	—
X	–40	—	—

1. The mask shall be defined by drawing straight lines through the above points where frequencies are normalized to the channel rate, and the amplitude is normalized to 0 dB at a frequency of 0.
2. X is equal to 35 kHz. For larger frequency offsets the spurious requirements of 4.2.3.5.6 apply.

Note.— This mask is illustrated in the guidance material contained in Attachment A to Part I of Annex 10, Volume III.

Table 4-7. Required spectral limits for A-QPSK received by AES

Upper bound		Lower bound	
Normalized frequency	Amplitude response (dB)	Normalized frequency	Amplitude response (dB)
–X	–40	—	—
–0.625	–40	—	—
–0.5	–20	—	—
–0.425	–10	—	—
–0.375	–6	—	—
–0.275	–3	—	—
–0.175	–1	—	—
–0.075	0.25	–0.05	-3
0.075	0.25	0.05	-3
0.175	–1	—	—
0.275	–3	—	—
0.375	–6	—	—
0.425	–10	—	—
0.5	–20	—	—
0.625	–40	—	—
X	–40	—	—

1. The mask shall be defined by drawing straight lines through the above points where frequencies are normalized to the channel rate, and the amplitude is normalized to 0 dB at a frequency of 0.
2. X is 35 kHz. For larger frequency offsets the spurious requirements of 4.2.3.5.6 apply.

Note.— This mask is illustrated in the guidance material contained in Attachment A to Part I of Annex 10, Volume III.

Table 4-8. Demodulator performance

Channel type		Required BER	E_s/N_0[1] (dB)
P:	0.6, 1.2 and 2.4 kbits/s	10^{-5}	7.3
R,T:	0.6, 1.2 and 2.4 kbits/s	10^{-5}	7.5
P:	4.8 and 10.5 kbits/s	10^{-5}	5.4
R,T:	10.5 kbits/s	10^{-5}	5.7
C:	5.25 kbits/s	10^{-3}	10.8
C:	6.0 kbits/s	10^{-3}	3.9
C:	10.5 kbits/s, 10 kHz[2]	10^{-3}	10.8
C:	10.5 kbits/s, 7.5 kHz[2]	10^{-3}	12.7
C:	21.0 kbits/s	10^{-3}	5.4

1. E_s/N_0 is the ratio of the average energy transmitted per channel bit period to the noise power spectral density.
2. Channel spacing.

Table 4-9. Channel rates

Channel rates (kbits/s)	Applicable channels	
	AES receive	AES transmit
0.6	P	R,T
1.2	P	R,T
2.4	P	R,T
4.8	P	—
5.25	C	C
6.0	C	C
10.5	P,C	R,T,C
21.0	C	C

Table 4-10. P channel information field components

	Channel rate (kbits/s)				
	0.6	1.2	2.4	4.8	10.5
Number of bits	1152	1152	1152	2304	4992
Number of interleaver blocks	3	2	1	1	1
Number of SUs/interleaver block	2	3	6	12	26

Table 4-11. P channel interleaver structure

	Channel rate (kbits/s)				
	0.6	1.2	2.4	4.8	10.5
Interleaver columns	6	9	18	36	78

Table 4-12. R and T channel preamble structure

	Channel ràte (kbits/s)			
	0.6	1.2	2.4	10.5
Unmodulated carrier (equivalent bit periods)	150	126	78	248
Modulated bits	74	74	74	256
Total	224	200	152	504

Table 4-13. T channel interleaver structure

	Channel rate (kbits/s)			
	0.6	1.2	2.4	10.5
Interleaver columns:				
first block	5	5	5	8-95[1]
subsequent blocks	3	3	3	NA

1. The number of interleaver columns is variable from 8 to 95 in steps of 3 and is chosen to match the amount of data.

Table 4-14. C channel preamble structure

	Channel rate (kbits/s)			
	5.25	6.0	10.5	21.0
Unmodulated carrier (equivalent bit periods)	80	96	160	336
Modulated bits	128	144	256	504
Total	208	240	416	840

Table 4-15. SNPDU type identifier encoding

Code	SNPDU TYPE
Bits 654321	(refer to Figures 4-13 through 4-24 SNPDU format)
000000	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., NO FACILITY FIELD, NO RESTRICTION ON RESPONSE
000001	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
000010	CONNECTION REQUEST, NO CALLING NSAP ADD., WITH CALLED NSAP ADD., NO FACILITY FIELD, NO RESTRICTION ON RESPONSE
000011	CONNECTION REQUEST, NO CALLING NSAP ADD., WITH CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
000100	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., NO FACILITY FIELD, NO RESTRICTION ON RESPONSE
000101	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
000110	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., NO FACILITY FIELD, NO RESTRICTION ON RESPONSE
000111	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., WITH FACILITY FIELD, NO RESTRICTION ON RESPONSE
001000	CONNECTION CONFIRM, NO CALLED NSAP ADD., NO FACILITY FIELD
001001	CONNECTION CONFIRM, NO CALLED NSAP ADD., WITH FACILITY FIELD
001010	CONNECTION CONFIRM, WITH CALLED NSAP ADD., NO FACILITY FIELD
001011	CONNECTION CONFIRM, WITH CALLED NSAP ADD., WITH FACILITY FIELD
0011XX	SPARES
010000	CONNECTION RELEASED, NO CALLED NSAP ADD., NO FACILITY FIELD
010010	CONNECTION RELEASED, WITH CALLED NSAP ADD., NO FACILITY FIELD
0100X1	SPARES
0101XX	SPARES
011000	CONNECTION RELEASE COMPLETE
011010	SPARE
0111X0	SPARES
011XX1	SPARES
100000	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., NO FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100001	CONNECTION REQUEST, NO CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100010	CONNECTION REQUEST, NO CALLING NSAP ADD., WITH CALLED NSAP ADD., NO FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100011	CONNECTION REQUEST, NO CALLING NSAP ADD., WITH CALLED NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100100	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., NO FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100101	CONNECTION REQUEST, WITH CALLING NSAP ADD., NO CALLED NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100110	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., NO FACILITY FIELD, WITH RESTRICTION ON RESPONSE
100111	CONNECTION REQUEST, WITH CALLING NSAP ADD., WITH CALLED NSAP ADD., WITH FACILITY FIELD, WITH RESTRICTION ON RESPONSE
101XXX	SPARES
110000	DATA
110001	SPARE
110010	INTERRUPT
110011	RESET
110100	RESERVED
110101	SPARE
11011X	SPARES
111000	RESERVED
111001	FLOW CONTROL
111010	INTERRUPT CONFIRM
111011	RESET CONFIRM
11110X	SPARES
111110	SPARE
111111	RESERVED

Table 4-16. SSNDPX generated cause field coding

Generating condition	Release/reset cause field coding Bits 8765	 Bits 4321
SSNDPX originated release (local link error)	1001	0011
SSNDPX originated release (invalid facility request)	1000	0011
SSNDPX originated release (network congestion)	1000	0101
SSNDPX originated reset (local link error)	1000	0101
SSNDPX originated reset (network congestion)	1000	0111

Table 4-17. Diagnostic code field codings (for those originated by the SSND sub-layer)

Generating condition	Diagnostic field coding (decimal)	Applicable SNPDUs
SSNDP operation:		
Disconnection (temporary, e.g. handover)	1110 0001 (225)	Released
Disconnection (permanent, e.g. log off)	1110 0010 (226)	Released
Unable to establish call (temporary)	1110 0011 (227)	Released
Unable to establish call (permanent)	1110 0100 (228)	Released
Connection rejection — requested quality of service not available (transient condition)	1110 0101 (229)	Released
Connection rejection — requested quality of service not available (permanent condition)	1110 0110 (230)	Released
Protocol error (SNPDU type invalid while in):		
Ready state	0001 0100 (20)	Released
IWF call request state	0001 0101 (21)	Released
Incoming call state	0001 0110 (22)	Released
Data transfer state	0001 0111 (23)	Released
Remote clear request state	0001 1010 (26)	Released
Flow control state	0001 1011 (27)	Reset
Remote reset request state	0001 1101 (29)	Reset
Protocol error (SNPDU not allowed):		
Unidentifiable SNPDU	0010 0001 (33)	Released, reset
Invalid LCN (see 4.7.3.3)	0010 0010 (34)	Released
SNPDU too short	0010 0110 (38)	Released, reset
SNPDU too long	0010 0111 (39)	Released, reset
SNPDU type not compatible with facility	0010 1010 (42)	Released
Unauthorized interrupt confirm SNPDU	0010 1011 (43)	Reset
Unauthorized interrupt SNPDU	0010 1100 (44)	Reset
Invalid called DTE address	0100 0011 (67)	Released

(continued)

Generating condition	Diagnostic field coding (decimal)	Applicable SNPDUs
Invalid calling DTE address	0100 0100 (68)	Released
Invalid facility length	0100 0101 (69)	Released
D-bit procedure not supported	1010 0110 (166)	Reset
Transmission error:		
No additional information	0000 0000 (0)	Released, reset
Invalid SNPDU number	0000 0001 (1)	Reset
Retransmission count surpassed	1001 0000 (144)	Released, reset
Timer expired:		
tN1 (for connection confirm SNPDU)	0011 0001 (49)	Released
tN3 (for reset confirm SNPDU)	0011 0011 (51)	Released
tN4 (for interrupt confirm SNPDU)	0011 1001 (57)	Reset
tN7 (for flow control (suspend) supervision)	0011 1011 (59)	Reset

Table 4-18. SSNDPX time supervision

Timer design	Start event	Normally terminated by	Action when timer expires
tN1	Transmission of connection request SNPDU	Reception of connection confirm or connection released SNPDU	The SSNDPX shall initiate a release of the connection
tN3	Transmission of reset SNPDU	Reception of reset confirm or reset SNPDU	The SSNDPX shall initiate a release of the connection
tN4	Transmission of interrupt SNPDU	Reception of interrupt confirm SNPDU	SSNDPX shall initiate a reset of connection
tN6	Transmission of connection released SNPDU	Reception of connection release complete or connection released SNPDU	Return logical channel to ready state
tN7	Transmission of flow control (suspend) SNPDU	Transmission of flow control (resume) SNPDU	SSNDPX shall initiate a reset of connection

NOTES:

1. The timers tN2, tN5 and tN8 are reserved.
2. Timers are started when the SSNDPX receives success status in the transmission status indication LIDU from the link layer, unless the response SNPDU from the remote SSNDPX has been received prior to the status indication.

Table 4-19. SSNDPX supervision of transmission errors — receiving a "Fail" LIDU

SNPDU type reported through fail	SSNDPX action
CONNECTION REQUEST	Send clear indication packet to IWF and return the logical channel to the ready state
CONNECTION CONFIRM, CONNECTION RELEASE COMPLETE, INTERRUPT CONFIRM	No action
RESET CONFIRM	Retry once. If retry fails then return the logical channel to the data transfer state
CONNECTION RELEASED	Retry once. If retry fails then return the logical channel to the ready state
DATA, INTERRUPT	SSNDPX initiates a reset of the connection (reset cause = "network congestion")
FLOW CONTROL	SSNDPX initiates a release of the connection (release cause = "network congestion")
RESET	Retry once. If retry fails then initiate a release of the connection (release cause = "network congestion")

Note.— For SNPDUs which are confirmed by the remote SSND sub-layer entity, processing of the corresponding fail LIDU only applies if it is received prior to the reception of the expected response from the other end.

Table 4-20. SSNDPX timers

Timer	Value (seconds)
tN1	180
tN3	120
tN4	120
tN6	120
tN7	60

Table 4-21. SSNDPX actions — any state

SNPDU received from remote SSNDPX	Any state
Any SNPDU with an invalid SNPDU type	Discard
Any SNPDU less than 2 octets in length	Discard

Note.— The SNPDU type is invalid if it is identified as "spare" or "reserved" in Table 4-15.

Table 4-22. SSNDPX actions — connection establishment states

SNPDU received from remote SSNDPX	Call setup states (Notes 1, 3)		
	Ready state	IWF call request	Incoming call
CONNECTION REQUEST	Action: Normal (forward to IWF)	Not applicable	Action: Error send CONNECTION RELEASED D = 0001 0110 (extend clear to IWF)
CONNECTION CONFIRM	Action: Error * send CONNECTION RELEASED D = 0001 0100	Action: Normal (forward to IWF) or Action: Error (Note 2), send CONNECTION RELEASED (extend clear to IWF) D = 0010 1010	Action: Error send CONNECTION RELEASED D = 0001 0110 (extend clear to IWF)
CONNECTION RELEASED	Action: Normal (do not forward)	Action: Normal (forward to IWF)	Action: Normal (forward to IWF)
CONNECTION RELEASE COMPLETE	Action: Error * send CONNECTION RELEASED D = 0001 0100	Action: Error send CONNECTION RELEASED D = 0001 0101 (extend clear to IWF)	Action: Error send CONNECTION RELEASED D = 0001 0110 (extend clear to IWF)
DATA, INTERRUPT, INTERRUPT CONFIRM, RESET, RESET CONFIRM, FLOW CONTROL	Action: Error * send CONNECTION RELEASED D = 0001 0100	Action: Error send CONNECTION RELEASED D = 0001 0101 (extend clear to IWF)	Action: Error send CONNECTION RELEASED D = 0001 0110 (extend clear to IWF)

*SSNDPX internal connection release request (i.e. IWF not informed)

NOTES:

1. In cases where the SNPDU is not acceptable to the state of the logical channel (i.e., Action = Error), the clearing cause field is equal to 147, i.e. SSND local link error.
2. The error may occur if fast select with restriction on response has been requested.
3. If the SNPDU is acceptable to the state of the logical channel (i.e. action = normal) but contains a format error or is otherwise unacceptable then the SSND initiates a connection release procedure (diagnostic codes that may apply include 34, 38, 39, 67, 68, 69, 225-230).

Table 4-23. SSNDPX actions — data transfer and connection release states

SNPDU received from remote SSNDPX	Data transfer and call clearing states		
	Data transfer	Local clear request*	Remote clear request
CONNECTION REQUEST	Action: Error send CONNECTION RELEASED D = 0001 0111 (see Note 1) (extend clear to IWF)	Action: Discard	Action: Error send CONNECTION RELEASED D = 0001 1010
CONNECTION CONFIRM	Action: Error send CONNECTION RELEASED D = 0001 0111 (see Note 1) (extend clear to IWF)	Action: Discard	Action: Error send CONNECTION RELEASED D = 0001 1010
CONNECTION RELEASE COMPLETE	Action: Error send CONNECTION RELEASED D = 0001 0111 (extend clear to IWF) (see Note 1)	Action: Normal	Action: Error send CONNECTION RELEASED D = 0001 1010
CONNECTION RELEASED	Action: Normal (forward to IWF)	Action: Normal (do not forward to IWF)	Action: Discard
DATA, INTERRUPT, INTERRUPT CONFIRM, RESET, RESET CONFIRM, FLOW CONTROL	See Table 4-24	Action: Discard	Action: Error send CONNECTION RELEASED D = 0001 1010

* Internal clear (at connection establishment) or clear requested by the IWF

NOTES:

1. The clearing cause field is equal to 147, i.e. SSND local link error.
2. If the SNPDU is acceptable to the state of the logical channel (i.e. Action = Normal) but contains a format error, then the SSND initiates a connection release procedure (diagnostic codes that may apply include 38, 39).

Table 4-24. SSNDPX actions — data transfer states

SNPDU received from remote SSNDPX	Data transfer states			
	Flow control		Local reset request	Remote reset request
RESET	Action: Normal		Action: Normal (do not forward)	Action: Discard
RESET CONFIRM	Action: Error send RESET SNPDU D = 0001 1011 (extend reset to IWF)		Action: Normal (do not forward)	Action: Error send RESET SNPDU D = 0001 1101
INTERRUPT	*No remote interrupt pending:*	*Remote interrupt ongoing:*		
	Action: Normal	Action: Error send RESET SNPDU D = 0010 1100 (extend reset to IWF)	Action: Discard	Action: Error, send RESET SNPDU D = 0001 1101
INTERRUPT CONFIRM	*No local interrupt pending:*	*Local interrupt ongoing:*		
	Action: Error send RESET SNPDU D = 0010 1011 (extend reset to IWF)	Action: Normal	Action: Discard	Action: Error, send RESET SNPDU D = 0001 1101
DATA with valid SNPDU No.	Action: Normal (if flow control ready) or Action: Discard (if flow control not ready)		Action: Discard	Action: Error send RESET SNPDU D = 0001 1101
DATA with invalid SNPDU No. (unrecoverable)	Action: Error send RESET SNPDU D = 0000 0001 (extend reset to IWF) or Action: Discard (if flow control not ready)		Action: Discard	Action: Error send RESET SNPDU D = 0001 1101
FLOW CONTROL (suspend) with valid SNPDU No. or flow control (resume)	Action: Normal		Action: Discard	Action: Error send RESET SNPDU D = 0001 1101
FLOW CONTROL (suspend) with invalid SNPDU No.	Action: Error send RESET SNPDU D = 0000 0001 (extend reset to IWF)		Action: Discard	Action: Error send RESET SNPDU D = 0001 1101

NOTES:

1. In cases where the SNPDU is not acceptable to the state of the logical channel (i.e. Action = Error), the resetting cause field is equal to 133, i.e. SSND local link error.
2. If the SNDPU is acceptable to the state of the logical channel (i.e. Action = Normal) but contains a format error, then the SSND initiates a connection reset procedure (diagnostic codes that may apply include 1, 38, 39).

Table 4-25. Summary of link interface data units and parameters

Direction	LIDU name	Parameters
From the subnetwork layer to the link layer	Data	GES ID (in AES) or AES ID (in GES) RLS Q number LSDU
From the link layer to the subnetwork layer	Data	GES ID (in AES) or AES ID (in GES) RLS Q number LSDU
	Transmission status indication	RLS Success/Fail First two octets of LSDU

Table 4-26. Subnetwork connection priority mapping

Categories of messages	Priority/Q number mapping		
	SNC priority in CALL REQUEST/CALL ACCEPTED packet	Q number	SNC priority in INCOMING CALL/CALL CONNECTED packet
Unspecified	255	0	None
Reserved	254-15	Invalid/reject call	Not applicable
Distress communications, urgent communications, network/systems management	14	14	14
Reserved	13	Invalid/reject call	Not applicable
Reserved	12	Invalid/reject call	Not applicable
Communications relating to direction finding, flight safety messages	11	11	11
Reserved	10	Invalid/reject call	Not applicable
Reserved	9	Invalid/reject call	Not applicable
Meteorological communications	8	8	8
Flight regularity communications	7	7	7
Aeronautical information services messages	6	6	6
Aeronautical administrative messages, network/systems administration	5	5	5
Reserved	4	Invalid/reject call	Not applicable
Urgent priority administrative and UN Charter communications	3	3	3
High priority administrative and State/Government communications	2	2	2
Normal priority/administrative	1	1	1
Low priority administrative	0	0	None

Note.— SNC priority value 255 (unspecified) in call request/call accepted packet should be mapped to Q number = 0, and none in incoming call/call connected packet.

Table 4-27. DCE actions at restart, call setup, and call clearing states

DCE state	State definition	Action when entering state
r1	PACKET LAYER READY	All VCs are returned to the p1 state (see p1 state READY explanation) and all PVCs are returned to d1, (flow control ready) state.
r2	DTE RESTART REQUEST	The DCE returns each VC to the p1 state (see p1 state explanation) and issues a restart confirmation packet to the DTE.
r3	DCE RESTART INDICATION	The DCE returns each VC to the p1 state (see p1 state explanation) and issues a restart indication packet to the DTE.
p1	READY	Release all resources assigned to VC channel.
p2	DTE CALL REQUEST	Determine if sufficient resources exist to support request; if so, allocate resources and forward ISO 8208 call request packet to IWF; if not, enter DCE clear indication to DTE state (p7). Determination of resources and allocation is as defined in ISO 8208.
p3	DCE INCOMING CALL	Determine if sufficient resources exist to support request; if so, allocate resources and forward ISO 8208 incoming call packet to DTE; if not, send a clear request packet to the IWF. Determination of resources and allocation is as defined in ISO 8208.
p4	DATA TRANSFER	No action.
p5	CALL COLLISION	Send a clear request packet to the IWF, corresponding to the incoming call packet (the DTE in its call collision state ignores the incoming call), and proceed with the DTE call request packet.
p6	DTE CLEAR REQUEST	Release all resources assigned to VC channel. Send an ISO 8208 clear confirmation packet to the DTE, a clear request packet to the IWF, and enter p1 state.
p7	DCE CLEAR INDICATION TO DTE	Forward ISO 8208 clear indication packet to DTE.

Note.— State nomenclature in this table may differ from that used in ISO 8208.

Table 4-28. DCE actions at reset, interrupt, and flow control states

DCE state	State definition	Action when entering state
d1	FLOW CONTROL READY	No action.
d2	RESET REQUEST BY DTE	Remove data packets transmitted to DTE from window; discard any data packets that represent partially transmitted M-bit sequences and discard interrupt and interrupt confirmation packets awaiting transfer to the DTE; reset all window counters to zero. Send reset confirmation packet to DTE. Return channel to d1 state.
d3	RESET INDICATION BY DCE TO DTE	Remove data packets transmitted to DTE from window; discard any data packets that represent partially transmitted M-bit sequences and discard interrupt and interrupt confirmation packets awaiting transfer to the DTE; reset all window counters to zero. Send reset indication packet to DTE.
i1	DTE INTERRUPT READY	No action.
i2	DTE INTERRUPT SENT	Forward interrupt packet received from DTE to IWF.
j1	DCE INTERRUPT READY	No action.
j2	DCE INTERRUPT SENT	Forward interrupt packet received from IWF to DTE.
f1	DCE RECEIVE READY	No action.
f2	DCE RECEIVE NOT READY	No action.
g1	DTE RECEIVE READY	No action.
g2	DTE RECEIVE NOT READY	No action.

Note.— State nomenclature in this table may differ from that used in ISO 8208.

Table 4-29. DCE state table — any state

Received from DTE	DCE special cases Any state
Any packet less than 2 octets in length	A = DIAG D = 38
Any packet with an invalid general format identifier	A = DIAG D = 40
Any packet with unassigned logical channel identifier	A = DIAG D = 36
Any packet with a valid general format identifier and an assigned logical channel identifier (includes a logical channel identifier of 0)	See Table 4-30

Table 4-30. DTE effect on DCE restart states

Packet received from DTE	DCE restart states (see Notes 6 and 7) Packet layer READY (see Note 1) r1	DTE RESTART REQUEST (see Note 4) r2	DCE RESTART INDICATION (see Note 5) r3
Packets having a packet type identifier shorter than 1 octet with assigned logical channel identifier <> 0	see Table 4-31	A = ERROR S = r3 D = 38 (see Note 3)	A = DISCARD
Packet supported by DCE other than restart with a logical channel identifier of 0	A = DIAG D = 36	A = DIAG D = 36	A = DIAG D = 36
Packet with a packet type identifier which is undefined or not supported by DCE and with assigned logical channel identifer <> 0	see Table 4-31	A = ERROR S = r3 D = 33 (see Note 3)	A = DISCARD
Restart request, or restart confirmation packet with a logical channel identifier <> 0	see Table 4-31	A = ERROR S = r3 D = 41 (see Note 3)	A = DISCARD
Restart request	A = NORMAL (see Note 1) S = r2	A = DISCARD	A = NORMAL (4.2) S = p1 or d1 (see Note 2)
Restart confirmation	A = ERROR S = r3 D = 17 (see Note 8)	A = ERROR S = r3 D = 18 (see Note 3)	A = NORMAL (4.4) S = p1 or d1 (see Note 2)
Restart request or restart confirmation packet with format error	A = DIAG D = 38, 39, 81, or 82	A = DISCARD	A = ERROR D = 38, 39, 81, or 82
Call setup, call clearing, data, interrupt, flow control, or reset packet	see Table 4-31	A = ERROR S = r3 D = 18	A = DISCARD
Packets having a packet type identifier shorter than 1 byte and a logical channel identifier equal to 0	A = DIAG D = 38	A = ERROR S = r3 D = 38	A = DISCARD
Packet with a packet type identifier which is undefined or not supported by DCE and a logical channel identifier equal to 0	A = DIAG D = 33	A = ERROR S = r3 D = 33 (see Note 4)	A = DISCARD

NOTES:

1. Receipt of a restart request packet causes the DCE to issue a clear request packet to the IWF for each VC associated with the DCE entity.
2. The VC channels are returned to state p1, the PVC channels are returned to state d1.
3. No action is taken by the DCE.
4. The restart request packet is not forwarded to the IWF.
5. The DCE upon entering the r3 state checks for the completion of r2 processing and issues an ISO 8208 restart indication packet to the DTE, when the r3 state is entered via the r2 state. If the r3 state is not entered via the r2 state, the DCE performs all of the actions normally performed when entering r2 and issues an ISO 8208 restart indication packet to the DTE, and send a clear request packet to the IWF for each VC associated with the DCE entity.
6. Table entries are defined as follows: A = action to be taken, S = state to be entered, D = diagnostic code to be used in packets generated as a result of this action, and discard indicates that the received packet is to be cleared from the buffers.
7. The number in the parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same action as the one taken by the DTE, acting as a DCE, to perform nominal processing on the received packet. If no paragraph number is referenced, the normal processing is defined in the table entry.
8. The error procedure consists of entering the r3 state and sending a restart indication packet to the DTE.

Table 4-31. DTE effect on DCE call setup and clearing states

Packet received from DTE	DCE call setup and clearing states (see Notes 5 and 6) READY p1	DTE CALL REQUEST p2	DCE INCOMING CALL p3	DATA TRANSFER p4	CALL COLLISION p5; see Notes 1 and 4	DTE CLEAR REQUEST p6	DCE CLEAR INDICATION TO DTE p7
Packet having a packet type identifier shorter than 1 octet	A = ERROR S = p7 D = 38	A = ERROR S = p7 D = 38 see Note 2	A = ERROR S = p7 D = 38 see Note 2	see Table 4-32	A = ERROR S = p7 D = 38 see Note 2	A = ERROR S = P7 D = 38 see Note 2	A = DISCARD
Packet having a packet type identifier which is undefined or not supported by DCE	A = ERROR S = p7 D = 33	A = ERROR S = p7 D = 33 see Note 2	A = ERROR S = p7 D = 33 see Note 2	see Table 4-32	A = ERROR S = p7 D = 33 see Note 2	A = ERROR S = p7 D = 33 see Note 2	A = DISCARD
RESTART REQUEST, or RESTART CONFIRMATION packet with logical channel identifier not = 0	A = ERROR S = p7 D = 41	A = ERROR S = p7 D = 41 see Note 2	A = ERROR S = p7 D = 41 see Note 2	see Table 4-32	A = ERROR S = p7 D = 41 see Note 2	A = ERROR S = p7 D = 41 see Note 2	A = DISCARD
CALL REQUEST	A = NORMAL (5.2.2) S = p2 (forward)	A = ERROR S = p7 D = 21 see Note 2	A = NORMAL (5.2.5) S = p5	A = ERROR S = p7 D = 23 see Note 2	A = ERROR S = p7 D = 24 see Note 2	A = ERROR S = p7 D = 25 see Note 2	A = DISCARD
CALL ACCEPTED	A = ERROR S = p7 D = 20	A = ERROR S = p7 D = 21 see Note 2	A = NORMAL (5.2.4) S = p4(Frd)/ A = ERROR S = p7 D = 42; see Notes 2 and 3	A = ERROR S = p7 D = 23 see Note 2	A = ERROR S = p7 D = 24; see Notes 2 and 4	A = ERROR S = p7 D = 25 see Note 2	A = DISCARD
CLEAR REQUEST	A = NORMAL (4.5.5.2) S = p6	A = NORMAL (4.5.5.2) S = p6 (forward)	A = NORMAL (4.5.5.2) S = p6 (forward)	A = NORMAL (4.5.5.2) S = p6 (forward)	A = NORMAL (4.5.5.2) S = p6 (forward)	A = DISCARD	A = NORMAL (4.5.5.4) S = p1 (do not forward)
CLEAR CONFIRMATION	A = ERROR S = p7 D = 20	A = ERROR S = p7 D = 21 see Note 2	A = ERROR S = p7 D = 22 see Note 2	A = ERROR S = p7 D = 23 see Note 2	A = ERROR S = p7 D = 24 see Note 2	A = ERROR S = p7 D =25 see Note 2	A = NORMAL (5.5.4) S = p1 (do not forward)
Data, interrupt, flow control or reset packets	A = ERROR S = p7 D = 20	A = ERROR S = p7 D = 21 see Note 2	A = ERROR S = p7 D = 22 see Note 2	see Table 4-32	A = ERROR S = p7 D = 24 see Note 2	A = ERROR S = p7 D = 25 see Note 2	A = DISCARD

NOTES:

1. On entering the p5 state, the DCE sends a clear request packet to the IWF, corresponding to the incoming call (the DTE in its call collision state ignores the incoming call), and proceed with the DTE call request.
2. The error procedure consists of performing the actions specified when entering the p7 state (including sending a clear indication packet to the DTE) and additionally sending a clear request packet to the IWF.
3. The use of fast select facility with restriction on response prohibits the DTE from sending a call accepted packet.
4. The DTE in the event of a call collision must discard the call request packet received from the DCE.
5. Table entries are defined as follows: A = action to be taken, S = the state to be entered, D = diagnostic code to be used in packets generated as a result of this action, and discard indicates that the received packet is to be cleaned from the buffers.
6. The number in parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same actions as the one taken by the DTE, acting as a DCE, to perform normal processing on the received packet. If no paragraph number is referenced, the normal processing is defined in the table entry.
7. If the packet is acceptable to the state of the logical channel (i.e. action = normal) but contains a format error or is otherwise unacceptable, then the DCE shall initiate a connection release procedure (diagnostic codes that may apply include 34, 38, 39, 65, 66, 67, 68, 69, 73, 77, 82). If such an error is detected in state p1 or state p7, the DCE does not send a clear request packet to the IWF.

Table 4-32. DTE effect on DCE reset states

Packet received from DTE	DCE reset states (see Notes 2 and 3) FLOW CONTROL READY d1	RESET REQUEST by DTE d2	RESET INDICATION BY DCE to DTE d3
Packet with a packet type identifier shorter than 1 octet	A = ERROR S = d3 D = 38 (see Note 1)	A = ERROR S = d3 D = 38 (see Note 1)	A = DISCARD
Packet with a packet type identifier which is undefined or not supported by DCE	A = ERROR S = d3 D = 33 (see Note 1)	A = ERROR S = d3 D = 33 (see Note 1)	A = DISCARD
RESTART REQUEST, or RESTART CONFIRMATION packet with logical channel identifier <> 0	A = ERROR S = d3 D = 41 (see Note 1)	A = ERROR S = d3 D = 41 (see Note 1)	A = DISCARD
RESET REQUEST	A = NORMAL (8.2) S = d2 (forward)	A = DISCARD	A = NORMAL (8.3) S = d1 (do not forward)
RESET CONFIRMATION	A = ERROR S = d3 D = 27 (see Note 1)	A = ERROR S = d3 D = 28 (see Note 1)	A = NORMAL (8.4) S = d1 (do not forward)
INTERRUPT packet	see Table 4-33	A = ERROR S = d3 D = 28 (see Note 1)	A = DISCARD
INTERRUPT CONFIRMATION packet	see Table 4-33	A = ERROR S = d3 D = 28 (see Note 1)	A = DISCARD
DATA or flow control packet	see Table 4-34	A = ERROR S = d3 D = 28 (see Note 1)	A = DISCARD

NOTES:

1. The error procedure consists of performing the specified actions when entering the d3 state (which includes forwarding a reset indication packet to the DTE) and sending a reset request packet to the IWF.
2. Table entries are defined as follows: A = action to be taken, S = the state to be entered. D = the diagnostic code to be used in packets generated as a result of this action, and discard indicates that the received packet is to be cleared from the AES buffers.
3. The number in parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same actions as those taken by the DTE to perform normal processing on the received packet. If no paragraph is referenced, the normal processing is defined in the table entry.
4. If the packet is acceptable to the state of the logical channel (i.e. action = normal) but contains a format error, then the DCE shall initiate a connection reset procedure (diagnostic codes that may apply include 38, 39, 81, 82).

Table 4-33. DTE effect on DCE interrupt transfer states

Packet received from DTE	DTE/DCE INTERRUPT TRANSFER STATES (see Notes 2 and 3) DTE INTERRUPT READY i1	DTE INTERRUPT SENT i2
INTERRUPT (see Note 1)	A = NORMAL (6.8.2) S = i2 (forward)	A = ERROR S = d3 D = 44 (see Note 4)

Packet received from DTE	DTE/DCE INTERRUPT TRANSFER STATES (see Notes 2 and 3) DCE INTERRUPT READY j1	DCE INTERRUPT SENT j2
INTERRUPT CONFIRMATION (see Note 1)	A = ERROR S = d3 D = 43 (see Note 4)	A = NORMAL (6.8.3) S = j1 (forward)

NOTES:

1. If the packet is acceptable to the state of the logical channel (i.e. action = normal) but contains a format error, then the error procedure applies (see Note 4).
2. Table entries are defined as follows: A = action to be taken. S = the state to be entered. and D = the diagnostic code to be used in packets generated as a result of this action.
3. The number in parentheses below an "A = normal" table entry is the paragraph number in ISO 8208. second edition. The DCE shall take the same action as those taken by the DTE to perform normal processing on the received packet. If no paragraph is referenced. the normal processing is defined in the table entry.
4. The error procedure consists of performing the specified actions when entering the d3 state (which includes forwarding a reset indication packet to the DTE) and sending a reset request packet to the IWF.

Table 4-34. DTE effect on DCE flow control transfer states

Packet received from DTE	DCE flow control transfer states (see Note 2) DCE RECEIVE READY f1	DCE RECEIVE NOT READY f2
DATA packet with invalid PR	A = ERROR S = d3 D = 2 (see Note 4)	A = ERROR S = d3 D = 2 (see Note 4)
DATA packet with valid PR but invalid PS or user data field with improper format	A = ERROR S = d3 D = (see Note 5) (see Note 4)	A = DISCARD (process PR data)
DATA packet with valid PR with M-bit set to 1 when the user data field is partially full, or the D-bit set to 1 (when not supported)	A = ERROR S = d3 D = 165 or 166 (see Note 4)	A = DISCARD (process PR data)
DATA packet with valid PR, PS and user data field with proper format	A = NORMAL (forward)	A = DISCARD (process PR data) (see Note 7)

Packet received from DTE	DCE flow control transfer states (see Notes 2 and 3) DTE RECEIVE READY g1	DTE RECEIVE NOT READY g2
RR, or RNR packet with an invalid PR	A = ERROR S = d3 D = 2 (see Note 4)	A = ERROR S = d3 D = 2 (see Note 4)
RR packet with a valid PR (see Note 6)	A = NORMAL (4.7.1.5)	A = NORMAL (4.7.1.5) S = g1
RNR packet with a valid PR (see Note 6)	A = NORMAL (4.7.1.6) S = g2	A = NORMAL (4.7.1.6)

NOTES:

1. The RR and RNR procedures are a local DTE/DCE matter and the corresponding packets are not forwarded to the IWF.
2. Table entries are defined as follows: A = action to be taken, S = the state to be entered, D = the diagnostic code to be used in packets generated as a result of this action, and discard indicates that the received packet is to be cleared from the buffers.
3. The number in parentheses below an "A = normal" table entry is the paragraph number in ISO 8208, second edition. The DCE shall take the same action as those taken by the DTE to perform normal processing on the received packet. If no paragraph is referenced, the normal processing is defined in the table entry.
4. The error procedure consists of performing the specified actions when entering the d3 state (which includes forwarding a reset indication packet to the DTE) and sending a reset request packet to the IWF.
5. The diagnostic codes are as follows: D = 1 for invalid PS; D = 39 for a user data field greater than 128 octets; D = 82 for a user data field not octet aligned.
6. For RR, RNR, or REJECT packets, the presence of one or more octets beyond the third octet is considered an error. Although a valid P(R) may be accepted to update the status of outstanding data packets, the DCE shall invoke the error procedure as defined in Note 4 (with D = 39).
7. If possible, the DCE should process these packets normally. On the other hand, the DCE may define an internal mechanism to indicate that valid data packets have been discarded during a receive-not-ready condition. In this case, when the receive-not-ready condition clears, the DCE should reset the logical channel, forwarding both a reset indication packet to the DTE (D=0, no additional information) and a reset request packet to the IWF.

Table 4-35. DCE timer

Timer design	Default time-limit value	Start event	Normally terminated by	Action when timer expires
tN10	60 s	DCE issues a RESTART INDICATION packet	Reception of RESTART CONFIRMATION or RESTART REQUEST packet	DCE enters the r1 state and may issue a DIAGNOSTIC packet (D = 52)
tN11	180 s	DCE issues an INCOMING CALL packet	Reception of CALL ACCEPTED or CLEAR REQUEST or CALL REQUEST packet	DCE enters the p7 state signalling a CLEAR INDICATION packet (D = 49) (see Note)
tN12	60 s	DCE issues a RESET INDICATION packet	Receipt of RESET CONFIRMATION or RESET REQUEST packet	DCE enters the p7 state signalling a CLEAR INDICATION packet (D = 51) (see Note)
tN13	60 s	DCE issues a CLEAR INDICATION packet	Reception of a CLEAR CONFIRMATION or CLEAR REQUEST packet	DCE enters the p1 state and may issue a DIAGNOSTIC packet (D = 50)

Note.— The clear is extended to the IWF, i.e. the DCE shall issue a clear request packet to the IWF.

Table 4-36. SSNDPX/IWF interface

Packets received from SSNDPX	Action
INCOMING CALL	See 4.7.5.1.2
CALL CONNECTED	See 4.7.5.1.3
CLEAR INDICATION	See 4.7.5.1.4
DATA	See 4.7.5.1.5
INTERRUPT	See 4.7.5.1.5
INTERRUPT CONFIRMATION	See 4.7.5.1.5
RESET INDICATION	See 4.7.5.1.5

Packets sent to SSNDPX
CALL REQUEST
CALL ACCEPTED
CLEAR REQUEST
DATA
INTERRUPT
INTERRUPT CONFIRMATION
RESET REQUEST

Table 4-37. ISO 8208 DCE/IWF interface

Packets received from ISO 8208 DCE	Action
CALL REQUEST	See 4.7.5.2.2
CALL ACCEPTED	See 4.7.5.2.3
CLEAR REQUEST	See 4.7.5.2.4
DATA	See 4.7.5.2.5
INTERRUPT	See 4.7.5.2.5
INTERRUPT CONFIRMATION	See 4.7.5.2.5
RESET REQUEST	See 4.7.5.2.5

Packets sent to ISO 8208 DCE
INCOMING CALL
CALL CONNECTED
CLEAR INDICATION
DATA
INTERRUPT
INTERRUPT CONFIRMATION
RESET INDICATION
RESTART INDICATION

Table 4-38. Circuit-mode — link interface data units

LIDU
1. Abbreviated access request — telephone
2. Call announcement
3. C channel assignment
4. Call information — service address
5. Call progress — call attempt result
6. Call progress — channel release
7. Call progress — data mode
8. Call progress — test
9. Call progress — connect
10. Telephony acknowledge

LICI parameters
Message type (all)
AES ID (all)
GES ID (all)
Q number (all)
Application reference number (all)
Source (1,2)
Service direction (1,2)
Service ID (1,2)
Network ID (1)
Circuit data rate (1,2)
Voice channel characteristics (1,2)
Called terminal (2)
Calling terminal (1,4)
Initial EIRP (3)
Receive channel frequency (3)
Transmit channel frequency (3)
Report type (5,6,7,8,9)
S (5,6)
Location (5,6)
Cause class (5,6)
Cause value (5,6)
Digit 0,1 (1)
Digit 2-9 (1,4)
Ack/nack (10)
Routing (5,6,10)
Message type of missing CM-LIDU (10)

Table 4-39. AES outgoing procedure — interworking telephony events

Event type	Event name	Parameter mapping requirements (Figure*)	To/from interworking interface with aircraft network
FITE 18	Calling party category indicator – AMS(R)S call origination	A5-1 a), b)	From
FITE 22	Clear forward	A5-2	From
BITE 5	Address complete	A5-3	To
BITE 12	Call unsuccessful – network congestion	A5-4	To
BITE 14	Call unsuccessful – address incomplete	A5-5	To
BITE 15	Call unsuccessful – unallocated number	A5-6	To
BITE 16	Call unsuccessful – called party busy	A5-7	To
BITE 17	Call unsuccessful – line out of service	A5-8	To
BITE 20	Call unsuccessful – send error indication	A5-9	To
BITE 22	Answer	A5-10	To
BITE 25	Clear back	A5-11	To

* Figures are located in Appendix 5 to Chapter 4.

Table 4-40. AES incoming procedure — interworking telephony events

Event type	Event name	Parameter mapping requirements (Figure*)	To/from interworking interface with aircraft network
FITE 18	Calling party category indicator – AMS(R)S call origination	A5-12	To
FITE 22	Clear forward	A5-13	To
BITE 12	Call unsuccessful – network congestion	A5-14	From
BITE 16	Call unsuccessful – called party busy	A5-15	From
BITE 17	Call unsuccessful – line out of service	A5-16	From
BITE 22	Answer	A5-17	From
BITE 25	Clear back	A5-18	From

* Figures are located in Appendix 5 to Chapter 4.

Table 4-41. GES outgoing procedure — interworking telephony events

Event type	Event name	Parameter mapping requirements (Figure*)	To/from interworking interface with terrestrial network
FITE 18	Calling party category indicator – AMS(R)S call origination	A5-19	From
FITE 22	Clear forward	A5-20	From
BITE 5	Address complete	A5-21	To
BITE 12	Call unsuccessful – network congestion	A5-22	To
BITE 16	Call unsuccessful – called party busy	A5-23	To
BITE 17	Call unsuccessful – line out of service	A5-24	To
BITE 20	Call unsuccessful – send error indication	A5-25	To
BITE 22	Answer	A5-26	To
BITE 25	Clear back	A5-27	To

* Figures are located in Appendix 5 to Chapter 4.

Table 4-42. GES incoming procedure — interworking telephony events

Event type	Event name	Parameter mapping requirements (Figure*)	To/from interworking interface with terrestrial network
FITE 18	Calling party category indicator – AMS(R)S call origination	A5-28	To
FITE 22	Clear forward	A5-29	To
BITE 5	Address complete	A5-30	From
BITE 12	Call unsuccessful — network congestion	A5-31	From
BITE 14	Call unsuccessful — address incomplete	A5-32	From
BITE 15	Call unsuccessful — unallocated number	A5-33	From
BITE 16	Call unsuccessful — subscriber busy	A5-34	From
BITE 17	Call unsuccessful — line out of service	A5-35	From
BITE 20	Call unsuccessful — send error indication	A5-36	From
BITE 22	Answer	A5-37	From
BITE 25	Clear back	A5-38	From
BITE 27	Sending finished — Set up speech condition	A5-39	From
BITE 29	Release incoming side	A5-40	From

* Figures are located in Appendix 5 to Chapter 4.

Table 4-43. Circuit-mode priority

Priority	Service	Link layer Q No.	C channel Q No.	Description
1	AMS(R)S	15	15	Distress and urgency
2	AMS(R)S	12	12	Flight safety
3	AMS(R)S	10	10	Regularity and meteorological
4	AMSS	9	4	Public correspondence

Table 4-44. AES management — link layer interface data units

LIDU Name	LIDU Parameters[1]
From link layer 1. Log-on confirm 2. Log-on acknowledgement 3. Log-off acknowledgement 4. Log-on reject 5. Log-on interrogation 6. Log-on prompt 7. P/R channel control 8. T channel control 9. AES system table broadcast a) index b) GES P/R channel advice c) satellite ID channel advice d) beam ID channel advice e) GES beam support advice 10. System time broadcast 11. Selective release broadcast 12. Log control data channel reassignment 13. Channel status report 13a. Log-off request *To link layer* 14. Log-on request 15. Log-off request 16. Log-on acknowledgement 17. Log control ready for reassignment 18. Log control reassignment reject 19. Channel status report	Q Number of application (14) Message type (all) AES ID (all) GES ID (all) Q Number (all) Satellite ID (1, 9c, 9d, 14) Initial EIRP (1) TDMA message (1) Received bit error rate (19) EIRP adjust (13) P/R message (1) Voice channel characteristics (1, 14) Channel rate(s) (7, 8, 9d) Reason (4) P, R channel frequencies (7, 9b, d) T channel frequencies (8) Number of frequencies (7, 8) Beam IDs (1, 9d, 14) Revision number (9a, b, c, d, e) Application reference No (13, 19) Satellite inclination (9c) Satellite right ascension (9c) Satellite longitude (9c) Satellite/beam identification frequencies (9c) Century, year, month, day, hour, second (10) Data bit rate capability (14) ACK/NAK messages 1-3 (2, 3, 16) Class of AES (1, 14) Number of C channels (14) Initial/renewal (14) Primary/secondary (14) Duration (13a) SC (SARPs compliance) (14) Existence (9a) NOT (number of transmitters) (14) Report type (13, 19) LOV (log-on verification) (14) Channel frequency (11)

1. Definitions of LIDU parameters shall be as given in Appendix C to Chapter 4. The number(s) associated with each LIDU parameter shall indicate the LIDU(s) containing the parameter.

Table 4-45. GES management — link interface data units (LIDUs)

LIDU name	LIDU parameters*
To link layer 1. Log-on confirm 2. Log-on acknowledgement 3. Log-off acknowledgement 4. Log-on reject 5. Log-on interrogation 6. Log-on prompt 7. P/R channel control 8. T channel control 9. AES system table broadcast a) index b) GES P/R channel advice c) satellite ID channel advice d) beam ID channel advice e) GES beam support advice 10. System time broadcast 11. Selective release broadcast 12. Log control-data channel reassignment 12a. Channel status report 12b. Log-off request *From link layer* 13. Log-on request 14. Log-off request 15. Log-on acknowledgement 16. Log control-ready for reassignment 17. Log control-reassignment reject 18. Channel status report	Message type (all) AES ID (all) GES ID (all) Q Number of application (13) Satellite ID (1, 9c, 9d, 13) Initial EIRP (1) BER (18) TDMA message (1) P/R message (1) Voice channel characteristics (1, 13) Bit rate (7, 8, 9d) Reason (4) P, R channel freqencies (7, 9b) T channel frequency (8) Number of frequencies (7, 8) Beam IDs (1, 9c, 9d, 13) Revision number (9a, b, c, d, e) Satellite inclination (9c) EIRP adjustment (12a) Satellite right ascension (9c) Satellite longitude (9c) Satellite/beam-ID. frequency (9c) Century, year, month, day, hour, minute, second (10) ACK/NAK MSG1, MSG2, MSG3 (2, 3, 15) Number of C channels (13) Initial/renew (13) Primary/secondary (13) Duration (12b) SC (SARPs compliance) (13) NOT (13) Beam-ID P channel frequency (9c) Beam support table (9e) Report type (12a, 18) Application reference number (12a, 18) Class of AES (13) LOV (13) Transmit channel frequency (11) Existence (9a)

* The order of the LIDU PARAMETER list does not correspond to the order of the LIDU NAME list. The number in parentheses after each LIDU parameter indicates the LIDU name to which the parameter applies.

FIGURES FOR CHAPTER 4

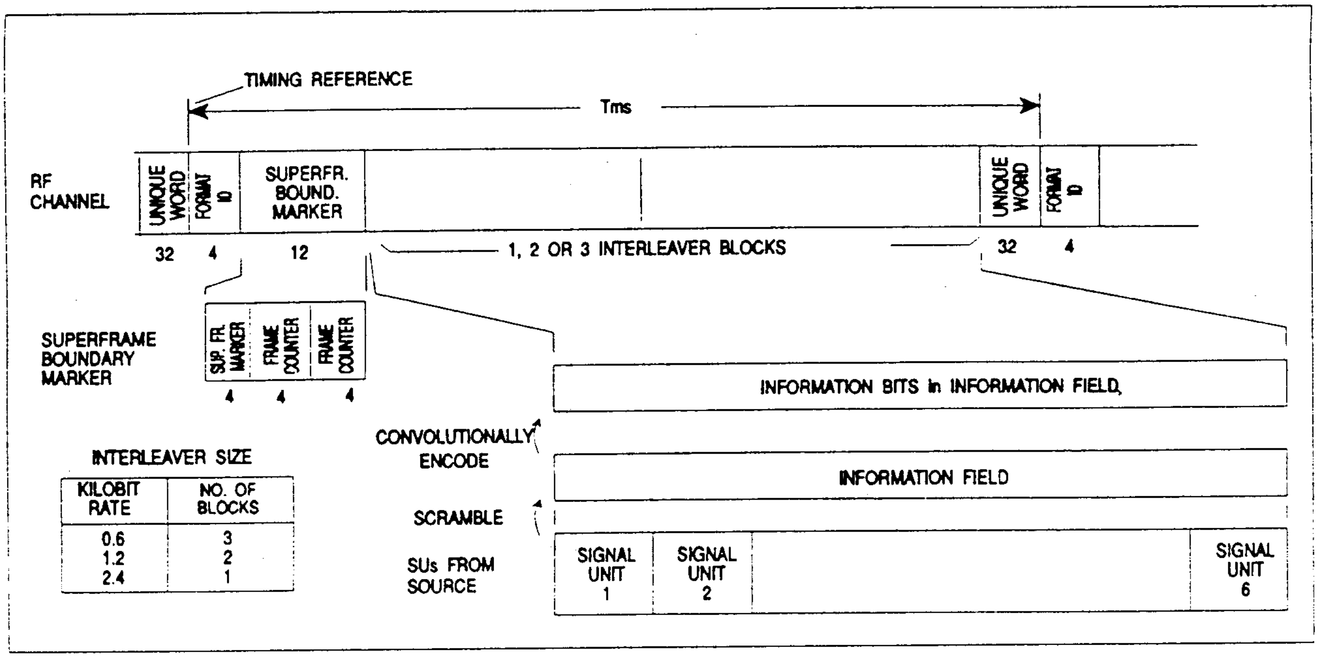


Figure 4-1. P channel format (0.6, 1.2 and 2.4 kbits/s)

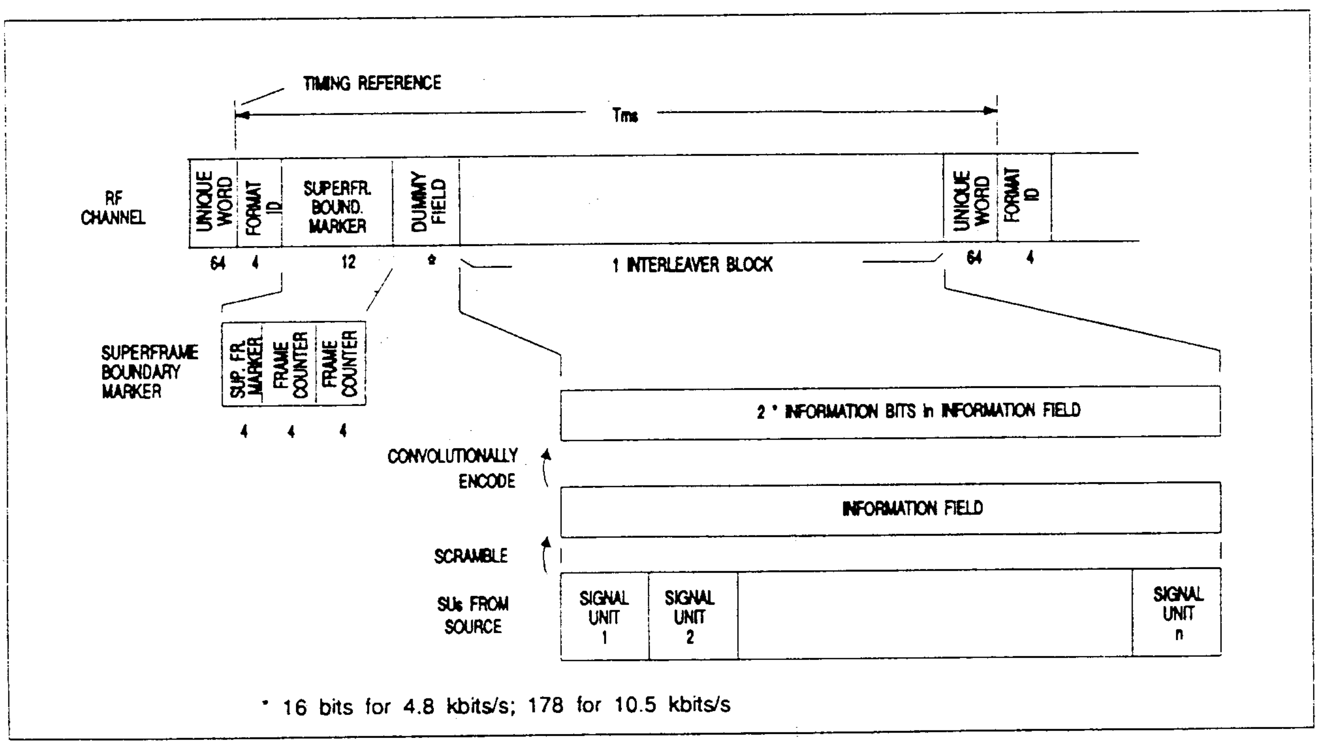


Figure 4-2. P channel format (4.8 and 10.5 kbits/s)

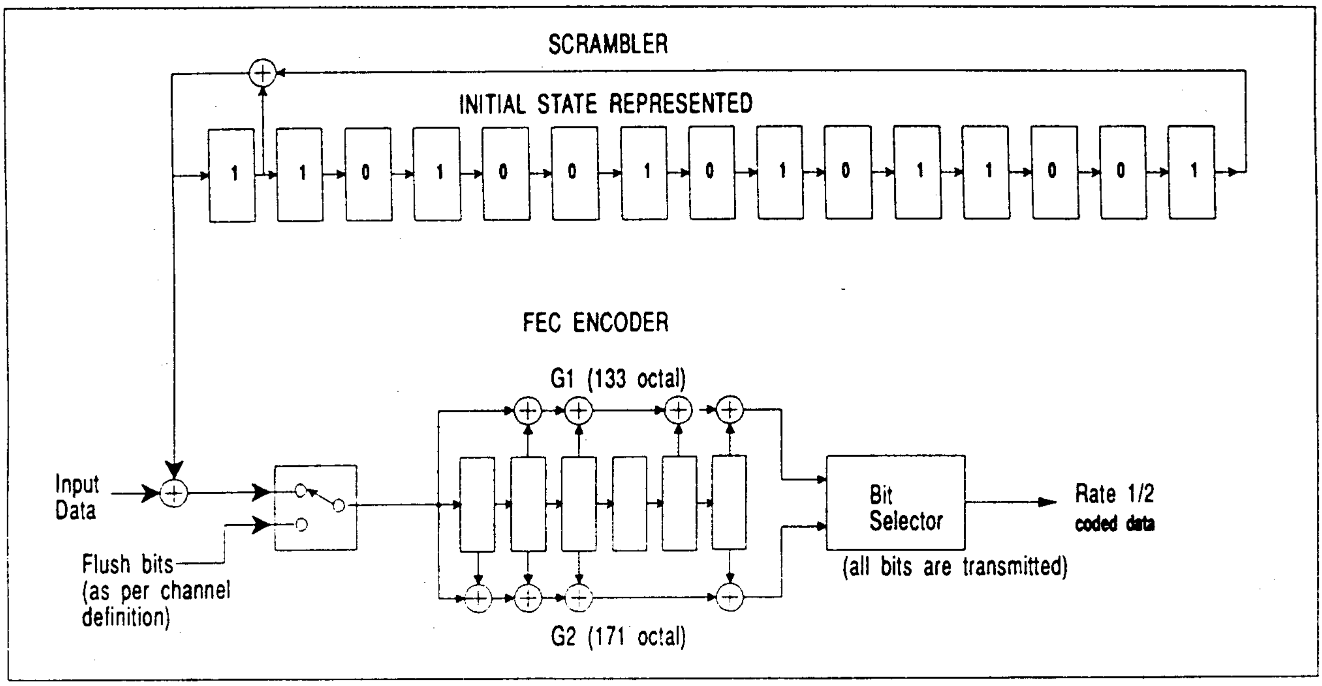


Figure 4-3. Scrambler and convolutional encoder functions

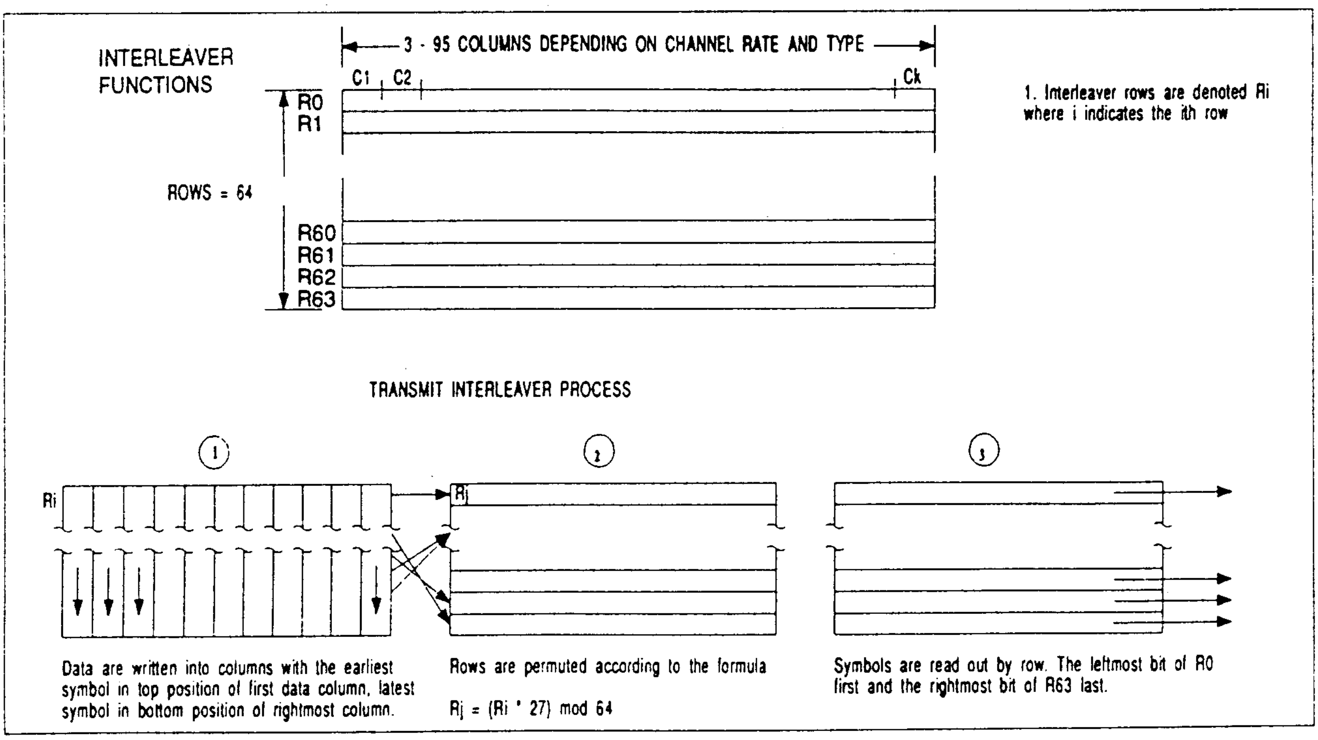


Figure 4-4. Interleaver functions

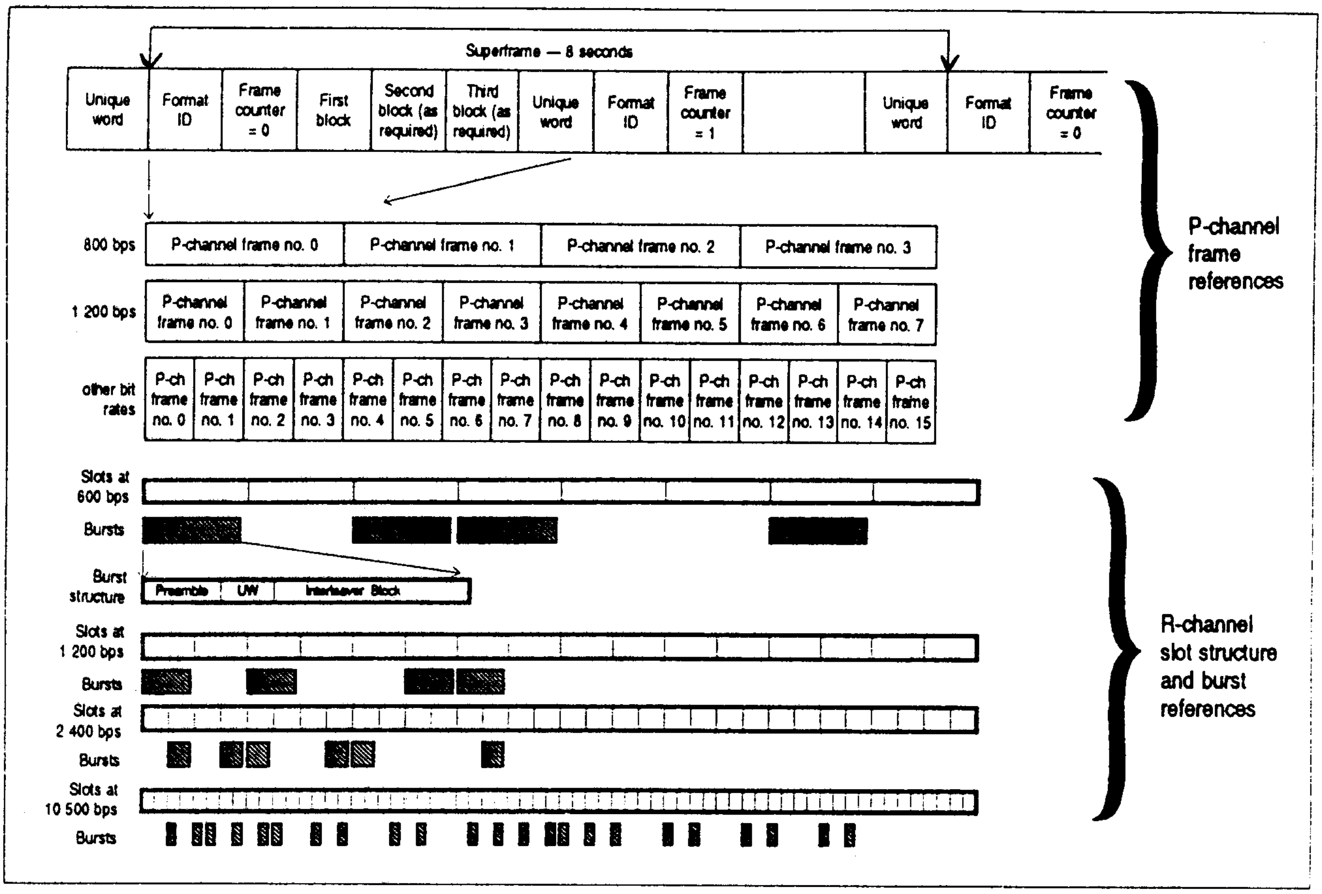


Figure 4-5. Timing references between P and R channels

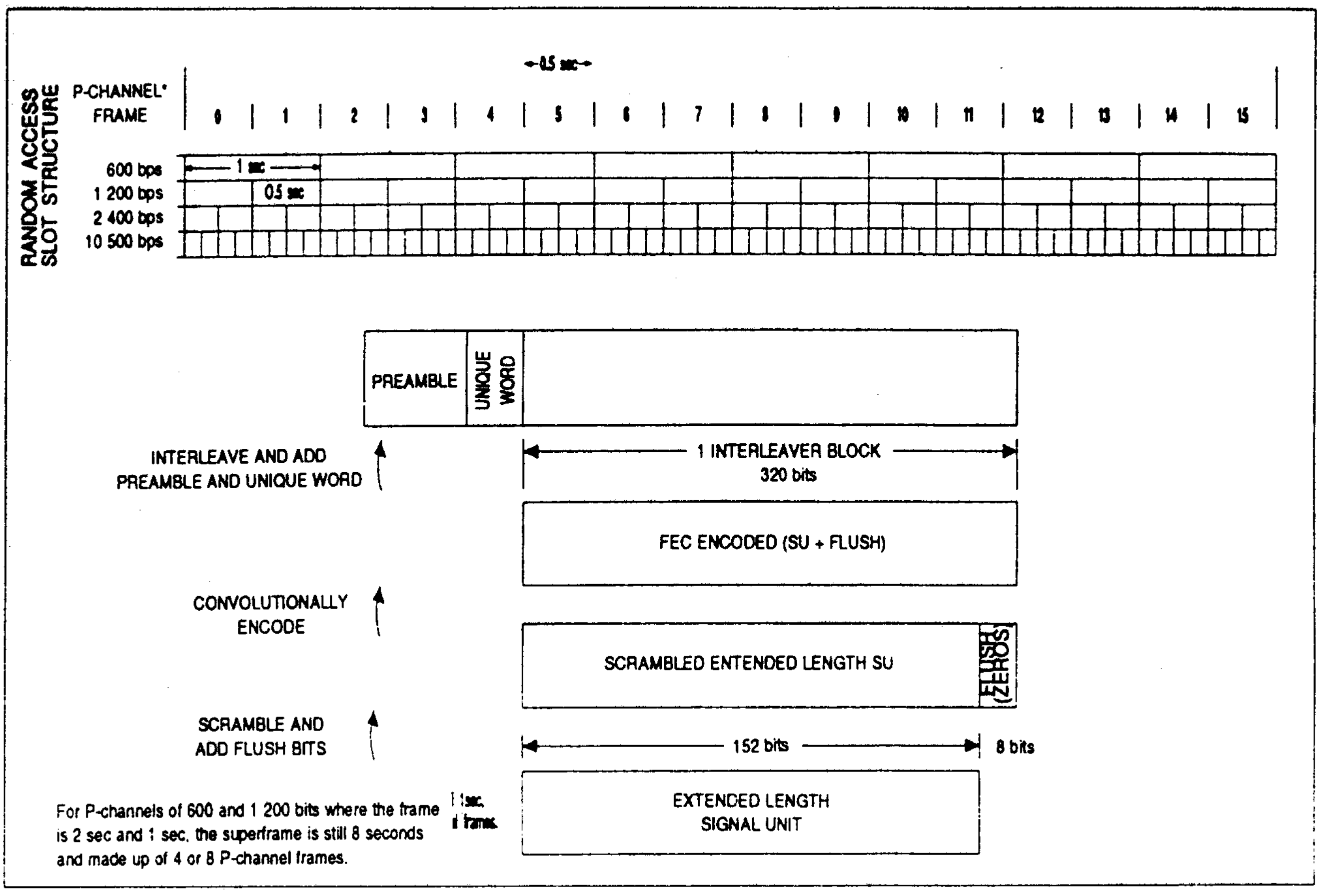


Figure 4-6. R channel burst format

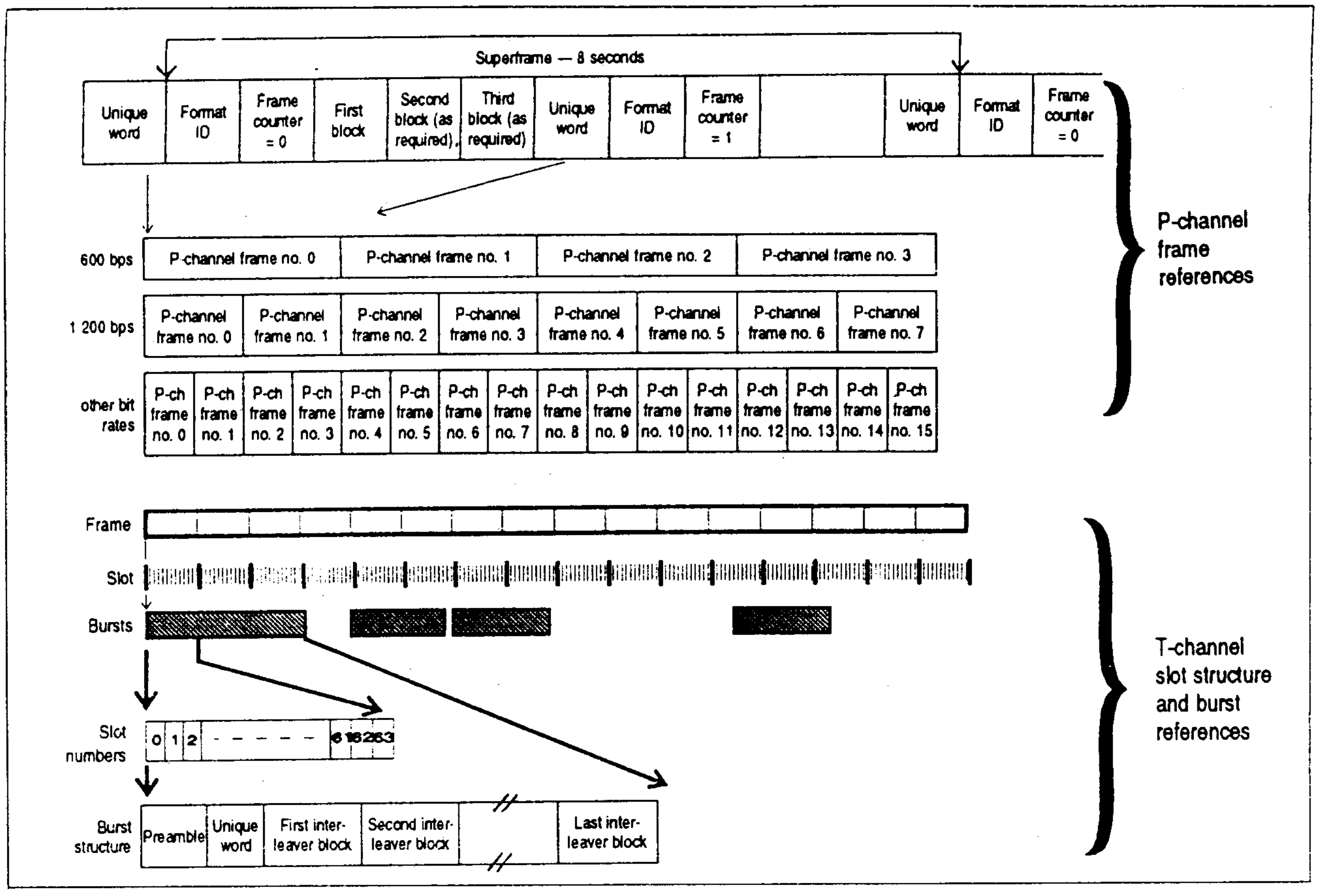
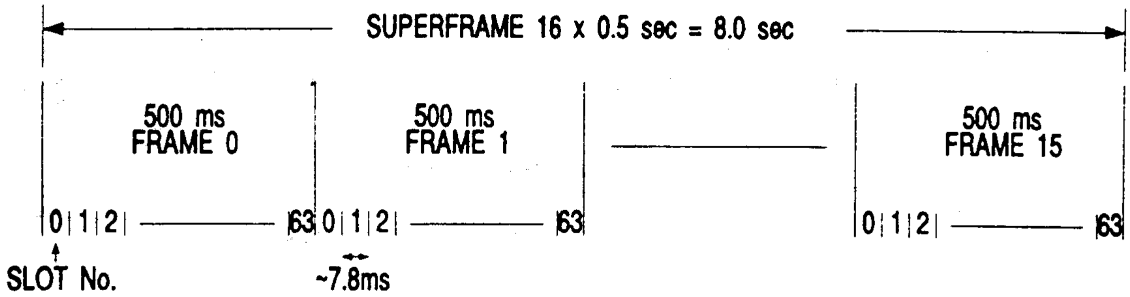
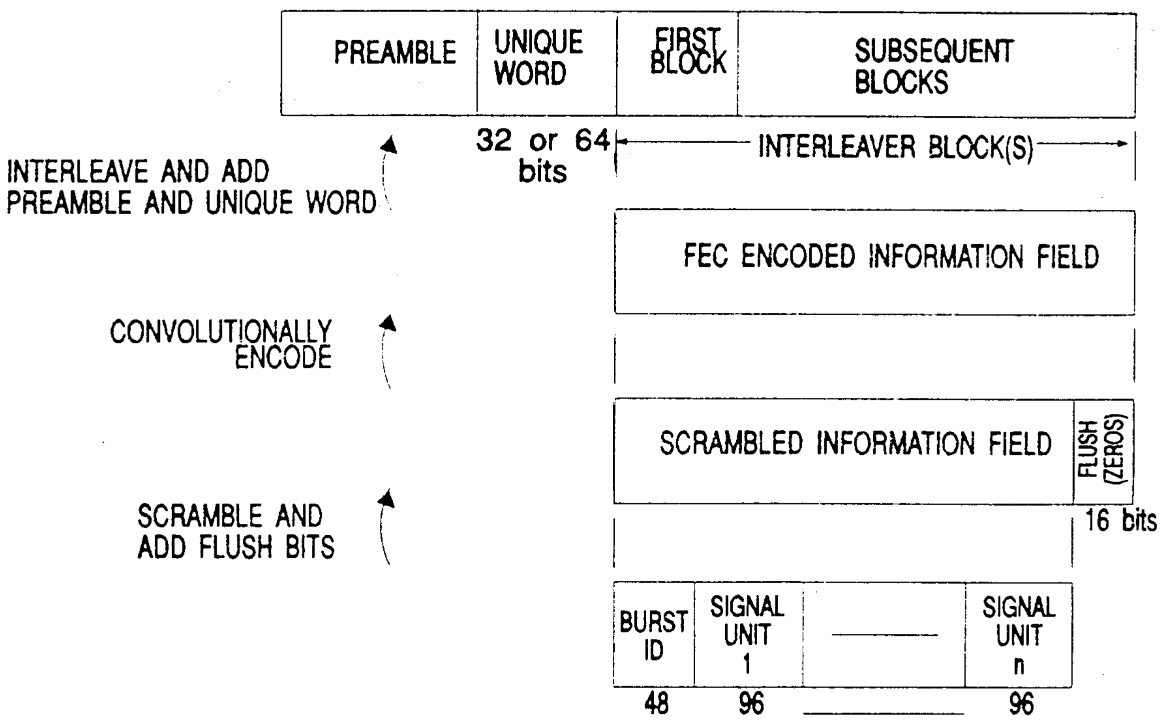


Figure 4-7. Timing references between P and T channels



a) Slot Structure



b) Burst Format

Figure 4-8. T channel format

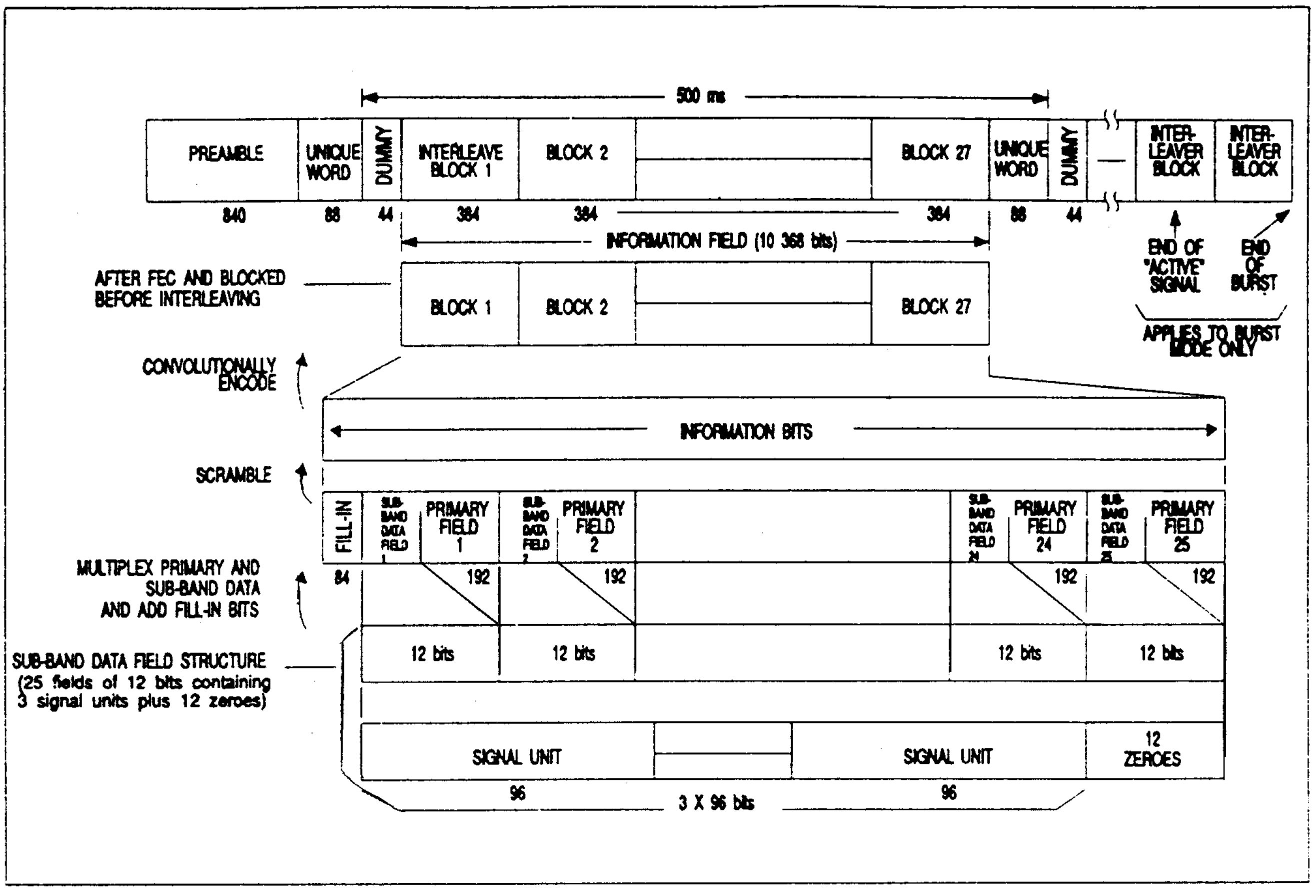


Figure 4-9. C channel format at 21.0 kbits/s channel rate

9/11/95

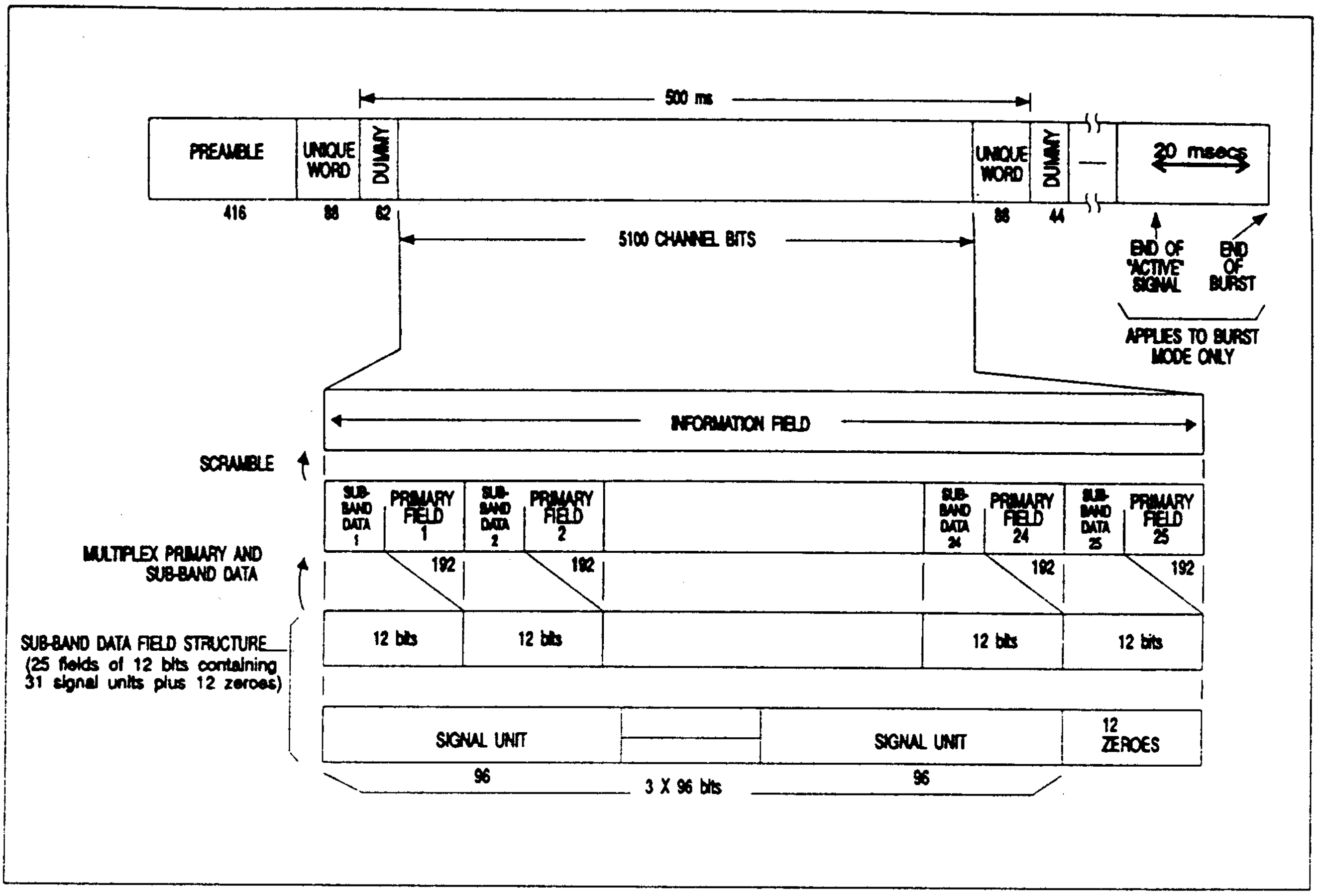


Figure 4-10. C channel format at 10.5 kbits/s channel rate

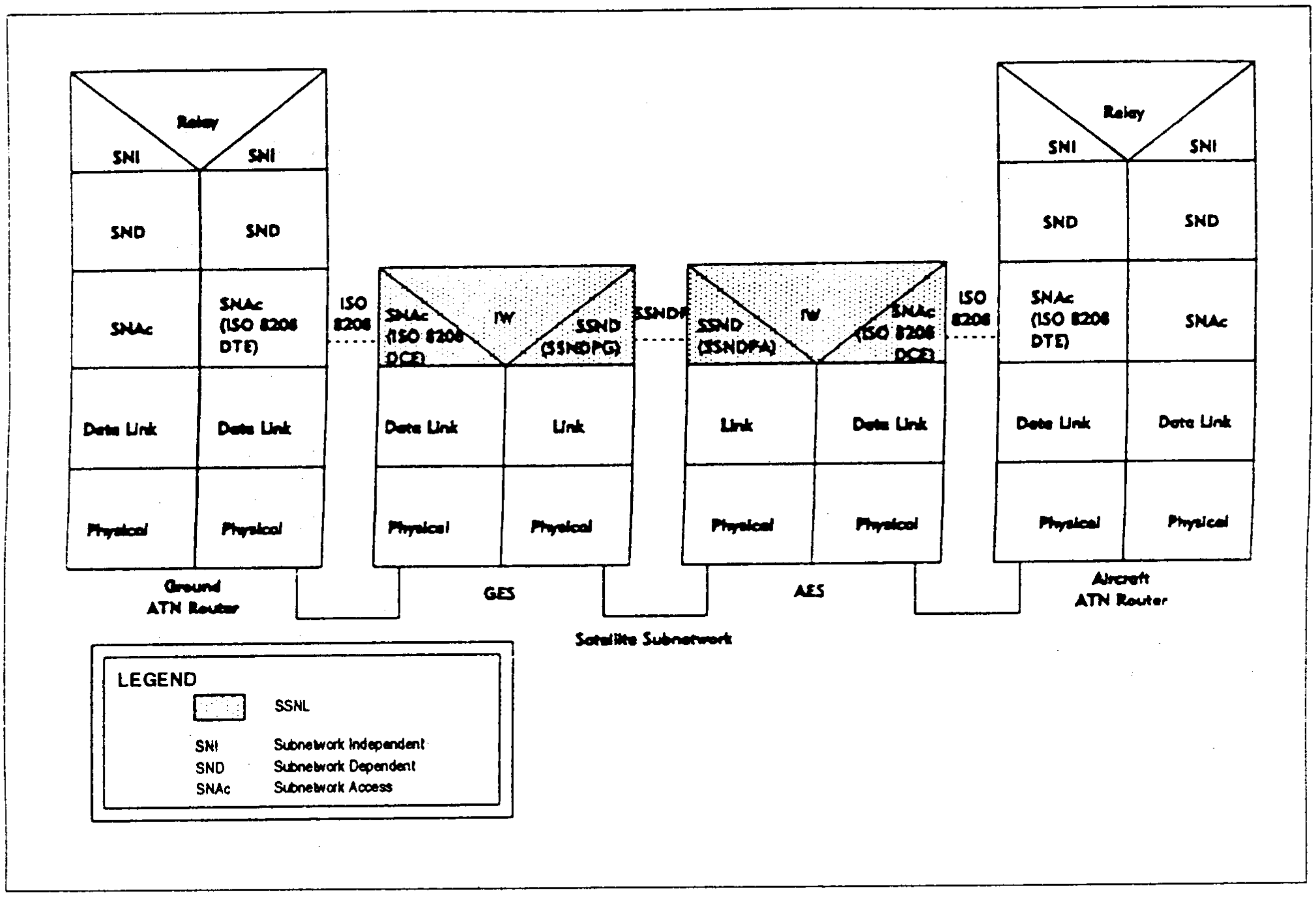


Figure 4-11. The SSNL functions and the ATN satellite subnetwork

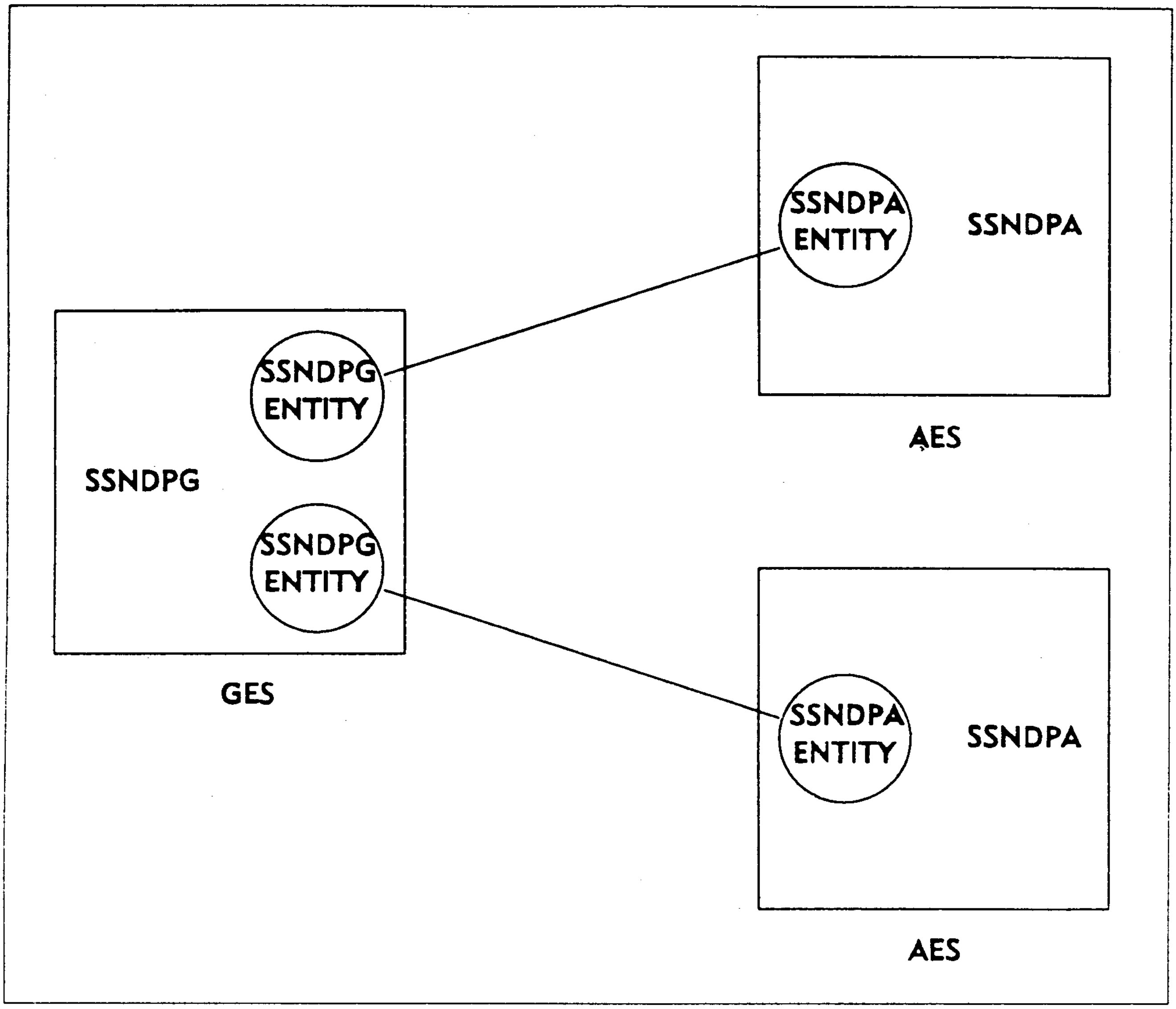


Figure 4-12. SSNDPX entities

Bits

Octets	8	7	6	5	4	3	2	1
1	M	D	SNPDU type identifier					
2	Logical channel number							
	Additional fields depending on SNPDU type							

Figure 4-13. General format of a SNPDU

Bits

Octets	8	7	6	5	4	3	2	1
1	0	X	X	0	0	X	X	X
2	Logical channel number							
3	DTE address length							
	Called DTE **							
	Calling DTE **							
	Called NSAP *							
	Calling NSAP *							
	Facility field length *							
	Facilities *							
	Call user data *							

* if present
** if length not equal to 0

Figure 4-14. Connection request SNPDU format

Bits

Octets		8	7	6	5	4	3	2	1
	1	0	X	0	0	1	0	X	X
	2	Logical channel number							
		Called NSAP address *							
		Facility field length *							
		Facilities *							
		Call user data *							

* if present

Figure 4-15. Connection confirm SNPDU format

Bits

Octets		8	7	6	5	4	3	2	1
	1	0	0	0	1	0	0	X	0
	2	Logical channel number							
		Called NSAP address *							
		Clearing cause							
		Diagnostic code							
		Clear user data *							

* if present

Figure 4-16. Connection released SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	0	0	0	1	1	0	0	0
2	Logical channel number							

Figure 4-17. Connection release complete SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	M	D	1	1	0	0	0	0
2	Logical channel number							
3	SNPDU number							
	User data							

Figure 4-18. Data SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	0	0	1	1	0	0	1	0
2	Logical channel number							
	Interrupt user data							

Figure 4-19. Interrupt data SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	0	0	1	1	1	0	1	0
2	Logical channel number							

Figure 4-20. Interrupt confirm SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	0	0	1	1	0	0	1	1
2	Logical channel number							
3	Resetting cause							
4	Diagnostic code							

Figure 4-21. Reset SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	0	0	1	1	1	0	1	1
2	Logical channel number							

Figure 4-22. Reset confirm SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	0	0	1	1	1	0	0	1
2	Logical channel number							
3	Flow control reason							
4	SNPDU number							

Figure 4-23. Flow control (suspend) SNPDU format

Bits

Octets	8	7	6	5	4	3	2	1
1	0	0	1	1	1	0	0	1
2	Logical channel number							
3	Flow control reason							

Figure 4-24. Flow control (resume) SNPDU format

Bits

	8	7	6	5	4	3	2	1
Code:	0	0	0	0	0	0	1	0

	8 7 6 5	4 3 2 1
Parameter field:	from the called DTE *	from the calling DTE *

* The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated on the right

Bits: 8765 or Bits: 4321	Throughput class (bits/s) as defined in ISO-8208
0000	Reserved
0001	Reserved
0010	Reserved
0011	75
0100	150
0101	300
0110	600
0111	1200
1000	2400
1001	4800
1010	9600
1011	19200
1100	48000
1101	64000
1110	Reserved
1111	Reserved

Figure 4-25. Throughput class negotiation (TCN) facility field

Bits

	8	7	6	5	4	3	2	1
Code:	0	1	0	0	1	0	0	1

	Bits 8 7 6 5 4 3 2 1
Parameter field: Octet 1	Transit delay expressed in millisecond (higher order bits)
Octet 2	Transit delay expressed in millisecond (lower order bits)

Figure 4.26. Transit delay selection and indication facility format

Bits

	8	7	6	5	4	3	2	1
Code:	0	0	0	0	0	0	0	1
Parameter field:	0	0	0	0	0	0	0	0

Figure 4-27. Fast select (use not permitted) facility format

Bits

	8	7	6	5	4	3	2	1
Code:	0	0	0	0	1	0	1	1
Parameter field:	0	0	0	0	0	0	0	0

Figure 4-28. Expedited data negotiation ("no use of expedited data") facility format

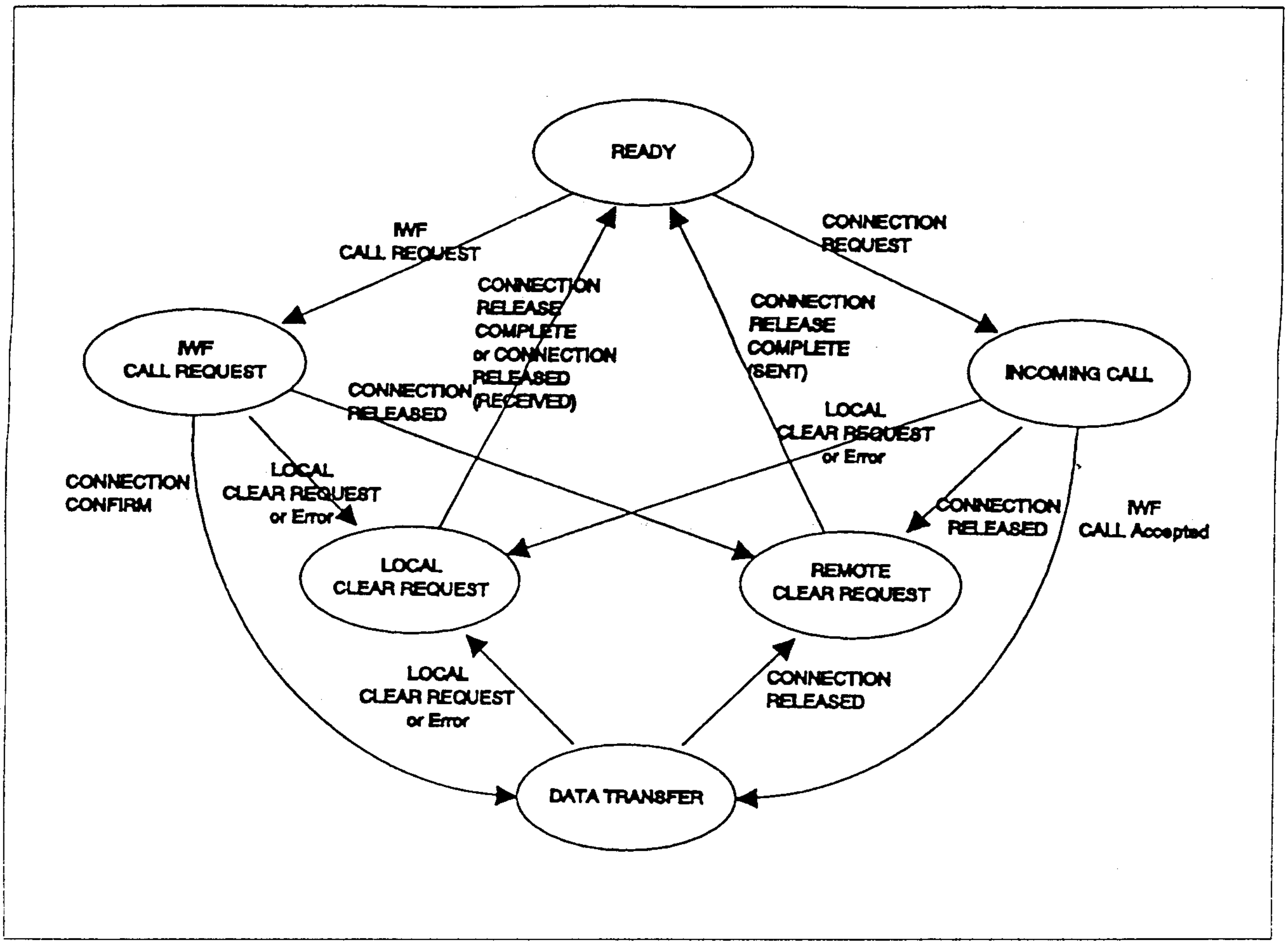


Figure 4-29. Connection establishment and release state diagram

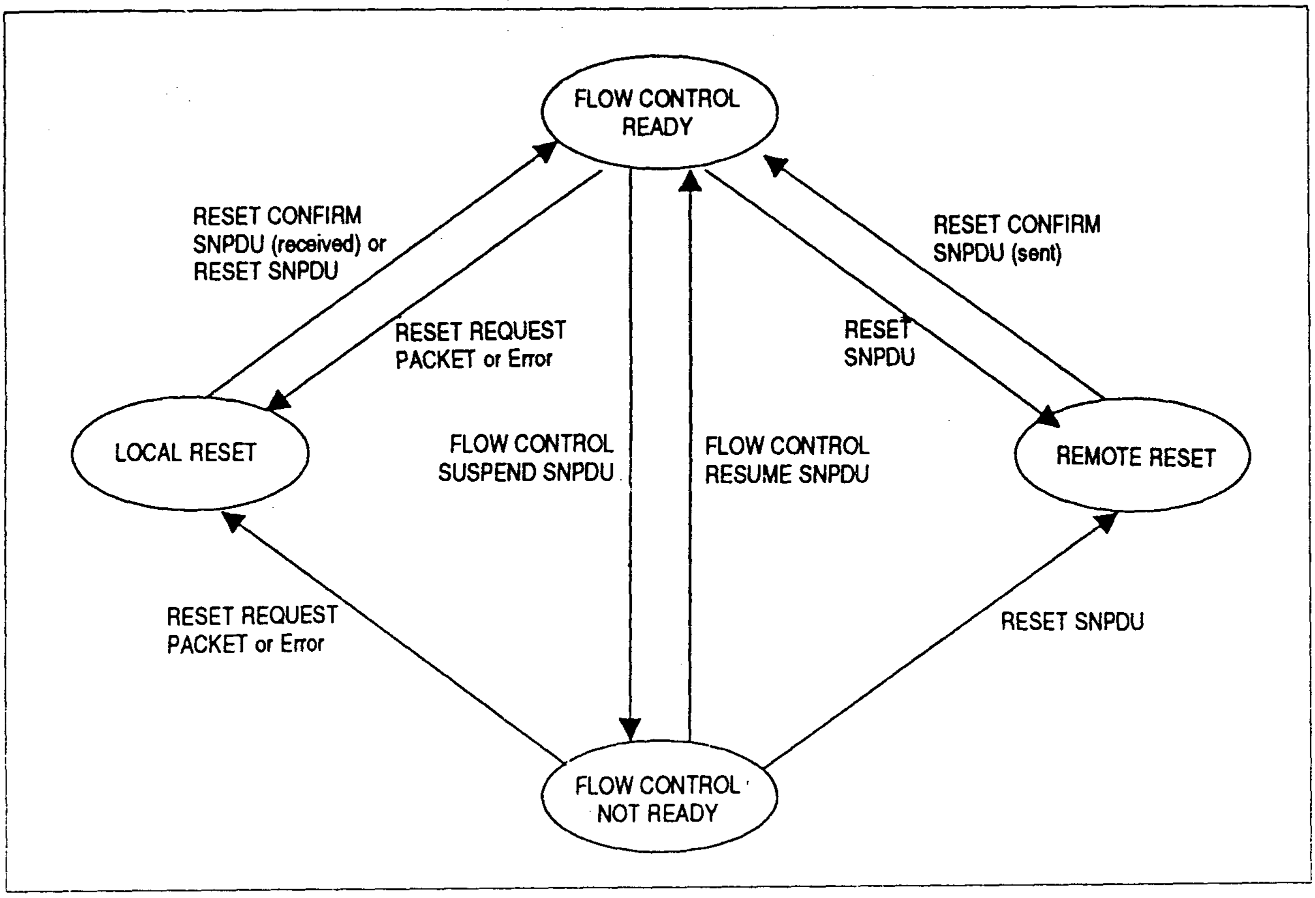


Figure 4-30. Reset and flow control state diagrams within the data transfer state

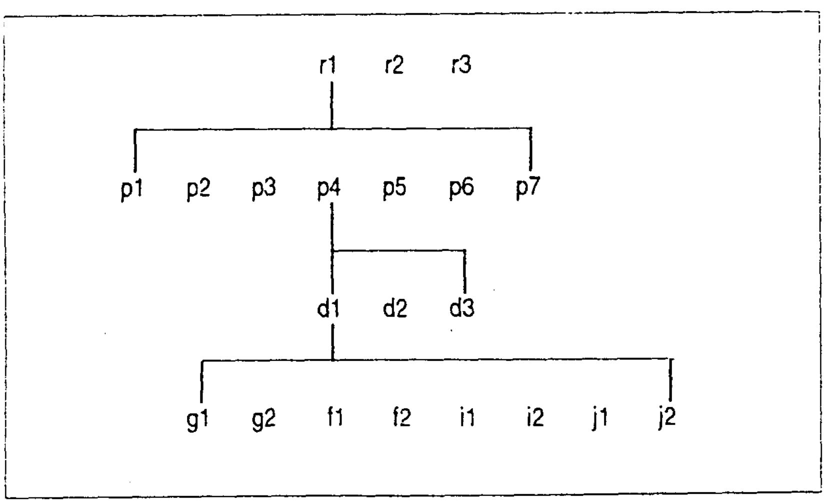


Figure 4-31. ISO-8208 DCE sub-state hierarchy

Appendix 1 to Chapter 4

RESPONSE MASKS OF A-BPSK AND A-QPSK FILTERS

Table A1-1. Required filter amplitude versus frequency response limits for A-BPSK

Upper bound		Lower bound	
Normalized frequency	Amplitude response (dB)	Normalized frequency	Amplitude response (dB)
0	0.25	0	−0.25
0.8	0.25	0.6	−0.25
1.133	−3.5	0.9	−2.5
1.333	−12	1.05	−5.5
1.533	−40	1.22	−12
—	—	1.333	−28
—	—	1.333	−45

The mask shall be defined by drawing straight lines through the above points where frequencies are normalized to the channel rate divided by 2, and the amplitude is normalized to 0 dB at a frequency of 0. This mask is illustrated in the guidance material.

Table A1-2. Required filter phase versus frequency response limits for A-BPSK and A-QPSK

Upper bound		Lower bound	
Normalized frequency	Phase response (deg)	Normalized frequency	Phase response (deg)
0	1.8	0	−1.8
1.0	1.8	1.0	−1.8
1.0	2.8	1.0	−2.8
1.25	≥ 2.8	1.25	≤ −2.8

The mask shall be defined by drawing straight lines through the above points where frequencies are normalized to the channel rate divided by 2, and the amplitude is normalized to 0 dB at a frequency of 0. This mask is illustrated in the guidance material.

Table A1-3. Required filter amplitude versus frequency response limits for A-QPSK

Upper bound		Lower bound	
Normalized frequency	Amplitude response (dB)	Normalized frequency	Amplitude response (dB)
0	0.25	0	−0.25
0.3	0.25	0.2	−0.25
0.7	−1	0.5	−1
1.1	−3	0.9	−3
1.5	−6	1.2	−6
1.7	−10	1.5	−10
2.0	−20	1.7	−16
2.5	−40	1.733	−27
3.0	−40	1.733	−40

The mask shall be defined by drawing straight lines through the above points where frequencies are normalized to the channel rate divided by 4, and the amplitude is normalized to 0 dB at a frequency of 0. This mask is illustrated in the guidance material.

Appendix 2 to Chapter 4

SIGNAL UNIT FORMATS

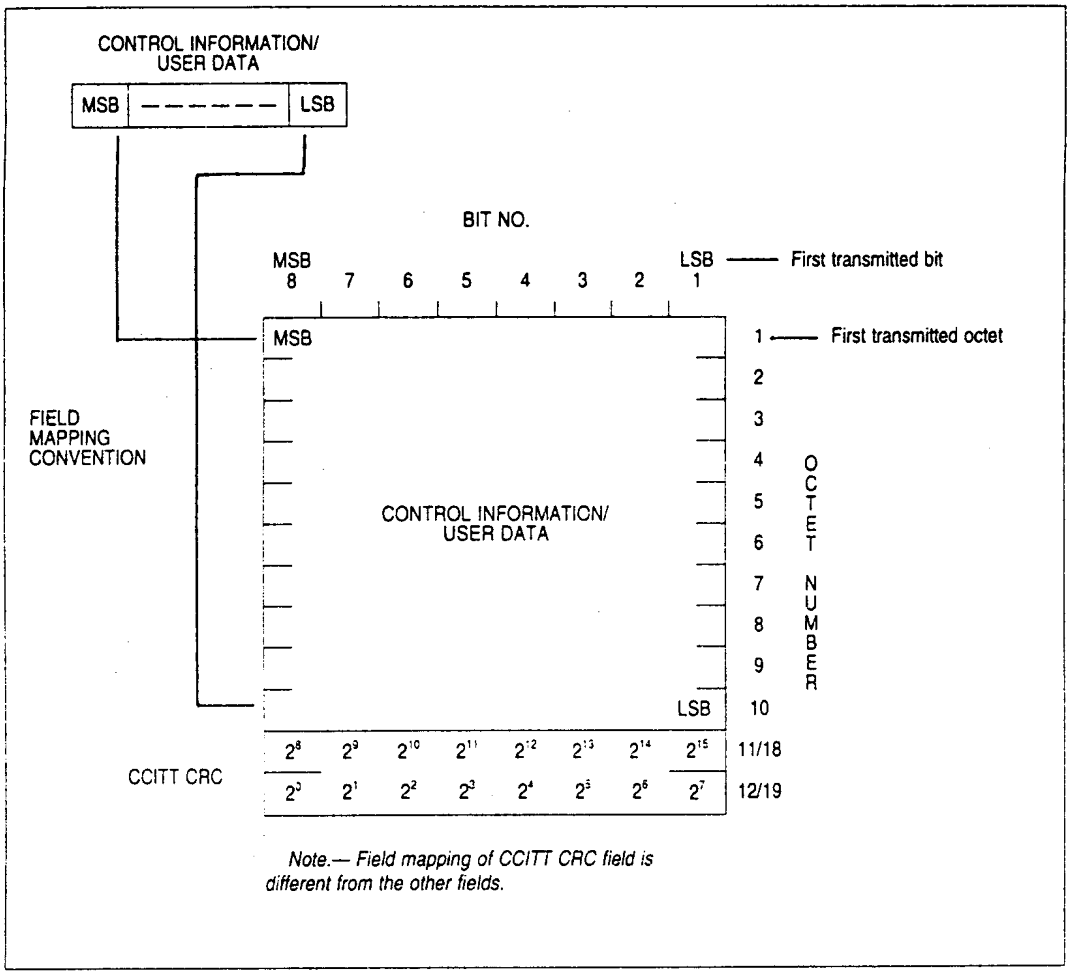


Figure A2-1. Signal unit field mapping and bit transmission order

BIT NO.

8	7	6	5	4	3	2	1	OCTET NUMBER
SEQUENCE INDICATOR				1	1	1	1	1
Q NO.				D/R*	REFERENCE NO.			2
MESSAGE TYPE								3
AES ID								4
								5
								6
GES ID								7
Q NO. (of applications)				NOT	LOV	I/R	P/S	8
SATELLITE ID (previous)						BEAM ID		9
BEAM ID (lsb)				NO. OF C CHANNELS				10
COA**		VOICE CH. CHARACTERISTICS						11
DATA BIT RATE CAPABILITY								12
RESERVED		SC	RESERVED					13
SPARE								14
								15
								16
								17
CCITT CRC								18
								19

* DLS/RLS always set to 0
** Class of AES

Figure A2-2. Log-on request — R channel

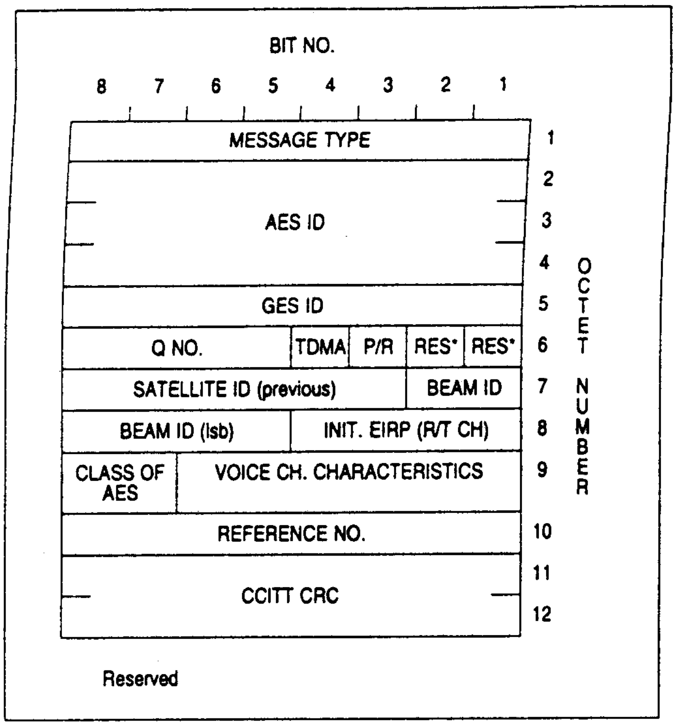


Figure A2-3. Log-on confirm — P channel

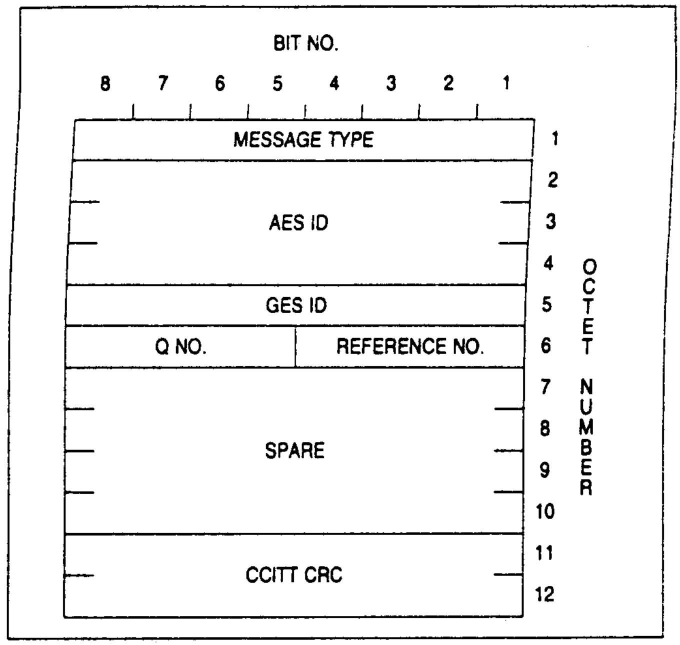


Figure A2-4. Log control — P channel
Log-on interrogation/log-on prompt/
log-off acknowledgement/data channel reassignment

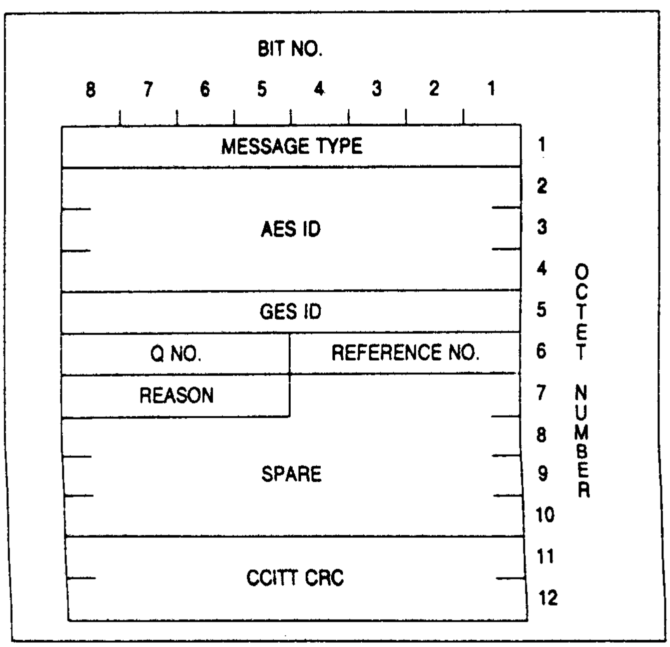


Figure A2-5. Log control — P channel
Log-on reject

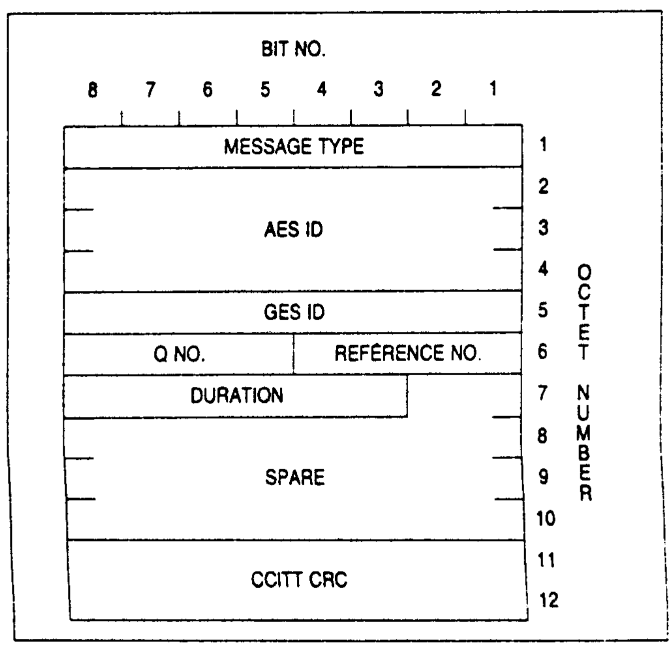


Figure A2-6. Log control — P channel
Log-off request

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–1			OCTET NUMBER
MESSAGE TYPE			1
AES ID			2–4
GES ID			5
Q NO.		RESERVED	6
SOURCE	SERVICE DIRECTION	SERVICE ID	7
Q NO. (of message)		REF. NO. (of message)	8
SPARE	MESSAGE LENGTH		9
SPARE			10
CCITT CRC			11–12

Figure A2-7. Access request data — T channel
Request for reservation (REQ)

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–1			OCTET NUMBER
MESSAGE TYPE			1
AES ID			2–4
GES ID			5
Q NO.		APPLICATION REF. NO.	6
SOURCE	SERVICE DIRECTION	SERVICE ID	7
CIRCUIT DATA RATE		RESERVED	8
SPARE	VOICE CH. CHARACTERISTICS		9
CALLED TERMINAL ID (units digit)		CALLED TERMINAL ID (tens digit)	10
CCITT CRC			11–12

Figure A2-8. Call announcement telephone — P channel

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–1		OCTET NUMBER
MESSAGE TYPE		1
AES ID		2–4
GES ID		5
Q NO.	APPLICATION REF. NO.	6
RESERVED	SEQUENCE NO.	7
CALLING TERMINAL ID (units digit)	CALLING TERMINAL ID (tens digit)	8
DIGIT 3	DIGIT 2	9
DIGIT 5	DIGIT 4	10
CCITT CRC		11–12

Figure A2-9. Call information telephone — from-aircraft sub-band C channel
Service address (ISU)

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–1			OCTET NUMBER
1	1	SEQUENCE NO.	1
Q NO.		APPLICATION REF. NO.	2
DIGIT 7		DIGIT 6	3
DIGIT 9		DIGIT 8	4
RESERVED		RESERVED	5
RESERVED		RESERVED	6
RESERVED		RESERVED	7
RESERVED		RESERVED	8
SPARE		SPARE	9.
SPARE		SPARE	10
CCITT CRC			11–12

Figure A2-10. Call information telephone — from-aircraft sub-band C channel
Service address (SSU)

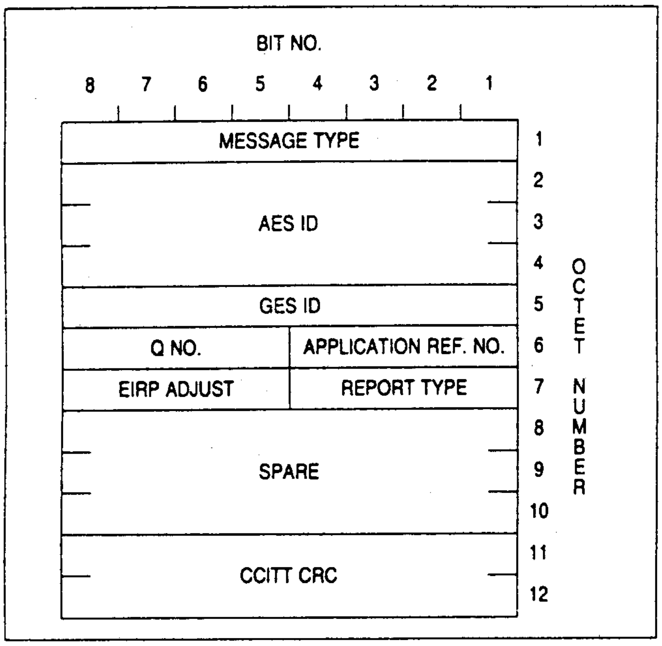


Figure A2-11. Call progress — to-aircraft sub-band C channel
Channel status report

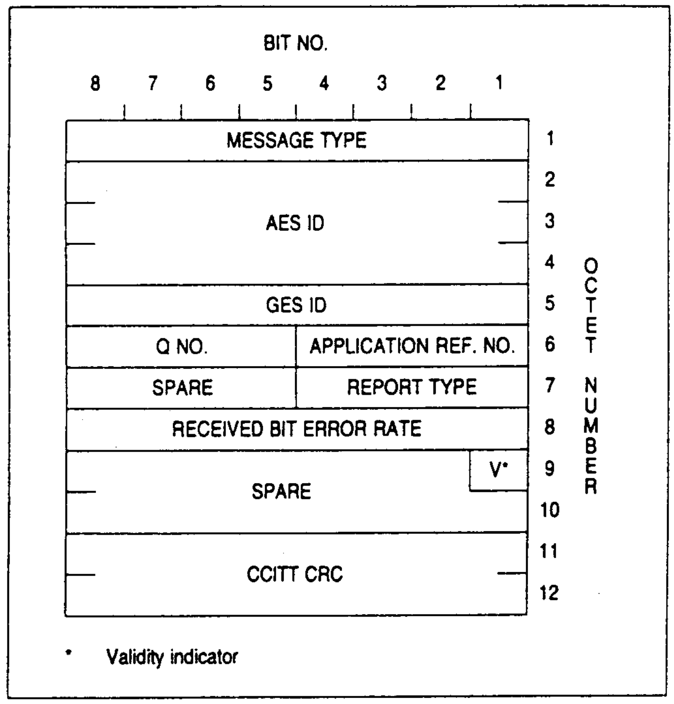


Figure A2-12. Call progress — from-aircraft sub-band C channel
Channel status report

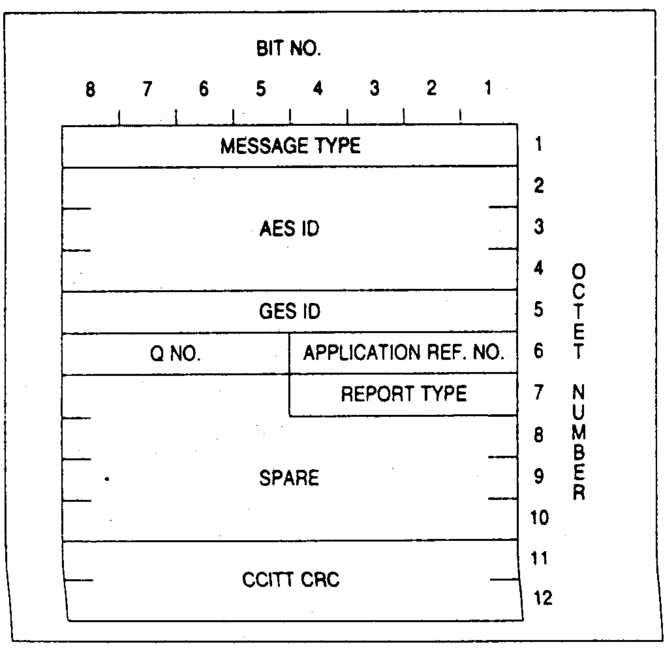


Figure A2-13. Call progress — To-/from-aircraft sub-band C channel
Connect

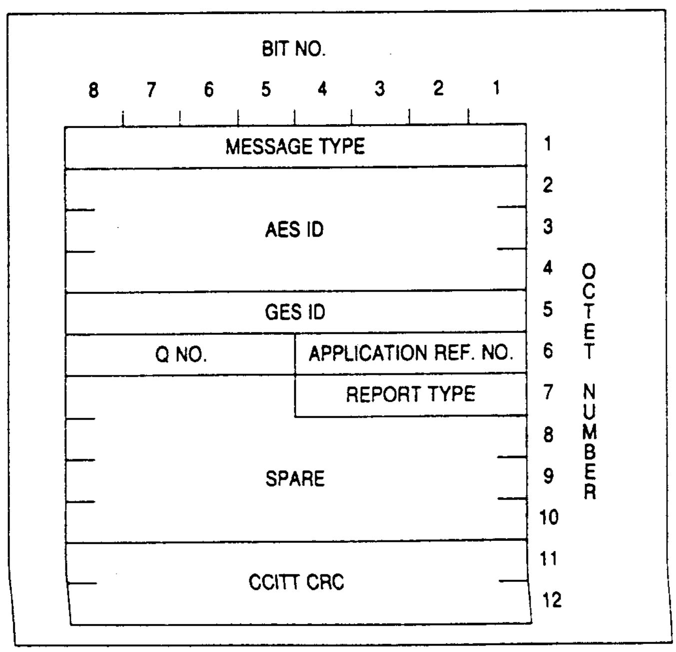


Figure A2-14. Call progress — To-/from-aircraft sub-band C channel
Test

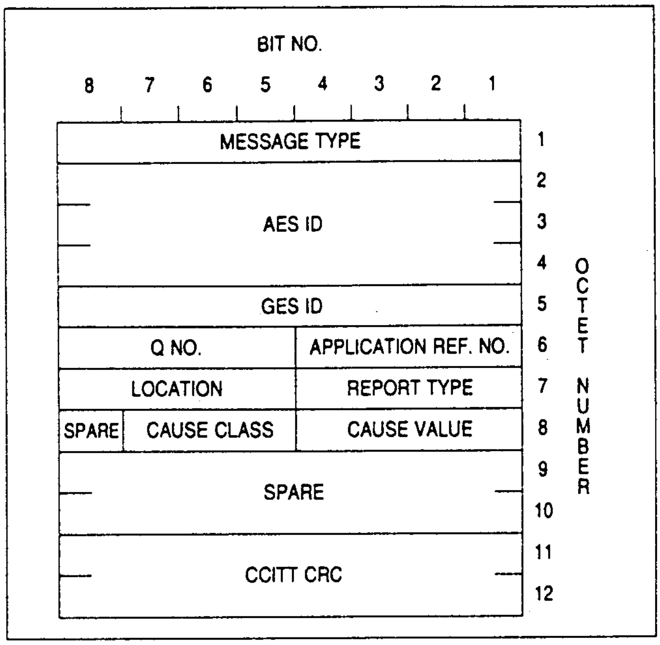


Figure A2-15. Call progress — P or to-/from-aircraft sub-band C channel
Call attempt result

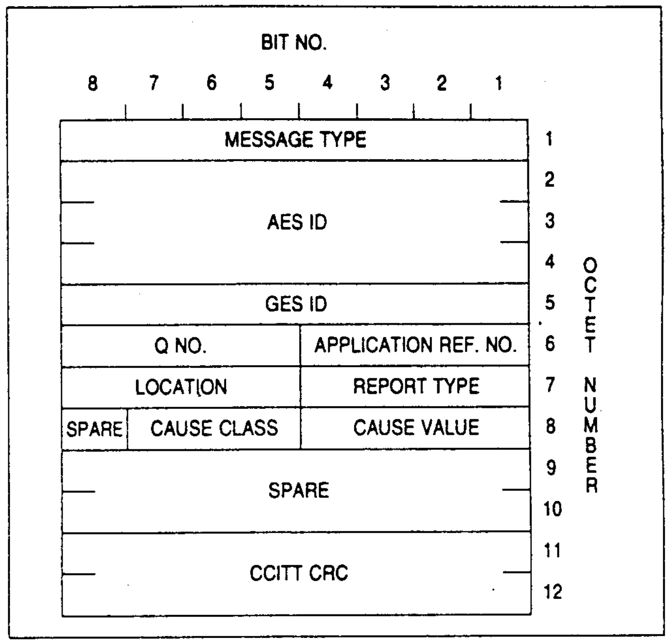


Figure A2-16. Call progress — P or to-/from-aircraft sub-band C channel
Channel release

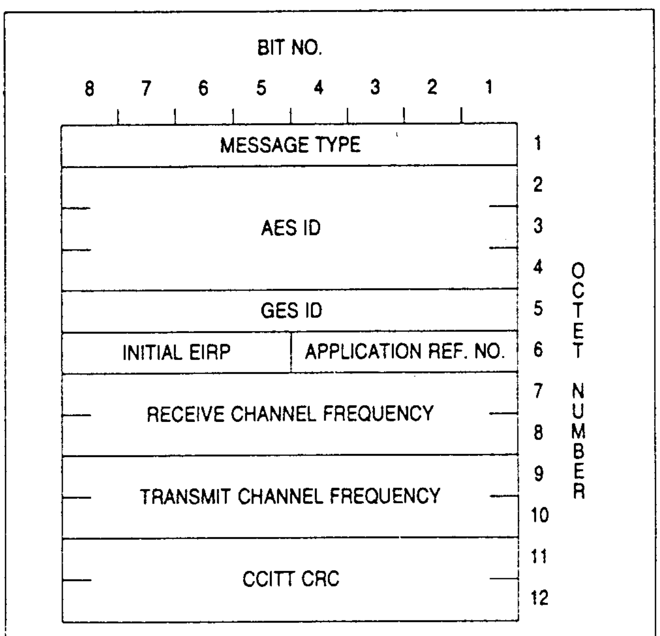


Figure A2-17. C channel assignment — P channel

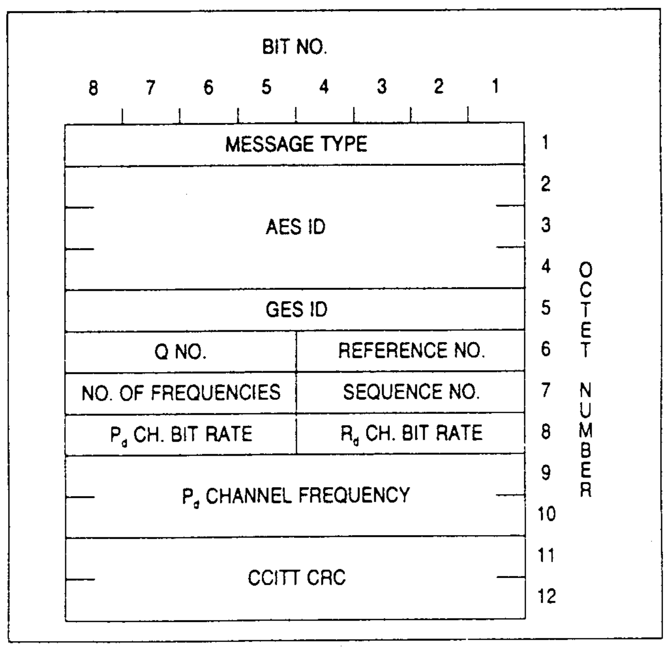


Figure A2-18. P/R channel control — P channel
(ISU)

Octet number	Bit no. 8 7 6 5	Bit no. 4 3 2 1
1	1 1 SEQUENCE NO.	
2	Q NO.	REFERENCE NO.
3–4	R_d CHANNEL NO. 0(4) FREQUENCY	
5–6	R_d CHANNEL NO. 1(5) FREQUENCY	
7–8	R_d CHANNEL NO. 2(6) FREQUENCY	
9–10	R_d CHANNEL NO. 3(7) FREQUENCY	
11–12	CCITT CRC	

Figure A2-19. P/R channel control — P channel (SSU)

Octet number	Bit no. 8 7 6 5	Bit no. 4 3 2 1
1	MESSAGE TYPE	
2–4	AES ID	
5	GES ID	
6	Q NO.	REFERENCE NO.
7	NO. OF FREQUENCIES	SEQUENCE NO.
8	SPARE	CH. NO. 0 BIT RATE
9–10	TDMA CHANNEL NO. 0 FREQUENCY	
11–12	CCITT CRC	

Figure A2-20. T channel control — P channel (ISU)

Octet number	Bit no. 8 7 6 5	Bit no. 4 3 2 1
1	1 1 SEQUENCE NO.	
2	Q NO.	REFERENCE NO.
3–4	TDMA CHANNEL NO. 1 FREQUENCY	
5–6	TDMA CHANNEL NO. 2 FREQUENCY	
7–8	TDMA CHANNEL NO. 3 FREQUENCY	
9	CH. NO. 2 BIT RATE	CH. NO. 1 BIT RATE
10	SPARE	CH. NO. 3 BIT RATE
11–12	CCITT CRC	

Figure A2-21. T channel control — P channel (SSU)

Octet number	Bit no. 8 7 6 5	Bit no. 4 3 2 1
1	MESSAGE TYPE	
2–4	AES ID	
5	GES ID	
6	Q NO.	SPARE
7	SPARE	
8	NO. OF BURSTS RESERVED	BURST LENGTH
9	STARTING SLOT NUMBER	T_x CH. NO.
10	BURST INTERVAL	STARTING FRAME NO.
11–12	CCITT CRC	

Figure A2-22. Unsolicited reservation — P channel

BIT NO. 8 7 6 5 4 3 2 1

Fields (bits 8–1)			Octet number
MESSAGE TYPE			1
AES ID			2–4
GES ID			5
Q NO.	SPARE	RFC*	6
Q NO. (of message)	REF. NO. (of message)		7
NO. OF BURSTS RESERVED	BURST LENGTH		8
STARTING SLOT NUMBER	T_x CH. NO.		9
BURST INTERVAL	STARTING FRAME NO.		10
CCITT CRC			11–12

* Reservation forthcoming flag

Figure A2-23. T channel assignment — P channel RES SU

BIT NO. 8 7 6 5 4 3 2 1

Fields (bits 8–1)			Octet number
MESSAGE TYPE			1
AES ID			2–4
GES ID			5
Q NO.	SPARE	RFC*	6
Q NO. (of message)	REF. NO (of message)		7
(MSB) DELAY TO RES. (LSB)	SPARE		8–10
CCITT CRC			11–12

* Reservation forthcoming flag

Figure A2-24. Reservation forthcoming — P channel RFC LSU

BIT NO. 8 7 6 5 4 3 2 1

Fields (bits 8–1)					Octet number
MESSAGE TYPE					1
AES ID					2–4
GES ID					5
Q NO.	REFERENCE NO.				6
SPARE	AN3*	AN2*	AN1*	SPARE	7
ACKNOWLEDGE MESSAGE TYPE OF MSG1					8
ACKNOWLEDGE MESSAGE TYPE OF MSG2					9
ACKNOWLEDGE MESSAGE TYPE OF MSG3					10
CCITT CRC					11–12

* ACK/NAK for Messages 1, 2 or 3

Figure A2-25. Log-on acknowledgement — P channel

BIT NO. 8 7 6 5 4 3 2 1

Fields (bits 8–1)			Octet number
MESSAGE TYPE			1
AES ID			2–4
GES ID			5
Q NO.	APPLICATION REF. NO.		6
SPARE	ACK/ NAK	REPORT TYPE	7
MESSAGE TYPE OF MISSING SU(s)			8
SPARE			9–10
CCITT CRC			11–12

Figure A2-26. Telephony acknowledgement — P/sub-band C channel

BIT NO. 8 7 6 5 4 3 2 1

Field		Octet number
MESSAGE TYPE		1
AES ID		2
AES ID		3
AES ID		4
GES ID		5
Q NO. (of message)	REF. NO. (of message)	6
SPARE	MESSAGE LENGTH	7
Q NO.	SPARE	8
SPARE		9
SPARE		10
CCITT CRC		11
CCITT CRC		12

Figure A2-27. Request for acknowledgement — P channel

BIT NO. 8 7 6 5 4 3 2 1

Field			Octet number
MESSAGE TYPE			1
AES ID			2
AES ID			3
AES ID			4
GES ID			5
Q NO. (of message)		REF. NO. (of message)	6
CH. TYPE	NO. OF SSU NK*	ACKNOWLEDGE CONTROL	7
Q NO.		SSU SEQUENCE IND.+	8
SPARE		SSU SEQUENCE IND**	9
SPARE		RESERVED	10
CCITT CRC			11
CCITT CRC			12

* Number of SSUs in acknowledgement indicating error
** Spare in RACK identifying one missing SU and in RACK indicating no error
\+ Spare in RACK indicating no error

Figure A2-28. Acknowledgement — P channel
R channel acknowledgement (RACK)

BIT NO. 8 7 6 5 4 3 2 1

Field			Octet number
MESSAGE TYPE			1
AES ID			2
AES ID			3
AES ID			4
GES ID			5
Q NO. (of message)		REF. NO. (of message)	6
CH. TYPE	NO. OF SSU NK*	ACKNOWLEDGE CONTROL	7
(MSB) DELAY TO RES. (LSB)	SSU SEQUENCE NO.**		8
(MSB) DELAY TO RES. (LSB)	SSU SEQUENCE NO.**		9
(MSB) DELAY TO RES. (LSB)	SSU SEQUENCE NO.**		10
CCITT CRC			11
CCITT CRC			12

* Number of SSUs in acknowledgement indicating error
** Spare in TACK requesting complete retransmissions and in TACK indicating no error
\+ Spare in TACK indicating no error

Figure A2-29. Acknowledgement — P channel
T channel acknowledgement (TACK)

BIT NO. 8 7 6 5 4 3 2 1

Field			Octet number
MESSAGE TYPE			1
REVISION NO.			2
INITIAL SEQ. NO. OF A2-31 (PARTIAL)	SPARE	EXS*	3
INITIAL SEQ. NO. OF A2-32 & 33 (PARTIAL)	SPARE	EXS*	4
INITIAL SEQ. NO. OF A2-34 (PARTIAL)	SPARE	EXS*	5
INITIAL SEQ. NO. OF A2-31 (COMP)	SPARE	EXS*	6
INITIAL SEQ. NO. OF A2-32 & 33 (COMP)	SPARE	EXS*	7
INITIAL SEQ. NO. OF A2-34 (COMP)	SPARE	EXS*	8
INITIAL SEQ. NO. OF 2nd 2-31 (COMP)	SPARE	EXS*	9
SPARE		SBS+	10
CCITT CRC			11
CCITT CRC			12

* Existence
\+ Spot beam series

Figure A2-30. AES system table broadcast — P channel
Global beam series index

9/11/95

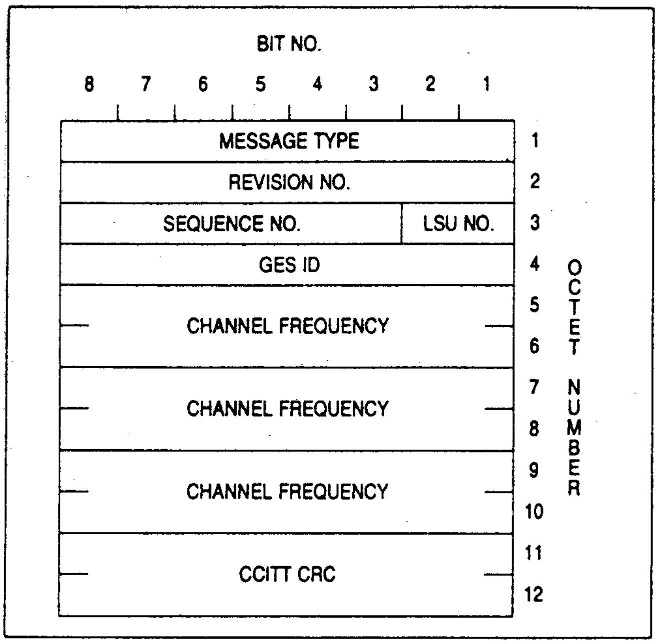


Figure A2-31. AES system table broadcast — P channel
GES P/R channel advice

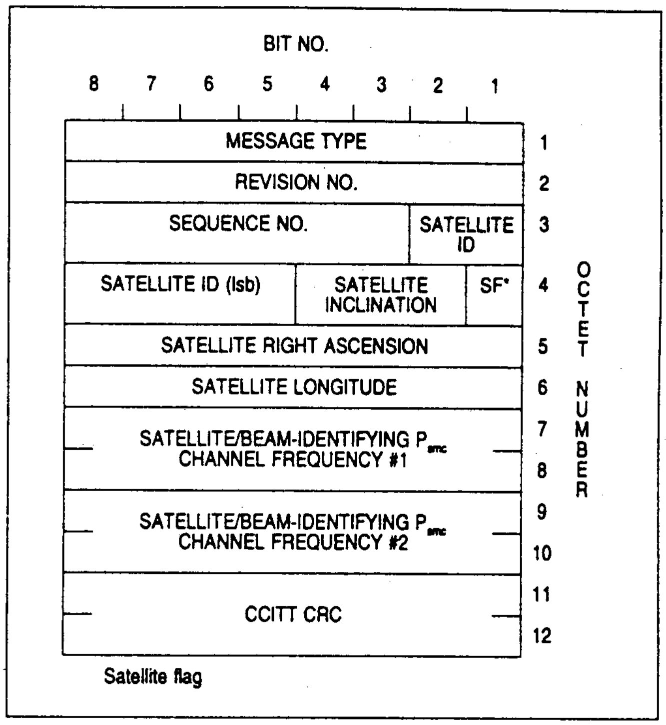


Figure A2-32. AES system table broadcast — P channel
Satellite/beam ID channel advice

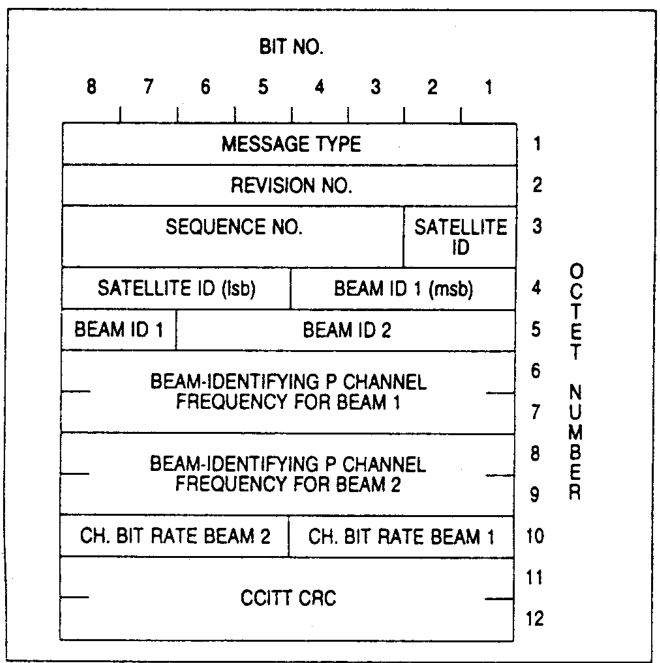


Figure A2-33. AES system table broadcast — P channel
Beam ID channel advice

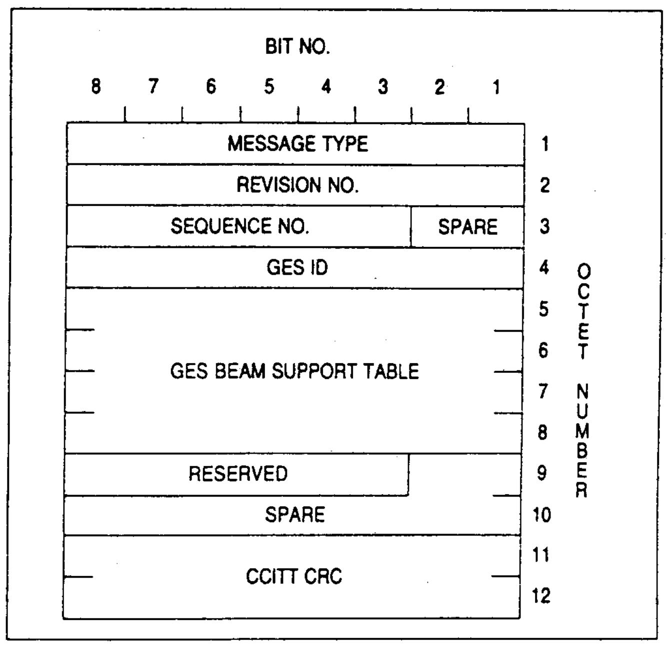


Figure A2-34. AES system table broadcast — P channel
GES beam support advice

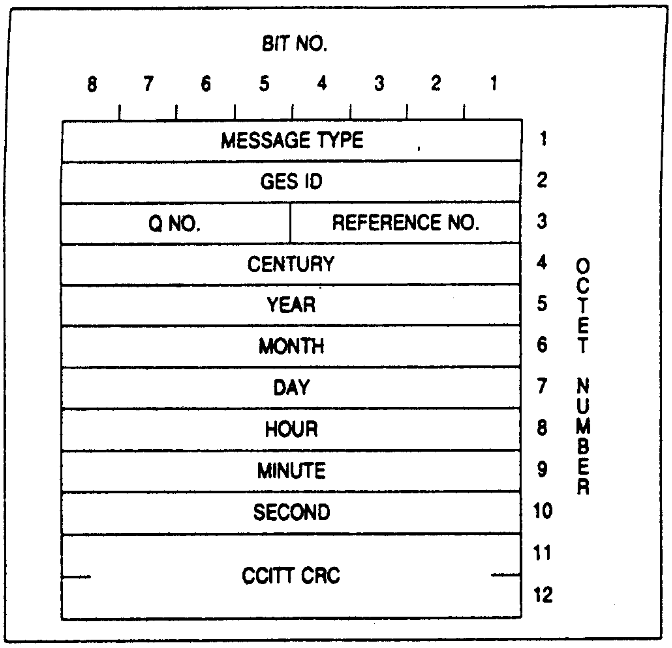


Figure A2-35. System broadcast — P channel
Universal Time

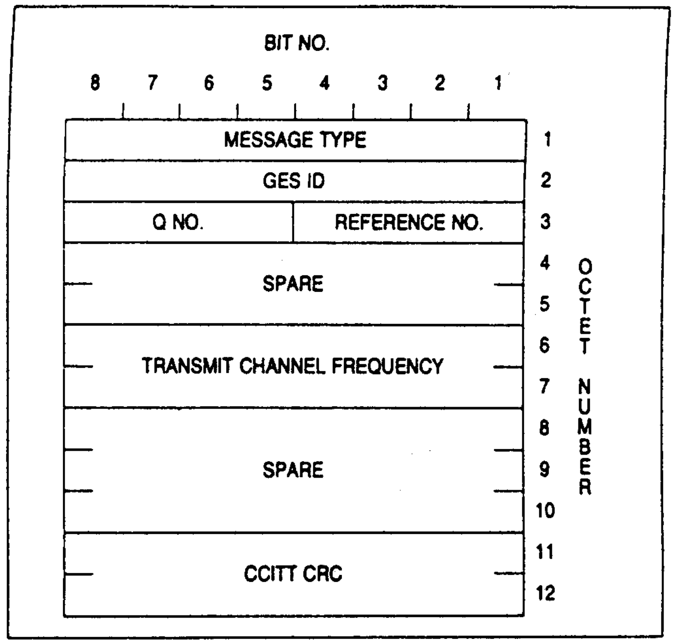


Figure A2-36. System broadcast — P channel
Selective release

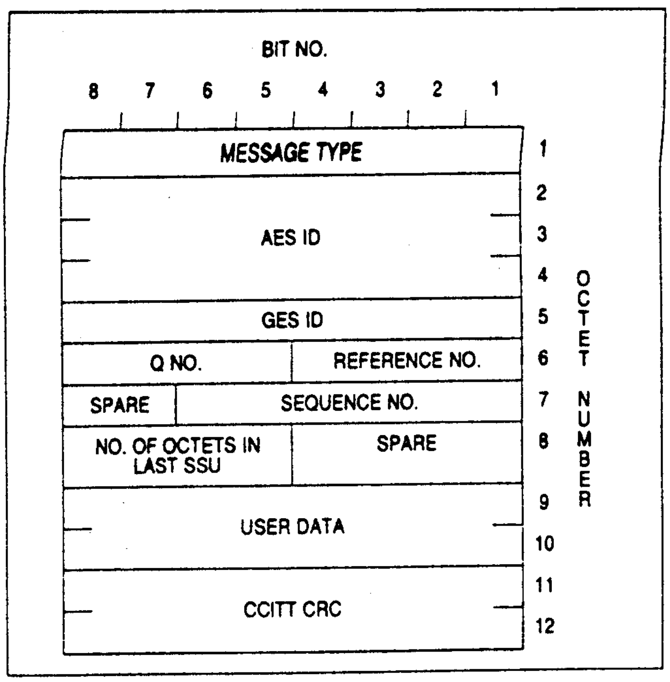


Figure A2-37. User data — P/T channel
ISU

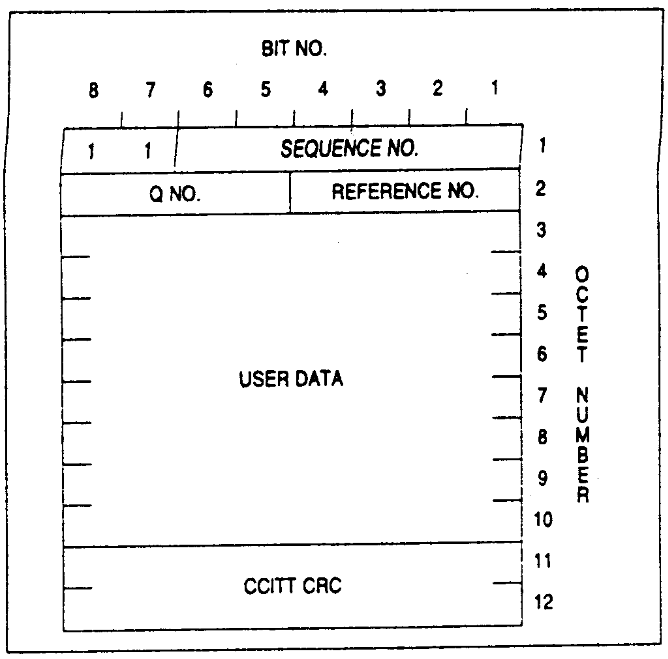


Figure A2-38. User data — P/T channel
SSU

9/11/95

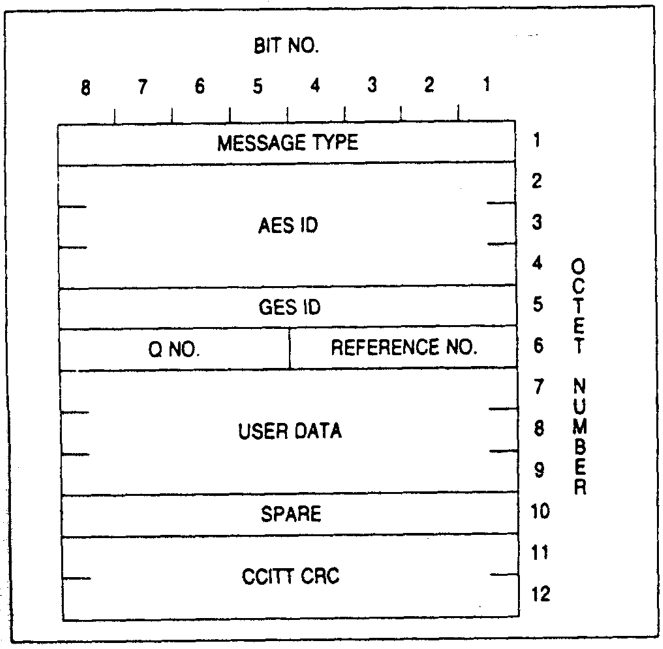


Figure A2-39. User data — P channel
3 octet LSU

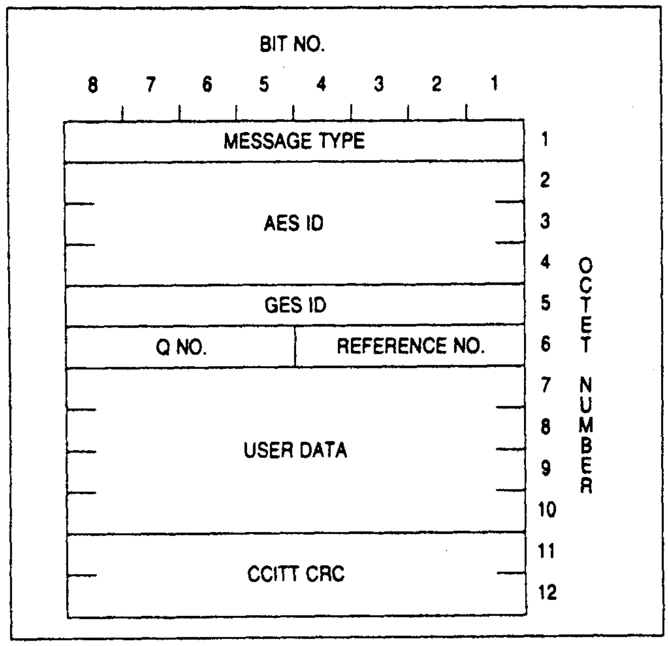


Figure A2-40. User data — P channel
4 octet LSU

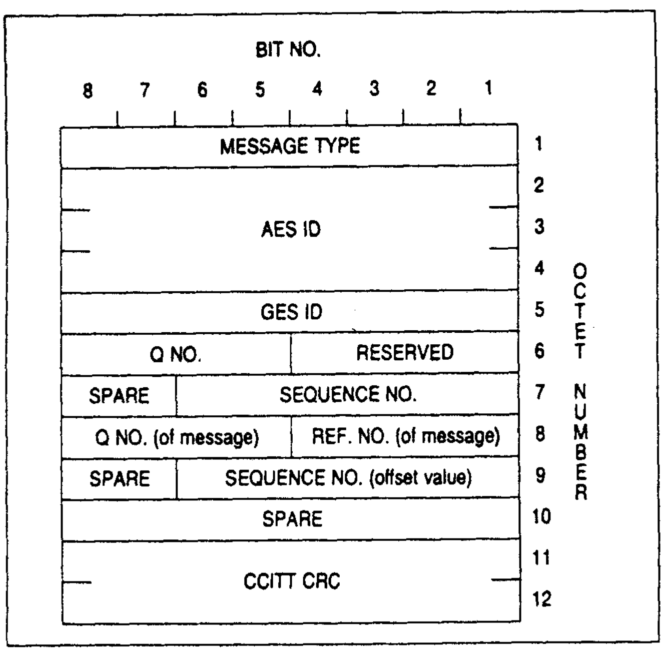


Figure A2-41. Retransmission header — P/T channel
RTX SU

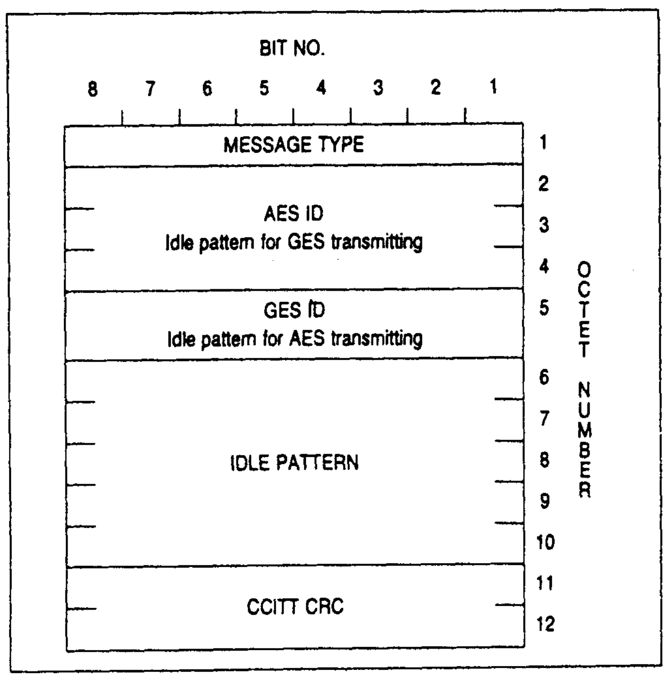


Figure A2-42. Fill-in — P, T and to-/from-aircraft sub-band C channel
FISU

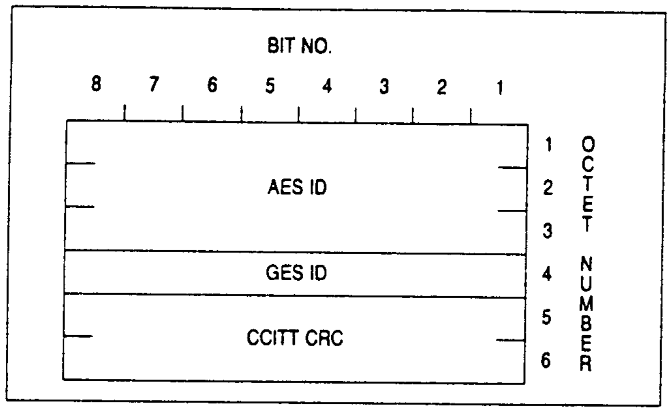


Figure A2-43. Burst identifier — T channel

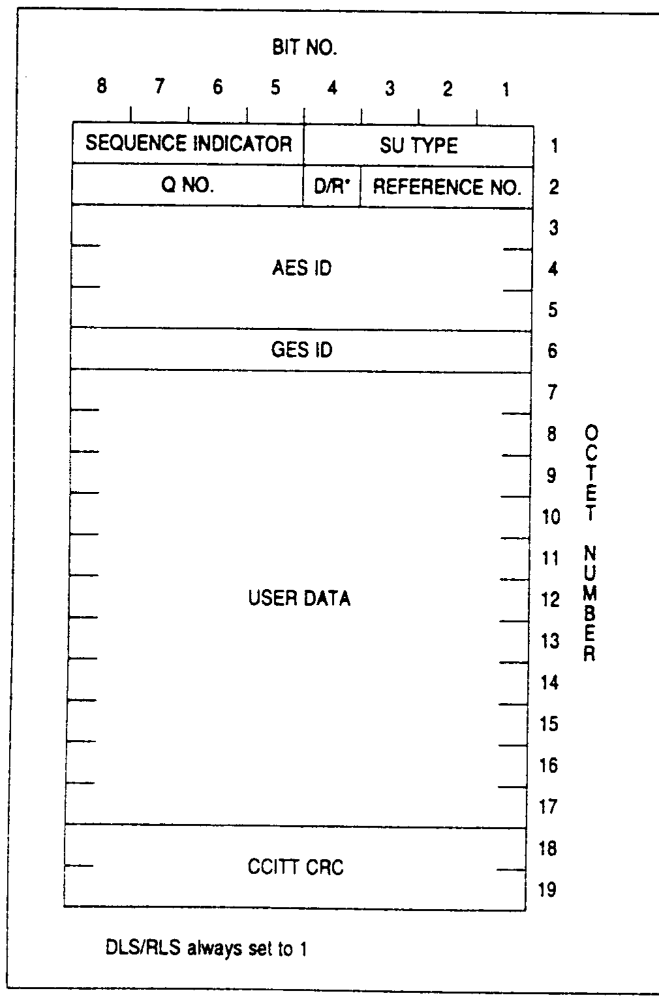


Figure A2-44. User data — R channel
ISU/SSU

BIT NO.

8	7	6	5	4	3	2	1	OCTET NUMBER
SEQUENCE INDICATOR				1	1	1	1	1
Q NO.				D/R*	RESERVED			2
MESSAGE TYPE								3
AES ID								4
								5
								6
GES ID								7
RESERVED				APPLICATION REF. NO.				8
SOURCE		SERVICE DIRECTION		SERVICE ID				9
RESERVED				NETWORK ID				10
SPARE		VOICE CH. CHARACTERISTICS						11
DIGIT 1				DIGIT 0				12
SPARE								13
								14
								15
								16
								17
CCITT CRC								18
								19

* DLS/RLS always set to 0

Figure A2-45. Access request telephone — R channel

BIT NO.

8	7	6	5	4	3	2	1	OCTET NUMBER
SEQUENCE INDICATOR				1	1	1	1	1
Q NO.				D/R*	RESERVED			2
MESSAGE TYPE								3
AES ID								4
								5
								6
GES ID								7
RESERVED				APPLICATION REF. NO.				8
SOURCE		SERVICE DIRECTION		SERVICE ID				9
RESERVED				NETWORK ID				10
SPARE		VOICE CH. CHARACTERISTICS						11
DIGIT 1				DIGIT 0				12
DIGIT 3				DIGIT 2				13
DIGIT 5				DIGIT 4				14
DIGIT 7				DIGIT 6				15
DIGIT 9				DIGIT 8				16
CALLING TERMINAL ID (units digit)				CALLING TERMINAL ID (tens digit)				17
CCITT CRC								18
								19

* DLS/RLS always set to 0

Figure A2-46. Abbreviated access request telephone — R channel

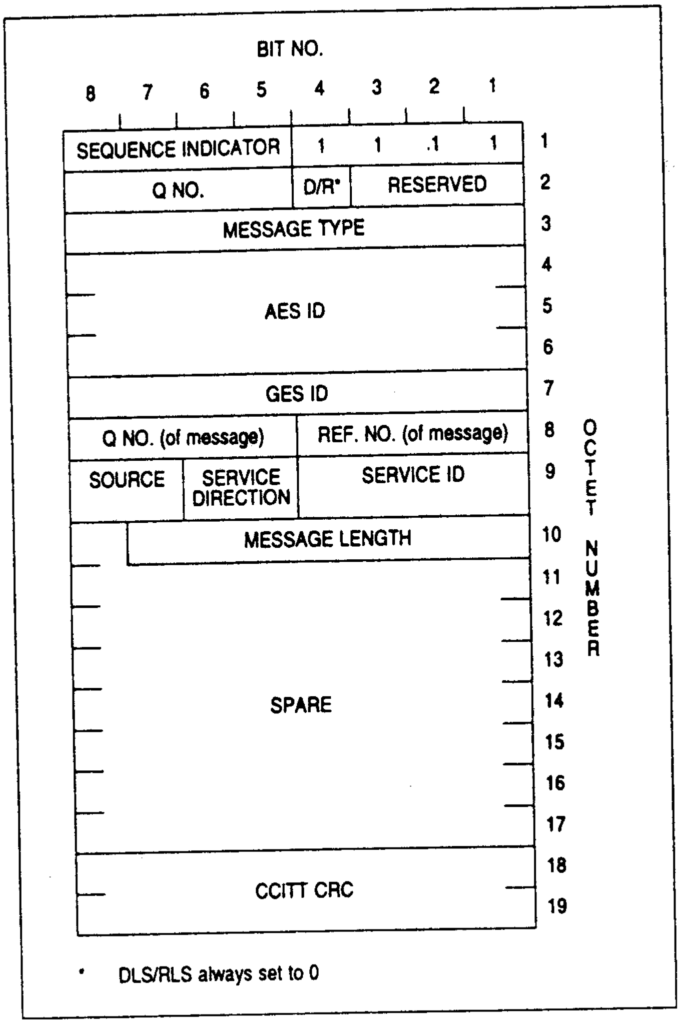


Figure A2-47. Access request data — R channel
Request for reservation (REQ)

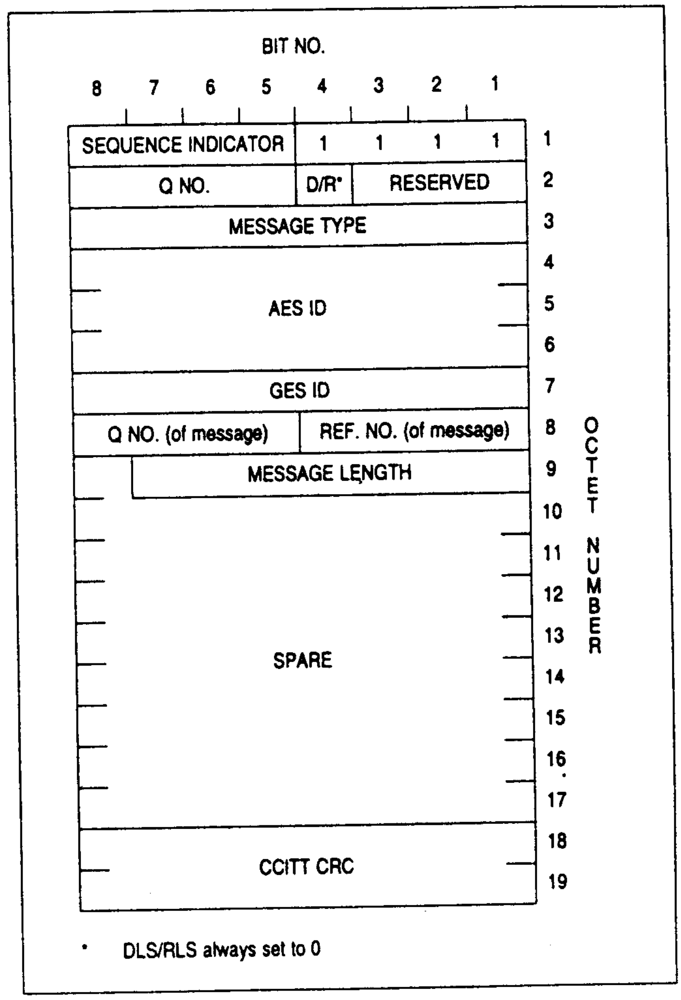


Figure A2-48. Request for acknowledgement — R channel
RQA SU

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–5		Bits 4–1		OCTET NUMBER
SEQUENCE INDICATOR		1 1 1 1		1
Q NO.		D/R*	RESERVED	2
MESSAGE TYPE				3
AES ID				4–6
GES ID				7
Q NO. (of message)		REF. NO. (of message)		8
CH. TYPE	NO. OF SSU NK**	ACKNOWLEDGE CONTROL		9
SPARE	SSU SEQUENCE NO.+			10
SPARE	SSU SEQUENCE NO.+			11
SPARE	SSU SEQUENCE NO.+			12
SPARE				13–17
CCITT CRC				18–19

* DLS/RLS always set to 0
** Number of SSUs in acknowledgement indicating error
\+ spare in PACK requesting complete retransmission and in PACK indicating no error

Figure A2-49. Acknowledgement — R channel
P channel acknowledgement (PACK)

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–5	Bits 4–1		OCTET NUMBER
SEQUENCE INDICATOR	1 1 1 1		1
Q NO.	D/R*	REFERENCE NO.	2
MESSAGE TYPE			3
AES ID			4–6
GES ID			7
RESERVED	SPARE		8
SPARE			9–17
CCITT CRC			18–19

* DLS/RLS always set to 0

Figure A2-50. Log control — R channel
Log-off request/ready for reassignment/
reassignment reject

BIT NO.

8 7 6 5	4 3 2 1	OCTET NUMBER
SEQUENCE INDICATOR	1 1 1 1	1
Q NO.	D/R* RESERVED	2
MESSAGE TYPE		3
AES ID		4
		5
		6
GES ID		7
RESERVED	APPLICATION REF. NO.	8
LOCATION	REPORT TYPE	9
SPARE CAUSE CLASS	CAUSE VALUE	10
SPARE		11
		12
		13
		14
		15
		16
		17
CCITT CRC		18
		19

* DLS/RLS always set to 0

Figure A2-51. Call progress — R channel
Channel release

BIT NO.

8 7 6 5	4 3 2 1	OCTET NUMBER
SEQUENCE INDICATOR	1 1 1 1	1
Q NO.	D/R* RESERVED	2
MESSAGE TYPE		3
AES ID		4
		5
		6
GES ID		7
RESERVED	APPLICATION REF. NO.	8
LOCATION	REPORT TYPE	9
SPARE CAUSE CLASS	CAUSE VALUE	10
SPARE		11
		12
		13
		14
		15
		16
		17
CCITT CRC		18
		19

* DLS/RLS always set to 0

Figure A2-52. Call progress — R channel
Call attempt result

BIT NO.

8	7	6	5	4	3	2	1	OCTET NUMBER
SEQUENCE INDICATOR				1	1	1	1	1
Q NO.				DR**	REFERENCE NO.			2
MESSAGE TYPE								3
AES ID								4–6
GES ID								7
RESERVED				SPARE				8
SPARE	AN3*	AN2*	AN1*	SPARE				9
ACKNOWLEDGE MESSAGE TYPE MSG1								10
ACKNOWLEDGE MESSAGE TYPE MSG2								11
ACKNOWLEDGE MESSAGE TYPE MSG3								12
SPARE								13–17
CCITT CRC								18–19

* ACK/NAK for messages 1, 2 or 3
** DLS/RLS always set to 0

Figure A2-53. Log-on acknowledgement — R channel

BIT NO.

8	7	6	5	4	3	2	1	OCTET NUMBER
SEQUENCE INDICATOR				1	1	1	1	1
Q NO.				DR**	RESERVED			2
MESSAGE TYPE								3
AES ID								4–6
GES ID								7
RESERVED				APPLICATION REF. NO.				8
SPARE			ACK/NAK	SPARE				9
MESSAGE TYPE OF MISSING SU								10
SPARE								11–17
CCITT CRC								18–19

* DLS/RLS always set to 0

Figure A2-54. Telephony acknowledge — R channel

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–3	Bit 2	Bit 1	OCTET NUMBER
MESSAGE TYPE			1
REVISION NO.			2
INITIAL SEQ. NO. OF A2-56 (PARTIAL)	SPARE	EXS*	3
INITIAL SEQ. NO. OF A2-58 (PARTIAL)	SPARE	EXS*	4
INITIAL SEQ. NO. OF A2-60 (PARTIAL)	SPARE	EXS*	5
INITIAL SEQ. NO. OF A2-56 (COMP)	SPARE	EXS*	6
INITIAL SEQ. NO. OF A2-58 (COMP)	SPARE	EXS*	7
INITIAL SEQ. NO. OF A2-60 (COMP)	SPARE	EXS*	8
INITIAL SEQ. NO. OF 2nd A2-56 (COMP)	SPARE	EXS*	9
SPARE		GBS+	10
CCITT CRC			11–12

* Existence + Global beam series

Figure A2-55. AES system table broadcast — P channel
Spot beam series index

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–3	Bits 2–1	OCTET NUMBER
MESSAGE TYPE		1
REVISION NO.		2
SEQUENCE NO.	LSU NO.	3
GES ID		4
CHANNEL FREQUENCY		5–6
CHANNEL FREQUENCY		7–8
CHANNEL FREQUENCY		9–10
CCITT CRC		11–12

Figure A2-56. AES system table broadcast — P channel
Spot beam series GES P/R channel advice SU

BIT NO. 8 7 6 5 4 3 2 1

Bits 8–3	Bits 2–1	OCTET NUMBER
MESSAGE TYPE		1
REVISION NO.		2
SEQUENCE NO.	SPARE	3
GES ID		4
BEAM ID	SPARE	5
SPARE		6–10
CCITT CRC		11–12

Figure A2-57. AES system table broadcast — P channel
Spot beam series GES P/R channel advice last SSU

BIT NO. 8 7 6 5 4 3 2 1

			OCTET NUMBER
MESSAGE TYPE			1
REVISION NO.			2
SEQUENCE NO.	SAT. ID		3
SAT. ID (lsb)	SAT. INCLINATION	SF*	4
SATELLITE RIGHT ASCENSION			5
SATELLITE LONGITUDE			6
SATELLITE/BEAM-IDENTIFYING P_{smc} CHANNEL FREQUENCY NO. 1			7–8
SATELLITE/BEAM-IDENTIFYING P_{smc} CHANNEL FREQUENCY NO. 2			9–10
CCITT CRC			11–12

* Satellite flag

Figure A2-58. AES system table broadcast — P channel
Spot beam series satellite/beam
ID channel advice ISU

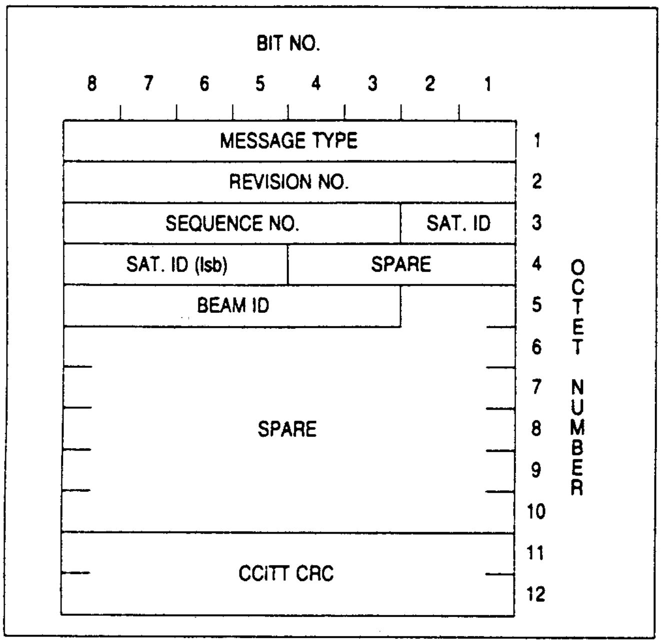


Figure A2-59. AES system table broadcast — P channel
Spot beam series satellite/beam ID channel advice SSU

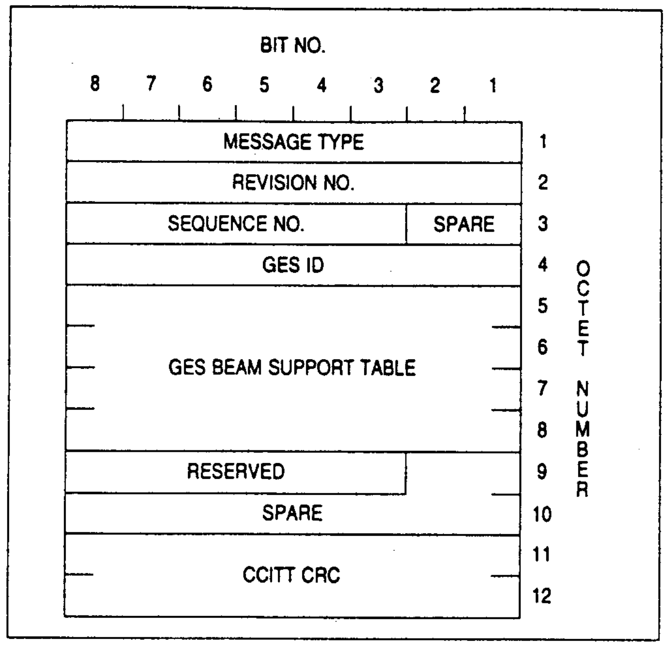


Figure A2-60. AES system table broadcast — P channel
Spot beam series GES beam support advice

Appendix 3 to Chapter 4
SIGNAL UNIT FIELD CODING AND DESIGNATION

1. ACK/NAK
2. Acknowledge control
3. AES ID
4. Application reference number
5. Beam ID
6. Burst interval
7. Burst length
8. Called/calling terminal
9. Cause class
10. Cause value
11. Channel bit rate
12. Channel frequency
13. Channel type
14. Circuit data rate
15. Circuit data requirement
16. Class of AES
17. CCITT CRC
18. Data bit rate capability
19. Delay to RES
20. Digit
21. DLS/RLS

21a. Duration

22. EIRP adjustment
23. Existence
24. GES ID
25. GES beam support table
26. Idle pattern
27. Initial EIRP
28. I/R (initial/renewal)
29. Length

29a. Global beam series (GBS)

30. Location
31. LSU number

31a. LOV

32. Message length
33. Message type
34. Network ID
35. NOT (number of transmitters)
36. Number of bursts reserved
37. Number of C channels
38. Number of frequencies
39. Number of octets in the last SSU
40. Number of SSUs (in Ack)
41. P/R MSG
42. P/S (primary/secondary)
43. Q number (precedence)
44. Reason
45. Received bit error rate
46. Reference number
47. Report type
48. Reserved
49. Revision number
50. RFC flag
51. S (coding standard)
52. Satellite flag
53. Satellite ID
54. Satellite inclination
55. Satellite longitude
56. Satellite right ascension
57. SC
58. Sequence indicator
59. Sequence number
60. Sequence number (off-set value)
61. Service direction
62. Service identity
63. Source
64. Spare

64a. Spot beam series (SPS)

65. Starting frame number
66. Starting slot number
67. SU type
68. TDMA MSG
69. T_X channel number
70. Universal time
71. Voice channel characteristics

SIGNAL UNIT FIELD CODING AND DESIGNATIONS

Note.— Codes are listed as their decimal values unless indicated as hexadecimal by the letters HEX. Codes marked RESERVED are reserved for use in particular AMSS system implementations.

1. ACK/NAK (1 bit)

Code	Function
0	NAK, retransmit indicated message
1	ACK, do not retransmit indicated message

2. Acknowledge control (4 bits)

Code	Function
0	This ACK includes all retransmission requests
1-13	Number of retransmission request ACK messages remaining (applicable for PACK and TACK SUs only)
14	No errors in entire message
15	Retransmit entire message (applicable for PACK and TACK SUs only)

3. AES ID (3 octets)

This field shall be the 24-bit ICAO identifier of the AES.

4. Application reference number (4 bits)

This field shall contain the direct binary number of the reference number assigned by the circuit-mode services to the circuit-mode call.

The application reference number shall uniquely identify a call between an AES/GES pair. Application reference numbers shall be assigned cyclically by the AES on air-to-ground calls from the range 0-7 and by the GES on ground-to-air calls to a given AES from the range 8-15.

5. Beam ID (6 bits)

Code	Function
0	Global beam
1-63	Spot beams

6. Burst interval (4 bits)

In a multi-burst reservation, this field shall indicate that there is one burst reservation per 2^{BI} frames, where BI=burst interval.

7. Burst length (5 bits)

This field shall indicate the length of the burst in terms of the number of signal units.

8. Called/calling terminal (8 bits)

Binary coded decimal (BCD) encoding, with the most significant digits appearing in least significant half octet, and vice versa.

9. Cause class (3 bits)

The assignment and interpretation of this field shall be dictated by the value assigned to the S (coding standard) field (Item 51). Cause class shall be used in association with cause value (Item 10) to identify the actual cause meaning.

CCITT Q.931 standard coding:

Code	Function
0	Normal event
1	Normal event
2	Resource unavailable
3	Service or option not available
4	Service or option not implemented
5	Invalid message (e.g. parameter out of range)
6	Protocol error (e.g. unknown message)
7	Interworking

Satellite network specific coding:

Code	Function
0	PSTN/ISDN call progress events
1	Call pre-emption
2	Resource unavailable
3	Invalid parameter
4	Out of service
5	Network failure
6	Service/option not supported
7	Normal event

10. Cause value (4 bits)

The assignment and interpretation of this field shall be dictated by the value of the S (coding standard) field (Item 51). Cause value shall be used in association with cause class (Item 9) to identify the actual cause meaning. The values given below are those required for interworking with the PSTN signalling systems R2, CCITT No. 5 and CCITT No. 7 TUP.

CCITT Q.931 standard coding:

Cause class	Cause value	Function
0	1	Unallocated number
0	3	No route to destination
1	0	Normal clearing
1	1	User busy
1	2	No user responding
1	3	Called user busy (user alerted)
1	5	Call rejected
1	11	Destination out of service
1	12	Invalid (incomplete) number format
1	15	Normal, unspecified
2	2	No circuit/channel available
2	6	Network out of order
2	10	Switching equipment congestion
4	2	Channel type not implemented

Satellite network specific coding:

Cause class	Cause value	Function
0	1	Address complete
1	1	Call pre-empted
2	1	No channel available
2	2	No channel unit available
2	3	Analog data equipment not available
2	4	Digital data equipment not available
3	1	Reserved
3	2	Invalid/incomplete address
4	1	Destination out of service
4	2	AES not authorized
4	3	Incoming calls barred
5	1	Continuity failure or no response
6	1	Reserved
6	2	Required analog data rate not supported
6	3	Required digital data rate not supported
6	4	Voice channel type not supported
6	5	Service type not supported
7	1	User busy
7	2	Unallocated number
7	3	AES absent
7	15	Undefined cause

11. Channel bit rate (receive or transmit) (4 bits)

Code	Function
0	600 bits/s
1	1 200 bits/s
2	2 400 bits/s
3	4 800 bits/s
4	6 000 bits/s
5	5 250 bits/s
6	10 500 bits/s
7	Unassigned
8	Unassigned
9	21 000 bits/s
10-15	Unassigned

12. Channel frequency (2 octets)

Most significant bit: 1=LHCP. 0=RHCP
Least significant 15 bits: 0000 to 7FFF (HEX)
Frequency expressed as binary number N, where:
frequency (MHz) = Base (MHz) + N * 0.0025 MHz;
base = 1 510.0000 MHz for receive channels;
base = 1 611.5000 MHz for transmit channels.

The all ZEROs code shall be used to denote the null value.

13. Channel type (2 bits)

This field shall identify the channel which was used for the message being acknowledged.

Code	Function
0	R channel
1	P channel
2	T channel
3	Unassigned

14. Circuit data rate (4 bits)

This field shall be used by the AES to indicate the requested circuit-mode data rate (modem type, if applicable). It shall also be used by the GES to inform the AES of the actual data rate achieved, which may be different from the requested data rate if a multi-rate modem is used or if modem synchronization is not achieved.

The coding shall be dependent on the type of circuit-mode data service, as indicated by the service identity field (Item 62).

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Analog-interconnect data service:

Code	Function
0	Data mode not required/achieved
1	1 200 bits/s: CCITT V.23
2	1 200 bits/s: CCITT V.22
3	1 200 bits/s: CCITT V.22bis
4	2 400 bits/s: CCITT V.22bis
5	4 800 bits/s: CCITT V.32
6	9 600 bits/s: CCITT V.32
7-14	Unassigned
15	Facsimile (Group 3) service: CCITT T.30

Digital interconnect data service:

Code	Function
0	Data mode not required/achieved
1	1 200 bits/s
2	2 400 bits/s
3	4 800 bits/s
4	9 600 bits/s
5-15	Unassigned

15. Circuit data requirement (2 bits)

This field shall be used by the AES to indicate whether all ground-to-air circuit-mode calls should be allocated circuit-mode data service-capable channel equipment by the GES, and if so, which type of interconnect capability shall be required.

Code	Function
00	Circuit-mode data service not required
01	Analog interconnect service required
10	Digital interconnect service required
11	Unassigned

16. Class of AES (2 bits)

The AESs shall be classified according to their equipment configuration and capabilities, as follows:

Class 1: Low gain antenna only, packet-mode services only;
Class 2: Reserved;
Class 3: High gain antenna only, circuit-mode and packet-mode (simultaneous and non-simultaneous) services;
Class 4: High gain antenna only, packet-mode services only.

Code	Function
0	Class 1
1	Reserved
2	Class 3
3	Class 4

17. CCITT CRC (16 bits)

Each signal unit shall contain 16 check bits (the last two octets) for error detection. These check bits shall be calculated from the first 10 octets of standard length SU, from the first 17 octets of an extended length signal unit or from the first 4 octets of the burst identifier SU (Appendix 2 to Chapter 4, Figure A2-47), using the following generator polynomial:

$$x^{16} + x^{12} + x^5 + 1$$

(see CCITT Red Book, Recommendation X.25, Section 2.2.7)

At the receiving end, the check bits for each received signal unit shall be calculated and if there is a mismatch with the received check bits, the signal unit shall be discarded.

18. Data bit rate capability (1 octet)

Each bit in this field shall indicate the availability ("1") or unavailability ("0") of the corresponding channel/bit rate combination at the AES as follows:

Bit	Combination	
1	Reserved	
2	P-Ch	2 400 bits/s
3	P-Ch	4 800 bits/s
4	P-Ch	10 500 bits/s
5	R-/T-Ch	2 400 bits/s
6	R-/T-Ch	10 500 bits/s
7,8	Unassigned	

Note.— 0.6 and 1.2 kbit/s P, R and T channels are mandatory for all AESs.

19. Delay to RES (6 bits)

This field shall indicate the delay before the reservation will be sent to the AES by the GES. The delay shall be given as a direct binary number of superframes.

20. Digit

This field shall be a binary coded decimal digit. The end-of-digits code shall be combination F (HEX).

21. DLS/RLS (1 bit)

Code	Function
0	Direct link service (DLS)
1	Reliable link service (RLS)

21a. Duration (6 bits)

The decimal equivalent of this field shall specify the length in minutes of the period of time during which the AES shall inhibit its log-on attempts to the specified GES.

22. EIRP adjustment (4 bits)

This field shall be used to indicate the EIRP adjustment value relative to the current transmit level as follows:

Code	Function
0	No adjustment
1	+1 dB
2	+2 dB
3	+3 dB
4-12	Unassigned
13	-3 dB
14	-2 dB
15	-1 dB

23. Existence (1 bit)

Code	Function
0	This series of broadcasts is not being transmitted
1	This series of broadcasts is being transmitted

24. GES ID (1 octet)

This field shall be the 8-bit identifier given to the GES.

25. GES beam support table (32 bits)

This field shall start from octet 5, bit 1 and shall end at octet 8, bit 8. Each bit shall correspond to a satellite beam, starting from global beam in the first bit then spot beam 1, 2, 3, etc. up to spot beam 31, respectively. 0 means the spot beam has no P or R channel from that GES. 1 means the GES has at least one P and R channel set in that beam.

26. Idle pattern

All zeros.

27. Initial EIRP (4 bits)

The EIRP value shall be equal to (10.5 + N) dBW where N is the value of this field (range 0 to 15).

28. I/R (initial/renewal) (1 bit)

This field shall indicate whether the log-on request is initial or for log-on renewal.

Code	Function
0	Initial log-on
1	Log-on renewal

29. Length (8 bits)

This field shall be the direct binary representation of the number of octets to follow.

29a. Global beam series (GBS) (1 bit)

This field shall indicate, in the spot beam series broadcast index SU, whether or not a global beam series is present. This field shall be set to one if the global beam series is present; otherwise, the field shall be set to zero.

30. Location (of cause) (4 bits)

This information element shall indicate the location relevant to the cause value and cause class information elements. Its interpretation shall be dictated by the value assigned to the S (coding standard) information element, which specifies whether the CCITT Q.931 standard coding or the satellite network specific coding rules apply.

CCITT Q.931 standard coding:

Code	Function
0	User
1	Private network serving the local user
2	Public network serving the local user

Code	Function
3	Transit network
4	Public network serving the remote user
5	Private network serving the remote user
7	International network
10	Network beyond interworking point

All other values are reserved.

Satellite network specific coding:

Code	Function
1	AES — user network side
2	AES — satellite network side
3	GES — satellite network side
4	GES — fixed network side
5	Reserved
6	Interworking with the terrestrial network

All other values are unassigned.

31. LSU number (2 bits)

Code	Function
0	Indicating the initial LSU and the LSU contains P_{smc}, $R_{smc}0$, $R_{smc}1$ frequencies in this order
1	LSU contains P_{smc}, $R_{smc}0$, $R_{smc}1$ frequencies in this order (as for code 0, but this can appear anywhere in the sequence)
2	LSU contains $R_{smc}2$, $R_{smc}3$, $R_{smc}4$ frequencies in this order
3	LSU contains $R_{smc}5$, $R_{smc}6$, $R_{smc}7$ frequencies in this order

31a. LOV (1 bit)

This field shall indicate the capability of the AES to respond to the log-on interrogation from the GES.

Code	Function
0	AES capable of responding
1	AES not capable of responding

32. Message length (7 bits)

This field shall indicate, in direct binary number, the number of SUs in an SU set (2 user octets in the initial signal unit, and 8 octets per subsequent signal unit). When used for requesting T channel capacity, this number shall be increased by one each time a request (initial or repeated) is transmitted via the T channel. The maximum length of an initial SU set shall be limited to 64 (SUs).

33. Message type (1 octet)

This field shall identify the type of the message. The complete set of message types shall be as listed in the table "Message type list" which is included at the end of this appendix.

34. Network ID (4 bits)

Code	Function
0	Unassigned
1	E164/E163
2	X.121
3	F.69
4	Private network — no address following
5	Private network — address following
6-14	To be coded for applicable public and private networks (SITA, ARINC, etc.)
15	Distress call

35. NOT (1 bit)

This field shall indicate the transmitter capability of the AES.

Code	Function
0	Indicating the AES has one transmitter
1	Indicating the AES has multiple transmitters

36. Number of bursts reserved (3 bits)

This field shall identify the number of bursts reserved as a binary number.

Code	Function
0	Unassigned
1-7	1-7 bursts reserved

37. Number of C channels (4 bits)

This field shall indicate, as a direct binary number, the number of voice channels which the AES is equipped for. This field shall be 1 for Level 3 AES.

38. Number of frequencies (4 bits)

This field shall indicate, as a direct binary number (e.g. 1 = 1 frequency), the number of frequencies assigned.

39. Number of octets in the last SSU (4 bits)

This field shall indicate, as a direct binary number (e.g. 1 = 1 octet), the number of octets of user data in the user data field of the last SSU of the SU set.

40. Number of SSUs (in ACK/NAK) (2 bits)

Code	Function
0	No SSU, only used when ACKCTL field equals 14 or 15
1	One SSU
2	Two SSUs
3	Three SSUs

41. P/R MSG (1 bit)

This field shall indicate whether the log-on confirm SU has an associated P/R channel control SU.

Code	Function
0	No associated P/R channel control SU
1	Associated P/R channel control SU exists

42. P/S (primary/secondary) (1 bit)

This field shall indicate whether the log-on is primary or secondary.

Code	Function
0	Primary log-on
1	Secondary log-on

43. Q number (precedence) (4 bits)

The following table shall indicate the scheme for the assignment of Q numbers to the various categories of messages for transmission on the P, R, T and sub-band C channels. The actual Q numbers assigned to the individual signal unit message types shall be as specified in the message type list at the end of this appendix.

Code	Function
15	Distress/urgency C channel request/assignment signalling; distress/urgency T channel request signalling; all T channel assignment signalling (including reservation forthcoming signalling); link layer protocol signalling for distress data traffic (Q = 14)
14	Distress/urgency packet-mode data
13	Link layer protocol signalling for flight safety, other safety and non-safety data traffic (Q = 0-3, 5-8, 11); AES/GES management SUs; flight safety and other "safety" T channel request signalling (Q = 11, 5-8); C channel signalling other than request/assignment
12	Flight safety C channel request/assignment signalling
11	Flight safety packet-mode data
10	Other "safety" C channel request/assignment signalling
9	"Non-safety" C channel request/assignment signalling; "non-safety" T channel request signalling (Q = 0-3)
5-8	Other "safety" packet-mode data (See Table 4-12)
4	Reserved for "non-safety" C channel precedence
0-3	"Non-safety" packet-mode data (See Table 4-12)
NA	System table broadcast SUs and fill-in SU

44. Reason (4 bits)

Code	Function	Rejection category
0	Log-on table full	Temporary unavailable
1	Requested voice channel characteristic not available	Permanent unavailable
2	Requested beam not served	Invalid parameters
3	Fixed network failure	Temporary unavailable
4	Unassigned	
5	Invalid satellite ID	Invalid parameters
6	Invalid GES ID	Invalid parameters
7	P/R/T channels not available	Temporary unavailable
8	Packet-mode data services not available	Permanent unavailable
9-13	Unassigned	
14	Other unspecified reason	Temporary unavailable
15	AES not authorized	Permanent unavailable

45. Received bit error rate (8 bits)

This field shall indicate the error rate before FEC decoding. The code value = V, where V = average number of errors per 2 560 channel bits.

46. Reference number (3 bits for R channel or 4 or 8 bits for P and T channels)

The value for this field shall be assigned by the AES for air-to-ground data transfer and by the GES for ground-to-air data transfer. The scope of the reference number shall be within its Q number (precedence level). The reference number, in association with the Q number, shall be used for message segmentation/assembly and ARQ error control at the link level.

Each user data message shall be given a reference number at the time of initial transmission and this is used in subsequent acknowledge, retransmission, and request for acknowledge messages to guard against confusion/duplication of messages. The allocation of the reference numbers shall be performed independently for messages sent via the R, T and P channels.

47. Report type (4 bits)

This field shall identify the specific type of call progress signal unit.

Code	Function
0	Unassigned
1	Channel status report
2	Connect
3	Test
4	Call attempt result
5	Channel release
6	Reserved
7-15	Unassigned

48. Reserved (variable number of bits)

Fields marked RESERVED are reserved for use in particular AMSS system implementations.

49. Revision number (8 bits)

This field shall indicate the revision number of the AES system table. It shall be incremented by one for each successive revision.

50. RFC flag (1 bit)

This field shall be used to identify whether or not a reservation (RES) SU or a reservation forthcoming (RFC) SU has been preceded by either an RFC LSU or TACK LSU indicating errors.

Code	Function
0	Not preceded by either RFC LSU or TACK SU set indicating errors
1	Has been preceded by either an RFC LSU or TACK SU set indicating errors

51. S (coding standard) (1 bit)

The field shall identify the rules (coding standard) according to which the location, cause class and cause value information elements are coded.

Code	Function
0	CCITT Q.931 standard coding
1	Satellite network specific coding

52. Satellite flag (1 bit)

Code	Function
0	Indicating the SU contains information for the satellite via which it is broadcast
1	Indicating the SU contains information for the satellite in another region

53. Satellite ID (6 bits)

This field shall be the 6-bit identifier given to the satellite.

54. Satellite inclination (3 bits)

Code	Function
0	0 to 5/8 degree
1	more than 5/8 up to 10/8 degrees
2	more than 10/8 up to 15/8 degrees
3	more than 15/8 up to 20/8 degrees
4	more than 20/8 up to 25/8 degrees
5	more than 25/8 up to 30/8 degrees
6	more than 30/8 up to 35/8 degrees
7	more than 35/8 up to 40/8 degrees

55. Satellite longitude (8 bits)

This field shall be a binary code representation of the longitudinal location of the satellite, as east longitude relative to the Greenwich meridian in units of 1.5 degrees.

56. Satellite right ascension (8 bits)

This field shall indicate the closest time point expressed in minutes from 00:00 UTC with 10 minutes increment to the time when the satellite crosses the equatorial plane from south to north on the New Year's day. The time of satellite ascension on day "n" of the year shall be "4 x n" minutes earlier than on the New Year's day.

57. SC (1 bit)

This field shall indicate the compliance of AES with SARPs.

Code	Function
0	Not SARPs compliant
1	SARPs compliant

58. Sequence indicator (4 bits)

This field shall be used only in extended length (i.e. 19 octet) SUs on the R channel. It shall indicate the position of the SU within the sequence of SUs that comprise an SU set. It also specifies the total number of SUs in the SU set.

Code	SU position	Number of SUs in the SU set
0	Unassigned	Unassigned
1	1	1
2	1 (first)	2
3	2 (last)	2
4	1 (first)	3
5	2 (intermediate)	3
6	3 (last)	3
7-15	Unassigned	Unassigned

59. Sequence number (4 bits or 6 bits)

This field shall be used in standard length (i.e. 12 octet) signal units on all channels. The field shall be set in an ISU of an SU set to the total number of subsequent signal units (SSUs) in the SU set and shall be decremented by one in each following SSU, until the last SSU of the SU set has a value of 0. The field in a broadcast index SU of the AES system table broadcast shall be set to the largest sequence number (one less than the number of LSUs included) in each series of broadcast LSUs. The sequence number in the first LSU in a series shall be set to the same number as in the index SU and shall be decremented by one in each following LSU, until the last LSU of the series has a value of 0. The field in an RTX SU heading of a retransmission SU set shall be set equal to the total number of SSUs in the retransmission SU set. In each retransmitted SSU, this field shall be offset by subtracting the value in the sequence number (offset value) field of the RTX SU from the original SSU sequence number.

60. Sequence number (offset value) (6 bits)

This field shall be used in standard length (i.e. 12 octet) signal units on all channels. It shall indicate the last (lowest) SSU sequence number in error.

61. Service direction (2 bits)

Code	Function
0	Unassigned
1	Air-to-ground
2	Ground-to-air
3	Bi-directional

62. Service identity (4 bits)

Code	Function
0	Unassigned
1	Telephone
2	Circuit-mode data, analog-interconnect
3	Circuit-mode data, digital-interconnect
4-9	Unassigned
10	Direct link service message
11	Reliable link service message
12-15	Unassigned

63. Source (2 bits)

This field shall identify the location at which the signal unit was generated.

Code	Function
0	Unassigned
1	AES
2	GES
3	Reserved

64. Spare (variable number of bits)

Fields marked SPARE shall be filled entirely with zeros.

64a. Spot beam series (SPS)
(1 bit)

This field shall indicate, in the global beam series broadcast index SU, whether or not a spot beam series is present. This field shall be set to one if the spot beam series is present; otherwise, the field shall be set to zero.

65. Starting frame number
(4 bits)

This field shall indicate, as a direct number, the starting frame number of the allocated reservation.

66. Starting slot number
(6 bits)

This field shall indicate, as a direct binary number, the starting slot number of the allocated reservation within the starting frame number.

67. SU type (4 bits)

This field shall indicate whether the extended length SU is carrying signalling application information or user data. In the latter case, its value shall represent the number of octets of user data in the user data field of the extended length (i.e. 19 octet) SU.

Code	Function
0	Unassigned
1-11	1 to 11 octets of user data SU
12-14	Unassigned
15	Signalling information SU

68. TDMA MSG
(1 bit)

This field shall indicate whether the log-on confirm SU has an associated T channel control message.

Code	Function
0	No associated T channel control message
1	Associated T channel control message exists

69. TX channel number
(2 bits)

Code	Function
0	Channel No. 0
1	Channel No. 1
2	Channel No. 2
3	Channel No. 3

70. Universal time
(7 octets)

The time information shall be synchronized to the UTC time standard.

Format:	Each of the following is a single octet field coded in the binary coded decimal (BCD) format. The code FF_H can be used in any field to represent a NULL entry.
Century:	Century AD (Anno Domini), CC (2 digit): 00 to 99
Year:	Year within the century, YY (2 digit): 00 to 99
Month:	Month within the year, MM (2 digit): 01 to 12
Day:	Day within the month, DD (2 digit): 01 to 31
Hour:	Hour within the day, hh (2 digit): 00 to 24
Minute:	Minute within the hour, mm (2 digit): 00 to 59
Second:	Second in the minute, ss (2 digit): 00 to 59

71. Voice channel characteristics
(6 bits)

Code	Voice rate to AES	Voice rate from AES	Channel bit rate	FEC rate
0	Unassigned			
1	Reserved			
2	9 600 LPC[1]	9 600 LPC[1]	21 000	1/2
3	Reserved			
4	Unassigned			
5	Reserved			
6	Unassigned			
7	Reserved			
8-63	Unassigned			

1. LPC corresponds to the multi-pulse excited linear predictive coding algorithm as defined in Section 4.8.

MESSAGE TYPE LIST (see paragraph 33)

Code (HEX)	Function	Message format figure (refer to Appendix 2 to Chapter 4)	Q number (precedence)
BROADCAST			
00	Reserved		
01	Fill-in signal unit	A2-42	NA
02	AES system table broadcast (GES P_{smc} and R_{smc} channels PARTIAL)	A2-31	NA
03	AES system table broadcast (beam identification PARTIAL)	A2-33	NA
04	AES system table broadcast (GES beam support PARTIAL)	A2-34	NA
05	AES system table broadcast (GES P_{smc} and R_{smc} channels COMPLETE)	A2-31	NA
06	AES system table broadcast (beam identification COMPLETE)	A2-33	17NA
07	AES system table broadcast (GES beam support COMPLETE)	A2-34	NA
08	System broadcast — selective release	A2-36	13
09	System broadcast — universal time	A2-35	13
0A	AES system table broadcast (index)	A2-30	NA
OB	AES system table broadcast (satellite identification PARTIAL)	A2-32	NA
OC	AES system table broadcast (satellite identification COMPLETE)	A2-32	NA
OD	AES system table broadcast (2nd series of GES P_{smc} and R_{smc} channels COMPLETE)	A2-31	NA
OE	Reserved		
SYSTEM LOG-ON/LOG-OFF			
10	Log-on request	A2-2	13
11	Log-on confirm	A2-3	13
12	Log control (R channel)-log-off request	A2-50	13
12	Log control (P channel)-log-off request	A2-6	13
13	Log control (P channel)-log-on reject	A2-5	13
13	Log control (R channel)-reassignment reject	A2-50	13
14	Log control (P channel)-log-on interrogation	A2-4	13
15	Log-on/log-off acknowledge (P channel)	A2-25	13
15	Log-on/log-off acknowledge (R channel)	A2-53	13
16	Log control (P channel)-log-on prompt	A2-4	13
17	Log control (P channel)-data channel reassignment	A2-4	13
17	Log control (R channel)-ready for reassignment	A2-50	13
CALL INITIATION			
20	Access request telephone (non-safety)	A2-45	9
20	Access request telephone (other safety)	A2-45	10
20	Access request telephone (flight safety)	A2-45	12

Code (HEX)	Function	Message format figure (refer to Appendix 2 to Chapter 4)	Q number (precedence)
20	Access request telephone (distress)	A2-45	15
20	Call announcement (non-safety)	A2-8	9
20	Call announcement (other safety)	A2-8	10
20	Call announcement (flight safety)	A2-8	12
20	Call announcement (distress)	A2-8	15
21	Call information service address (ISU)	A2-9	13
22	Access request data (R/T channel) (non-safety)	A2-47/A2-7	9
22	Access request data (R/T channel) (flight safety and other safety)	A2-47/A2-7	13
22	Access request data (R/T channel) (distress)	A2-47/A2-7	15
23	Abbreviated access request telephone (other safety)	A2-46	10
23	Abbreviated access request telephone (flight safety)	A2-46	12
23	Abbreviated access request telephone (distress)	A2-46	15
CALL PROGRESS			
30	Call progress (P/C channel)	A2-11/A2-12/A2-13/ A2-14/A2-15/A2-16	13
30	Call progress (R channel)	A2-51/A2-52	13
31	C channel assignment (distress)	A2-17	15
32	C channel assignment (flight safety)	A2-17	12
33	C channel assignment (other safety)	A2-17	10
34	C channel assignment (non-safety)	A2-17	9
CHANNEL INFORMATION			
40	P/R channel control (ISU)	A2-18	13
41	T channel control (ISU)	A2-20	13
TDMA RESERVATION			
50	Unsolicited reservation	A2-22	15
51	T channel assignment	A2-23	15
52	Reserved		
53	Reservation forthcoming (RFC)	A2-24	15
ACKNOWLEDGEMENT			
60	Telephony acknowledge (P/C channel)	A2-26	13
60	Telephony acknowledge (R channel)	A2-54	13
61	Request for acknowledgement (RQA) (P channel) — distress data	A2-27	15
61	Request for acknowledgement (RQA) (P channel) — all other data	A2-27	13
61	Request for acknowledgement (RQA) (P channel) — distress data	A2-48	15
61	Request for acknowledgement (RQA) (P channel) — all other data	A2-48	13

Code (HEX)	Function	Message format figure (refer to Appendix 2 to Chapter 4)	Q number (precedence)
62	Acknowledge (RACK, TACK) (P channel) — distress data	A2-29/A2-28	15
62	Acknowledge (RACK, TACK) (P channel) — all other data	A2-29/A2-28	13
62	Acknowledge (PACK) (R channel) — distress data	A2-49	15
62	Acknowledge (PACK) (R channel) — all other data	A2-49	13
USER DATA			
70	Reserved		
71	User data (ISU) — RLS (P/T channel)	A2-37	V(0-3,5-8,11,14)
72	Retransmission header (RTX) (P/T channel)	A2-41	V(0-3,5-8,11,14)
73	Reserved		
74	User data (3 octet LSDU) — RLS (P channel)	A2-39	V(0-3,5-8,11,14)
75	Reserved		
76	User data (4 octet LSDU) — RLS (P channel)	A2-40	V(0-3,5-8,11,14)
N/A	User data (ISU/SSU) (R channel)	A2-44	V(0-3,5-8,11,14)
80	Broadcast reserved		
81	AES system table broadcast-spot beam series GES P/R channel (partial)	A2-56/A2-57	NA
82	AES system table broadcast-spot beam series GES beam support (partial)	A2-60	NA
83	AES system table broadcast-spot beam series GES P/R channel (complete)	A2-56/A2-57	NA
84	AES system table broadcast-spot beam series GES beam support (complete)	A2-60	NA
85	AES system table broadcast-spot beam series index	A2-55	NA
86	AES system table broadcast-spot beam series satellite/beam ID (partial)	A2-58/A2-59	NA
87	AES system table broadcast-spot beam series satellite/beam ID (complete)	A2-58/A2-59	NA
88	AES system table broadcast-spot beam series 2nd series of GES P/R channel (complete)	A2-56/A2-57	NA
SUBSEQUENT SIGNAL UNITS: bits 8-7 = 1 1			
	Call information service address (SSU)	A2-10	13
	P/R channel control (SSU)	A2-19	13
	T channel control (SSU)	A2-21	13
	User data (SSU) — (P/T channel)	A2-38	V(0-3,5-8,11,14)

All other codes are unassigned.

In the Q number column, message types with a variable Q number are indicated by V followed in brackets by the value or range of values normally used.

Appendix 4 to Chapter 4

TIME-OUT VALUES

Time	Value (seconds)
tG1	9.3
tG2	5
tG3	18
tG3A	Reserved
tG3B	Reserved
tG4	2.5
tG5	Reserved
tG6	At the discretion of the GES operator
tG7	Unassigned
tG8	10
tG9	20 to 30
tG10	Tch (Note 3)
tG11	12
tG12	10
tG13	10
tG14	7
tG15	Unassigned
tG16	10
tG17	10
tG18	7
tG19	10
tG20	120 to 240
tG21	120 to 240
tG22	60 to 120
tG23	10
tG24	10
tG25	2
tG26	25
tG27	12
tG28-tG29	Unassigned
tG30	2
tG31	5 + 5* (P-Ch Frame Duration)
tG32	10
tG33	10
tG34	4
tG35	Tch (Note 3)
tG36	2
tA1	20 + (No. of SUs)*Ts (Note 2)
tA2	Unassigned
tA3	7.9 + RND (0,Z_k − 1)*Ts (Notes 2, 4)
tA4	Unassigned
tA4A	8
tA4B	7.9 + RND (0,Z_k − 1)*Ts (Notes 2, 4)
tA5	4
tA6	8
tA7	7.9 + RND (0,Z_k − 1)*Ts (Notes 2, 4)
tA8(i) (Note 1)	(Delay to res)*8 + 2
tA9	Unassigned
tA10	5 + RND (0,Z_k − 1)*Ts (Notes 2, 4)
tA11	12 + RND (0,Z_k − 1)*Ts (Notes 2, 4)
tA12	10
tA13	10
tA14	10
tA15-tA17	Unassigned
tA18	20 to 30
tA19	10
tA20	15+RND (0,Z_k − 1)*Ts (Notes 2, 4)
tA21	Unassigned
tA22	Tch (Note 3)
tA23-tA24	Unassigned
tA25	5
tA26	Tch (Note 3)
tA27	10
tA28	10
tA29	K *Tch, K = 2 (Note 3)
tA30	10
tA31	20
tA32	10
tA33	Tch (Note 3)
tA34	20
tA35	10
tA36	Tch (Note 3)
tA37	5
tA38	(No. of SUs)*Tch (Note 3)
tA39	5
tA40	(No. of SUs)*Tch (Note 3)
tA41	15
tA42	120 to 240
tA43-tA49	Unassigned
tA50	4 + 2* (P-Ch frame duration)

NOTES

1. Multiple timers as required, indicated by suffix (i).
2. Z_k = Zo * 2^k, Zo = 4 normally; Ts = R channel slot duration and k is the number of retries; k = 0 for initial transmission.
3. Tch = time required to transmit 1 SU on sub-band C channel, e.g. 0.167 seconds for 21 000 bits/s channel.
4. RND(x,y) = function that randomly selects an integer value from the interval [x,y]; all integers in the interval are equally probable.

Appendix 5 to Chapter 4
INTERWORKING TELEPHONY EVENT MAPPING

FITE 18	Event Name: AMS(R)S Call Origination (Calling-Party Category Indicator,Subscriber, Call with Priority)	
MAPS INTO:	AMS(R)S CM-LIDU: Abbreviated Access Request - Telephone and Call Information - Service Address	Procedure Usage: AES Outgoing

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING	
CPCI (Calling Party's Category Indicator)	Q Number	
Distress/Urgency	→	15
Flight Safety	→	12
Regularity	→	10
Called Party Number Ground Address (10-digit fixed length)	Address Digit 0-9 (10-digit fixed length) →	(Variable)
Calling Party Subaddress Aircraft Audio System Channel	Calling Terminal →	(Variable)
	Network ID	10 (AMS(R)S Terrestrial Voice Network)
	Service ID	1
	Circuit Data Rate	0
	Voice Channel Characteristics	2
	Source	1
	Service Direction	3
	Application Reference Number	(Variable)
	Message Type	23 (hex)
	Routing	R-channel

Comments:

This parameter mapping is applicable to the "Abbreviated Access Request - Telephone" CM-LIDU only.

Figure A5-1 a)

FITE 18 CONTINUED	Event Name: AMS(R)S Call Origination (Calling-Party Category Indicator,Subscriber, Call with Priority)	
MAPS INTO:	AMS(R)S CM-LIDU: Abbreviated Access Request - Telephone and Call Information - Service Address	Procedure Usage: AES Outgoing

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
Called Party Number Ground Address ------>	Address Digit 2-8 ------> (Variable)
Calling Party Subaddress Aircraft Audio System Channel ------>	Calling Terminal ------> (Variable)
	Message Type 21 (hex)
	Routing C-channel subband

Comments:

This parameter mapping is applicable to the "Call Information - Service Address" CM-LIDU only.

Figure A5-1 b)

FITE 22	Event Name: Clear Forward	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Outgoing

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing R-Channel or C-Channel subband

Comments: (1) The preemption event is generated internal to the AES Outgoing procedure in response to the arrival of the higher priority AMS(R)S call. It does not arrive via the interworking interface.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
(1) Preemption by higher priority AMS(R)S call at the AES	1	1	1	1
Normal forward clearing by the calling subscriber	0	0	1	0

Figure A5-2

BITE 5	Event Name: Address Complete	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 4
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Address complete signal received from the terrestrial network	1	6	0	1

Figure A5-3

BITE 12	Event Name: Call Unsuccessful - Network Congestion	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release or Call Progress - Call Attempt Result	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5 (Channel release) 4 (Call attempt result)

Comments:
① This event is generated internal to the AES Outgoing procedure. It does not arrive via the Link Layer.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
C-Channel frequency unavailable at GES	1	3	2	1
C-Channel unit unavailable at GES	1	3	2	2
GES equipment congestion	0	2	2	10
Terrestrial network congestion	0	4	2	10
① C-Channel unit unavailable at AES	1	2	2	2

Figure A5-4

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BITE 14	Event Name: Call Unsuccessful - Address Incomplete	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Incomplete called number format detected by terrestrial network	0	4	1	12
Incomplete called number format detected by GES	1	4	3	2

Figure A5-5

BITE 15	Event Name: Call Unsuccessful - Unallocated Number	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Unallocated called number detected by terrestrial network	0	4	0	1

Figure A5-6

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BITE 16	Event Name: Call Unsuccessful - Called Party Busy	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Called user busy	0	5	1	1
Called user busy (Called user alerted)	0	5	1	3

Figure A5-7

BITE 17	Event Name: Call Unsuccessful - Line out of Service	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) <	S (Coding Standard) [Values as per table below]
Cause Location (See below) <	Location (of Cause) [Values as per table below]
Cause Class (See below) <	Cause Class [Values as per table below]
Cause Value (See below) <	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5

Comments:

(1) The "No response from GES" event trigger is generated internally by the AES Outgoing procedure and is not mapped from a received CM-LIDU.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT

Event Trigger	Coding Std.	Location	Cause Class	Cause Value
C-Channel continuity test failure at the GES or carrier interruption	1	3	5	1
Destination out of service	0	5	1	11
(1) No response from GES	1	2	5	1

Figure A5-8

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BITE 20	Event Name: Call Unsuccessful - Send Error Indication	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Reqd voice characteristics not supported by GES	1	3	6	4
Undefined cause	1	3	7	15
Calling AES not authorized for service	1	3	4	2
Expiry of answer timer at GES	0	4	1	2

Figure A5-9

BITE 22	Event Name: Answer	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Connect	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
	Message Type 30 (hex)
	Report Type 2
Comments:	

Figure A5-10

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BITE 25	Event Name: Clear Back	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5

Comments:

(1) The preemption event is generated internal to the AES Outgoing procedure in response to the arrival of a higher priority AMS(R)S call.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Normal backward clearing	0	0	1	0
(1) Preemption by higher priority AMS(R)S call at the AES	1	2	1	1

Figure A5-11

FITE 18	Event Name: AMS(R)S Call Origination (Calling-Party-Category Indicator, Subscriber, Call with Priority)	
MAPS FROM:	AMS(R)S CM-LIDU: Call Announcement and C-Channel Assignment	Procedure Usage: AES Incoming

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
CPCI (Calling Party Category Indicator) Distress/Urgency ← Flight Safety ← Regularity ←	Q Number 15 12 10
Called Party Subaddress Aircraft Audio System Channel ←	Called Terminal (Variable)
Network-Specific Facilities Voice Call ←	Service ID 1
User Data Rate Data Mode Not Required ←	Circuit Data Rate 0
	Voice Channel Characteristics 2
	Source 2
	Service Direction 3
	Message Type 20 (hex)
Comments: This parameter mapping is applicable to the "Call Announcement" CM-LIDU only.	

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
	Initial EIRP (Variable)
	Receive Channel Frequency (variable)
	Transmit Channel Frequency (variable)
	Message Type 31 (hex)
Comments: This parameter mapping is applicable to the "C-Channel Assignment" CM-LIDU only.	

Figure A5-12

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FITE 22	Event Name: Clear Forward	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Incoming

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5

Comments:

① The preemption event is generated internal to the AES Incoming procedure in response to the arrival of a higher priority AMS(R)S call. It does not arrive via the CM-LIDU.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Normal forward clearing	0	0	1	0
① Preemption by higher priority AMS(R)S call at the AES	1	1	1	1
Undefined cause	1	4	7	15
C-channel continuity test failure at the GES/AES not responding or interruption in received AES carrier.	1	3	5	1
Expiry of answer timer (internally generated by the AES)	0	1	1	2
Connection acknowledgement not received by AES (internally generated by the AES)	1	2	5	1
Call preempted at the GES	1	3	1	1

Figure A5-13

BITE 12	Event Name: Call Unsuccessful - Network Congestion	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: AES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard	S (Coding Standard) [Value as per table below]
Cause Location	Location (of Cause) [Value as per table below]
Cause Class	Cause Class [Value as per table below]
Cause Value	Cause Value [Value as per table below]
	Message Type 30 (hex)
	Report Type 4
	Routing R-Channel

Comments:

These events are generated internal to the AES incoming procedure and do not arrive via the interworking interface.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
C-channel unit unavailable at the AES	1	2	2	2
Preempted by higher priority AMS(R)S call at the AES	1	1	1	1

Figure A5-14

BITE 16	Event Name: Call Unsuccessful - Called Party Busy	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: AES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 4
	Routing R-Channel
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Called Terminal Busy	1	1	7	1

Figure A5-15

BITE 17	Event Name: Call Unsuccessful - Line out of Service	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: AES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 4
	Routing R-channel

Comments:
(1) These events are generated internally by the AES incoming procedure.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
(1) Continuity test failure at the AES	1	2	5	1
Called terminal out of service	1	1	4	1
(1) Call announcement or C-channel assignment CM-LIDU not received from GES	1	2	3	2

Figure A5-16

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BITE 22	Event Name: Answer	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Connect	Procedure Usage: AES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
	Message Type 30 (hex)
	Report Type 2
	Routing C-channel subband
Comments:	

Figure A5-17

BITE 25	Event Name: Clear Back	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: AES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing C-Channel subband

Comments:

(1) These events are generated internal to the AES incoming procedure.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
(1) Preemption by AMS(R)S call at the AES	1	1	1	1
Normal backward clearing	0	0	1	0
(1) Answer timer expiry at the AES	0	1	1	2
(1) Connection-acknowledgement timer expiry at the AES	1	2	5	1
Undefined cause	1	2	7	15

Figure A5-18

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FITE 18	Event Name: AMS(R)S Call Origination (Calling-Party Category Indicator,Subscriber, Call with Priority)	
MAPS INTO:	AMS(R)S CM-LIDU: Call Announcement and C-Channel Assignment	Procedure Usage: GES Outgoing

Parameter Mapping:

FITE PARAMETER	UCI PARAMETER CODING	
CPCI (Calling Party Category Indicator)	Q Number	
Distress/Urgency	→	15
Flight Safety	→	12
Regularity	→	10
First 8 digits of 10-digit address (Variable)	AES ID →	(Variable)
Last 2 digits of 10-digit address (Variable)	Called Terminal →	(Variable)
	Service ID	1
	Circuit Data Rate	0
	Voice Channel Characteristics	2
	Source	2
	Service Direction	3
	Message Type	20 (hex)
	Routing	P-Channel

Comments: This parameter mapping is applicable to the "Call Announcement" CM-LIDU only.

	Initial EIRP	(Variable)
	Receive Channel Frequency	(variable)
	Transmit Channel Frequency	(variable)
	Message Type	31 (hex)
	Routing	P-Channel

Comments: This parameter mapping is applicable to the "C-Channel Assignment" CM-LIDU only.

Figure A5-19

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FITE 22	Event Name: Clear Forward	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Outgoing

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below)	S (Coding Standard) [Values as per table below]
Cause Location (See below)	Location (of Cause) [Values as per table below]
Cause Class (See below)	Cause Class [Values as per table below]
Cause Value (See below)	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-Channel or C-Channel subband

Comments:

(1) These events are generated internal to the GES outgoing procedure.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Normal forward clearing by the calling subscriber	0	0	1	0
(1) C-channel continuity test failure at the GES/AES not responding	1	3	5	1
(1) Interruption in received AES carrier	1	3	5	1
(1) Call preempted by higher priority AMS(R)S call	1	3	1	1
Undefined cause	1	4	7	15

Figure A5-20

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BITE 5	Event Name: Address Complete	
MAPS FROM:	AMS(R)S CM-LIDU: Telephony Acknowledge (When received by the GES at the completion of the C-Channel continuity check)	Procedure Usage: GES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
	Message Type 60 (hex)
	Ack/Nack Ack

Comments:

No parameters are mapped for this event. However, the Telephony Acknowledge CM-LIDU received during the C-Channel continuity check must have its Ack/Nack parameter set to ACK.

Figure A5-21

BITE 12	Event Name: Call Unsuccessful - Network Congestion	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: GES Outgoing

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below)	S (Coding Standard) → [Values as per table below]
Cause Location (See below)	Location (of Cause) → [Values as per table below]
Cause Class (See below)	Cause Class → [Values as per table below]
Cause Value (See below)	Cause Value → [Values as per table below]
	Message Type 30 (hex)
	Report Type 4

Comments:

(1) These events are generated internal to the GES outgoing procedure.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT

Event Trigger	Coding Std.	Location	Cause Class	Cause Value
(1) C-Channel frequency unavailable at GES	1	3	2	1
(1) C-Channel unit unavailable at GES	1	3	2	2
(1) GES equipment congestion	0	4	2	10
Call preempted by higher priority AMS(R)S call at the AES	1	1	1	1

Figure A5-22

BITE 16	Event Name: Call Unsuccessful - Called Party Busy	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: GES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 4
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Called party busy	1	1	7	1
C-channel unit unavailable at AES	1	2	2	2

Figure A5-23

BITE 17	Event Name: Call Unsuccessful - Line out of Service	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: GES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) <	S (Coding Standard) [Values as per table below]
Cause Location (See below) <	Location (of Cause) [Values as per table below]
Cause Class (See below) <	Cause Class [Values as per table below]
Cause Value (See below) <	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 4

Comments:

(1) This event trigger is generated internally by the GES Outgoing procedure upon the failure of the C-Channel continuity test within the GES. It does not arrive via the CM-LIDU.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
C-channel continuity test failure at the AES	1	2	5	1
(1) C-channel continuity test failure at the GES/AES not responding	1	3	5	1
Called terminal out of service	1	1	4	1
Call announcement or C-channel assignment CM-LIDU not received from GES	1	2	3	2

Figure A5-24

BITE 20	Event Name: Call Unsuccessful - Send Error Indication	
MAPS FROM:	AMS(R)S CM-LIDU: (None. See below.)	Procedure Usage: GES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Comments: This event is generated internal to the GES Outgoing procedure when a call is attempted to an AES which is not logged-on.	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
AES not logged on	1	3	7	3

Figure A5-25

BITE 22	Event Name: Answer	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Connect	Procedure Usage: GES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
	Message Type 30 (hex)
	Report Type 2
Comments:	

Figure A5-26

BITE 25	Event Name: Clear Back	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Outgoing

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) <	S (Coding Standard) [Values as per table below]
Cause Location (See below) <	Location (of Cause) [Values as per table below]
Cause Class (See below) <	Cause Class [Values as per table below]
Cause Value (See below) <	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5

Comments:

(1) These events are generated internal to the AES incoming procedure.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Normal backward clearing	0	0	1	0
Preempted by higher priority AMS(R)S call at the AES	1	1	1	1
Answer timer expiry at the AES	0	1	1	2
Connection-acknowledgement timer expiry at the AES	1	2	5	1
(1) Interruption in received AES carrier	1	3	5	1
(1) Call preempted for higher priority AMS(R)S call	1	3	1	1
Undefined cause	1	2	7	15

Figure A5-27

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FITE 18	Event Name: AMS(R)S Call Origination (Calling-Party Category Indicator,Subscriber, Call with Priority)	
MAPS FROM:	AMS(R)S CM-LIDU: Abbreviated Access Request - Telephone	Procedure Usage: GES Incoming

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING	
CPCI (Calling Party Category Indicator)	Q Number	
Distress/Urgency <		15
Flight Safety <		12
Regularity <		10
Called Party Number	Address Digit 0-9 (10 digit fixed length)	
Ground Address (10 digit fixed length) <		(Variable)
Calling Party Number	AES ID	
Aircraft Address (first 8 of 10 digits) <		(Variable)
	Calling Terminal	
Aircraft Address (last 2 of 10 digits) <		(Variable)
Closed User Group Info	Network ID	
AMS(R)S Terrestrial Voice Network <		10
Network-Specific Facilities	Service ID	
Voice Call <		1
User Data Rate	Circuit Data Rate	
Data Mode Not Required <		0
	Voice Channel Characteristics	2
	Source	1
	Service Direction	3
	Application Reference Number	(Variable)
	Message Type	23 (hex)

Comments:

Figure A5-28

FITE 22	Event Name: Clear Forward	
MAPS FROM:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Incoming

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ←	S (Coding Standard) [Values as per table below]
Cause Location (See below) ←	Location (of Cause) [Values as per table below]
Cause Class (See below) ←	Cause Class [Values as per table below]
Cause Value (See below) ←	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5

Comments:

(1) This event is generated internal to the GES incoming procedure.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Preemption by higher priority AMS(R)S call at the AES	1	1	1	1
Normal forward clearing by the calling party	0	0	1	0
(1) Interruption in received AES carrier or continuity failure	1	3	5	1

Figure A5-29

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BITE 5	Event Name: Address Complete	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 4
	Routing C-Channel subband
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Address complete signal received from the terrestrial network	1	8	0	1

Figure A5-30

BITE 12	Event Name: Call Unsuccessful - Network Congestion	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release or Call Progress - Call Attempt Result	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below)	S (Coding Standard) [Values as per table below]
Cause Location (See below)	Location (of Cause) [Values as per table below]
Cause Class (See below)	Cause Class [Values as per table below]
Cause Value (See below)	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5 (channel release) 4 (call attempt result)
	Routing P-channel or C-channel subband

Comments:

① This event trigger is generated internal to the GES Incoming procedure and does not arrive via the interworking interface with the terrestrial network.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
① C-Channel frequency unavailable at GES	1	3	2	1
① C-Channel unit unavailable at GES	1	3	2	2
① GES equipment congestion	0	2	2	10
Terrestrial network congestion or no route to destination	0	4	2	10

Figure A5-31

BITE 14	Event Name: Call Unsuccessful - Address Incomplete	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Releas	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-channel or C-channel subband
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Incomplete called number format detected by the terrestrial network	0	4	1	12
Invalid called number format detected by the terrestrial network	1	4	3	2

Figure A5-32

BITE 15	Event Name: Call Unsuccessful - Unallocated Number	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Incoming

Parameter Mapping:

FITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-channel or C-channel subband
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Unallocated called number detected by terrestrial network	0	4	0	1

Figure A5-33

BITE 16	Event Name: Call Unsuccessful - Called Party Busy	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below)	S (Coding Standard) → [Values as per table below]
Cause Location (See below)	Location (of Cause) → [Values as per table below]
Cause Class (See below)	Cause Class → [Values as per table below]
Cause Value (See below)	Cause Value → [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-channel or C-channel subband

Comments:

① The "called party busy (called party alerted)" event trigger is supported only by a GES which is equipped to receive that event from the terrestrial network.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Called party busy	0	5	1	1
① Called party busy (Called party alerted)	0	5	1	3

Figure A5-34

BITE 17	Event Name: Call Unsuccessful - Line out of Service	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-channel or C-channel subband

Comments: (1) This event is generated internal to the GES Incoming procedure. It does not arrive via the Interworking Interface.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
(1) C-Channel continuity test failure at the GES or carrier interruption	1	3	5	1
Destination out of service	0	5	1	11

Figure A5-35

BITE 20	Event Name: Call Unsuccessful - Send Error Indication	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress -- Channel Release	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-channel or C-channel subband

Comments:

All event triggers for this BITE are generated internal to the GES Incoming procedure. They do not arrive via the interworking interface.

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Reqd voice characteristics not supported by GES	1	3	6	4
Undefined cause	1	3	7	15
Calling AES not authorized for service	1	3	4	2
Expiry of answer timer at GES	0	4	1	2

Figure A5-36

BITE 22	Event Name: Answer	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Connect	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
	Message Type 30 (hex)
	Report Type 2
	Routing C-channel subband
Comments:	

Figure A5-37

BITE 25	Event Name: Clear Back	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) ---->	S (Coding Standard) [Values as per table below]
Cause Location (See below) ---->	Location (of Cause) [Values as per table below]
Cause Class (See below) ---->	Cause Class [Values as per table below]
Cause Value (See below) ---->	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-Channel or C-channel subband

Comments:

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Normal backward clearing	0	0	1	0

Figure A5-38

BITE 27	Event Name: Sending Finished - Set Up Speech Condition	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Call Attempt Result	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 4
	Routing C-channel subband
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Address complete signal received from the terrestrial network	1	6	0	1

Figure A5-39

BITE 29	Event Name: Release Incoming Side	
MAPS INTO:	AMS(R)S CM-LIDU: Call Progress - Channel Release	Procedure Usage: GES Incoming

Parameter Mapping:

BITE PARAMETER	LICI PARAMETER CODING
Coding Standard (See below) →	S (Coding Standard) [Values as per table below]
Cause Location (See below) →	Location (of Cause) [Values as per table below]
Cause Class (See below) →	Cause Class [Values as per table below]
Cause Value (See below) →	Cause Value [Values as per table below]
	Message Type 30 (hex)
	Report Type 5
	Routing P-Channel or C-channel subband
Comments:	

SPECIFIC CM-LIDU PARAMETER CODING INDICATIVE OF THIS EVENT				
Event Trigger	Coding Std.	Location	Cause Class	Cause Value
Release Incoming Side event received from terrestrial network (Normal backward clearing)	0	0	1	0

Figure A5-40

9/11/95

Appendix 6 to Chapter 4
AMS(R)S CONFIGURATION PARAMETERS

Table A6-1. Circuit-mode configuration parameters

Parameter	Description	Value
nA21	Length of CM-LIDU series for distress/urgency air-orginations	4
nA22	Length of CM-LIDU series for flight safety air-originations	3
nA23	Length of CM-LIDU series for regularity/meteorological air-originations	2

Appendix 7 to Chapter 4
VOICE ENCODING ALGORITHM DEFINITION

Note.— The voice encoding algorithm is subject to BT (formerly British Telecom) patent rights and copyrights. BT has agreed to grant royalty-free non-exclusive licenses under such patent rights and copyrights to all manufacturers of AES and GES implementations operating in the AMS(R)S service. These manufacturers should enter into a royalty-free license agreement with BT Laboratories prior to incorporating the algorithm in equipments operating in the AMS(R)S service.

1. INTRODUCTION

Interoperability of equipments operating in the AMS(R)S service can only be ensured if all provisions of this algorithm definition are fully complied with.

Note 1.— Refer to Figure A7-1 for a schematic representation of the algorithm.*

Note 2.— The flow and processing of information within the algorithm is defined with the use of the Pascal language. Individual implementations of this algorithm need not use this language.

Note 3.— All scalar variable names are depicted with a simple name. All vector variable names are depicted with a simple name followed by paired brackets ([]).

2. REQUIREMENTS FOR NUMERIC CALCULATIONS

Except where explicitly noted, and except for obvious integer variables such as vector indices and loop counters, all variables shall be maintained as floating-point values with a minimum mantissa precision of 24 bits inclusive of a sign bit. The range of the associated exponent shall be such that the magnitude of a positive or negative non-zero variable can vary over a minimum range of $5.87747*10^{-39}$ to $3.40282*10^{38}$.

Note.— Compliance with this minimum numeric range is essential if interoperability between different vocoder implementations is to be ensured.

3. AUDIO INPUT CHARACTERISTICS

3.1 Audio input spectral characteristics

Prior to sampling and quantization, speech audio which is presented to the encoding algorithm shall exhibit the following minimum spectral characteristics. These characteristics may be met by any combination of specific anti-aliasing filters and/or the natural spectral roll-off characteristics of transducers and audio channels:

Note.— All specifications are referenced to 1 020 Hz.

a) over a passband of 300 to 3 400 Hz, a gain variation of no more than ±2 dB;

b) over a transition band of 4 000 Hz to 4 600 Hz, a gain of −45 dB or lower; and

c) at 4 600 Hz and above, a gain of −75 dB or lower.

Note 1.— In addition to the listed spectral characteristics, additional filtering appropriate to the particular equipment installation should be provided in the low-end response characteristics of the vocoder so as to mitigate the effects of power supply noise pickup (e.g. 400 Hz for AES installations and 50/60 Hz for GES installations).

Note 2.— The input to the encoding algorithm is defined in 3.2 to be quantized audio samples with at least 12 bits of resolution. Consequently, all required spectral characteristics at the point of sampling are defined with this in mind. The use of u-law or A-law companded audio in conjunction with both reduced resolution (e.g. 8 bits) and appropriately relaxed transition-band and stop-band gain characteristics is permitted provided that the quantized samples are decompanded (linearized) prior to their presentation to the algorithm.

* All figures are located at the end of this chapter.

3.2 Sampling, quantization and scaling

Audio which exhibits the spectral characteristics defined in 3.1 shall be sampled at a continuous 8 kHz rate, and the resultant series of samples shall be quantized to an equivalent time-ordered series of linear (i.e. non-companded) binary values. Each quantization operation shall be performed with a precision of at least 12 bits and a linearity of at least 10 bits. The maximum dynamic range of this series shall be scaled up or down in magnitude as appropriate so that it is tightly bounded by the floating-point range of 4 095.0 to –4 096.0 without exceeding it. The resultant time-ordered series of scaled values shall be presented to the segmentation and windowing logic defined in 4.1.

Note.— The above bounding range of scaled values is indicative of a fixed-point signed value of 13 bits in length. Scaling of the time-ordered series of binary values to the indicated numeric range is required in order to take maximum advantage of the internal numeric range of the algorithm.

4. ENCODING PROCESS DEFINITION

4.1 Segmentation and windowing

The time-ordered stream of input samples shall be subdivided into time-ordered segments termed *segspch[ ]*, each comprising 256 time-ordered input samples (32 ms). Each *segspch[ ]* shall be so constructed that the first and last 96 samples (12 ms) contained within it overlap with the immediately previous and subsequent *segspch[ ]*. Each *segspch[ ]* shall be windowed with a Hamming window vector *hamwindow[ ]* defined by:

```
FOR n:=0 TO 255 DO hamwindow[n]:=
0.54−0.46*COS(2*3.1415927*n/255);
```

and a windowing operation defined by:

```
FOR n:=0 TO 255 DO windspch[n]:=
segspch[n]*hamwindow[n];.
```

An additional time-ordered vector *spch[ ]* corresponding to the central 160 samples of each *segspch[]* vector shall be generated by the operation defined by:

```
FOR n:=0 TO 159 DO spch[ ]:=segspch[n+48];.
```

4.2 Autocorrelation

For each *windspch[ ]*, an eleven element autocorrelation vector *corr[ ]* shall be generated by the operation defined by:

```
FOR i:=0 TO 10 DO
BEGIN
dot:=0;
   FOR n:=0 TO 255-i DO dot:=dot+windspch[n]
   *windspch[n+i];
corr[i]:=dot
END;
```

4.3 Durbin's recursion

For each *corr[ ]*, a partial correlation coefficient vector *parcor[ ]* shall be generated by the operation defined by:

```
IF corr[0]=0 THEN FOR i:=1 TO 10 DO parcor[i]:=0;
ELSE
BEGIN
parcor[1]:=corr[1]/corr[0];
taps[1]:=parcor[1];
error:=(1-sqr(parcor[1]))*corr[0];
FOR i:=2 TO 10 DO
   BEGIN
   FOR j:=1 TO pred(i) DO alpha[j]:=taps[j];
   parcor[i]:=corr[i];
   FOR j:=1 TO pred(i) DO parcor[i]:=parcor[i]-
      alpha[j]*corr[i-j];
   parcor[i]:=parcor[i]/error;
   taps[i]:=parcor[i];
   FOR j:=1 TO pred(i) DO taps[j]:=alpha[j]-
      parcor[i]*alpha[i-j];
   error:=(1-sqr(parcor[i]))*error
   END
END;
```

4.4 Quantization of the partial correlation coefficients

For each *parcor[ ]*, the ten partial correlation coefficients contained within shall be quantized and stored in vector *qparcor[ ]* which is generated by the operation defined by:

```
{Quantizer initialization procedure}

{No. of quantizer levels for each coefficient}

plevel[1]:=64;
plevel[2]:=64;
plevel[3]:=32;
plevel[4]:=32;
plevel[5]:=16;
plevel[6]:=16;
plevel[7]:=8;
plevel[8]:=8;
plevel[9]:=4;
plevel[10]:=4;
```

```
FOR i:=1 TO 10 DO
FOR j:=0 TO pred(plevel[i]) DO
    parql[i,j]:=pardl[i,pred(j)]+pardl[i,j]/2;

{Partial correlation coefficient quantizer}.

FOR i:=1 TO 10 DO
BEGIN
j:=0;
        WHILE (parcor[i]>pardl[i,j] and
        (j<pred(plevel[i])) DO j:=succ(j);
    qparcor[i]:=parql[i,j]
END;
```

Note.— Vector pardl[] *contains the fixed decision levels for each partial correlation coefficient and its contents are defined in Table A7-1.**

4.5 Line codes for the partial correlation coefficients

A line code corresponding to each quantized partial correlation coefficient contained in *qparcor[]* shall be inserted into the transmission frame. Each line code shall be generated by the table look-up operation defined by:

a) for *qparcor[1]* use Table A7-2;

b) for *qparcor[2]* use Table A7-3;

c) for *qparcor[3]* use Table A7-4;

d) for *qparcor[4]* use Table A7-5;

e) for *qparcor[5]* use Table A7-6;

f) for *qparcor[6]* use Table A7-7;

g) for *qparcor[7]* use Table A7-8;

h) for *qparcor[8]* use Table A7-9;

i) for *qparcor[9]* use Table A7-10; and

j) for *qparcor[10]* use Table A7-11.

4.6 LPC filter tap step up

For each *qparcor[]*, the vector *qtaps[]* shall be generated by the operation defined by:

```
qtaps:=qparcor; {all 10 elements of vector qtaps set equal
to corresponding elements in qparcor}

FOR i:=2 TO 10 DO
BEGIN
    FOR j:=1 TO pred(i) DO alpha[j]:=qtaps[j];
        FOR j:=1 TO pred(i) DO qtaps[j]:=alpha[j]-
            qtaps[i]*alpha[i-j]
END;
```

4.7 Long-term correlation analysis

4.7.1 LPC INVERSE FILTERING

For each *spch[]*, the vector *residue[]* shall be generated by the operation defined by:

```
FOR n:=0 TO 159 DO
BEGIN
sum:=spch[n];
FOR i:=1 TO 10 DO sum:=sum-qtaps[i]*spch[n-i];
residue[n]:=sum
END;
```

Note.— The values near the start of each spch[], *for which the index of* spch[] *is less than zero, refers to speech samples at the end of the previous* spch[]. *For the first* spch[] *processed by the encoder, these values shall be considered to be zero.*

4.7.2 LONG-TERM CORRELATION

For each *residue[]*, the scalars *gain* and *delay* shall be generated by the operation defined by:

```
max:=0
FOR lag:=33 TO 96 DO
    BEGIN
    sum:=0;
    FOR n:=0 TO 159 DO sum:-
        sum+residue[n]*residue[n-lag];
        IF sum>max THEN
        BEGIN
        max:=sum;
        delay:=lag
        END
    END;
sum:=0;
FOR n:=0 TO 159 DO sum:=sum+sqr(residue[n-delay]);
IF sum=0 THEN gain:=0 ELSE gain:=max/sum;
END;
```

* All tables are located at the end of this chapter.

Note 1.— The scalar delay is a 16-bit signed integer.

Note 2.— Negative values of the indices n-lag and n-delay point to entries in the residue[] *that were calculated for the previous* spch[]. *For the first* spch[] *processed, the referenced entries in* residue[] *shall be considered to be zero.*

4.7.3 QUANTIZATION AND LINE ENCODING OF THE SCALAR GAIN

For each *gain*, its contents shall be quantized and stored in scalar *qgain* by the operation defined by:

```
IF gain>0.75 THEN qgain:=0.9 ELSE
    IF gain>0.45 THEN qgain:=0.60 ELSE
        IF gain>0.2 THEN qgain:=0.325 ELSE qgain:=0.1
```

A 2-bit line code corresponding to *qgain* shall be inserted into the transmission frame. The line code shall be generated by the table look-up operation defined by Table A7-12.

4.7.4 LINE ENCODING OF THE SCALAR DELAY

A line code corresponding to *delay* shall be generated by the table look-up operation defined by Table A7-13.

4.8 Excitation analysis

Note 1.— The transmission frame generated by this encoding algorithm contains five excitation frames. Each group of five excitation frames is associated with the same speech frame (spch[]) *from which the partial correlation coefficients of the current transmission frame were calculated.*

Note 2.— Any operation that generates an output variable that is a component of an excitation frame must be performed at the generation rate of the excitation frames (i.e. five executions for each spch[]).

4.8.1 ERROR SIGNAL DERIVATION

For each *delay*, *qgain*, *qtaps[]*, *synthspch[]*, and *s2[]*, the vector *error[]* shall be generated by the operation defined by:

```
local_synthspch:=synthspch; {create a local copy
    of the short term predictor filter memory}
local_s2:=s2; {create a local copy of the
    long term predictor filter memory}
FOR n:=b TO b+31 DO
    BEGIN
    sum:=0;
        FOR i:=1 TO 10 DO sum:=sum+qtaps[i]*
        local_synthspch[n-i];
    local_synthspch[n]:=qgain*local_s2[n-delay]+sum;
    error[n]:=spch[n]-local_synthspch[n]
    END;
```

Note.— This operation is performed for each of the five excitation frames contained within a transmission frame.

4.8.2 IMPULSE RESPONSE CALCULATION

For each *qtaps[]*, the vectors *iresp[]* and *ipwr[]* shall be generated by the operation defined by the following:

```
iresp[0]:=1;
ipwr[31]:=1;
FOR n:=1 TO 31 DO
    BEGIN
    sum:=0;
    FOR j:=1 TO 10 DO IF n>=j THEN
        sum:=sum+qtaps[j]*iresp[n-j];
    iresp[n]:=sum;
    ipwr[32-succ(n)]:=ipwr[32-n]+sqr(sum)
    END;
```

Note.— Since the minimum possible value for the delay parameter is 32, the long-term predictor has no influence on the first 32 samples of the impulse response.

4.8.3 CROSS-CORRELATION CALCULATION

For each *error[]* and *iresp[]*, the vector *xcorr[]* shall be generated by the operation defined by:

```
FOR n:=0 TO 31 DO
    BEGIN
    dot:=0;
        FOR j:=n TO 31 DO dot:=dot+error[b+j]*
            iresp[j-n];
    xcorr[n]:=dot
    END;
```

Note 1.— The scalar b is the sample number corresponding to the start of the current excitation frame within the current speech frame. For the first, second, third, fourth and fifth excitation frames of each speech frame, the value of b equals 0, 32, 64, 96, and 128 respectively.

Note 2.— This operation is performed for each of the five excitation frames contained within a transmission frame.

4.8.4 PULSE SELECTION

For each *xcorr[]*, *ipwr[]*, and *iresp[]*, the vectors *posns[]* and *qamp[]* shall be generated by the operation defined by:

```
FOR pulse:=1 TO 3 DO
BEGIN
max:=0;
FOR n:=0 TO 31 DO
    IF (sqr(xcorr[n])>=max*ipwr[n]) and not
        (n in posn_set) THEN BEGIN
    max:=sqr(xcorr[n])/ipwr[n];
    pos:=n
END;
posn_set:=posn_set+[pos];
posns[pulse]:=pos;
amp:= xcorr[pos]/ipwr[pos];
qamp[pulse]:=quantamp(amp,pulse);

{Account for the effect of the quantized pulse
    just calculated on the error to be minimized}
    WHILE pulse<npulse DO
    BEGIN
        FOR n:=0 TO pred(pos) DO
        BEGIN
        dot:=0;
            FOR j:=0 TO 31-pos DO dot:=dot+iresp[j]*
                iresp[j+(pos-n)];
        xcorr[n]:=xcorr[n-qamp*dot
        END;

        FOR n:= pos TO 31 DO
        BEGIN
        dot:=0;
            FOR j:=0 TO 31-n DO dot:=dot+iresp[j]*
                iresp[j+(n-pos)];
        xcorr[n]:=xcorr[n]-qamp*dot
        END
    END
END;
```

Note 1.— The second and third pulses selected in each excitation frame are not allowed to occupy a position already occupied by a previously selected pulse in that excitation frame.

Note 2.— The function quantamp(amp,pulse) *is defined in 4.8.4.1.*

Note 3.— This operation is performed for each of the five excitation frames contained within a transmission frame.

4.8.4.1 *PULSE AMPLITUDE QUANTIZATION*

Where invoked elsewhere, the function *quantamp(amp,pulse)* shall be used to generate values in the vector *qamp[]* by the operation defined by:

```
{Pulse amplitude quantizer initialization}

gfact_leak:=1; maxadapt:=false;
adjust[1]:=1; adjust[2]:=1.0/0.625; adjust[3]:=1.0/0.375;

{3 bit quantizer initialization}

adapt[3,0]:=0.875; adapt[3,1]:=0.875;
    adapt[3,2]:=1.0; adapt[3,3]:=1.5;
quant[3,0]:=0.5006; quant[3,1]:=1.050;
    quant[3,2]:=1.748;
inv_quant[3,0]:=0.2451; inv_quant[3,1]:=0.7560;
    inv_quant[3,2]:=1.344;
inv_quant[3,3]:=2.152;

{4 bit quantizer initialization}

adapt[4,0]:=0.75; adapt[4,1]:=0.875;
    adapt[4,2]:=0.875; adapt[4,3]:=0.875;
adapt[4,4]:=1.0;
adapt[4,5]:=1.25; adapt[4,6]:=1.5; adapt[4,7]:=2.0;
quant[4,0]:=0.2582; quant[4,1]:=0.5224;
    quant[4,2]:=0.7996;
quant[4,3]:=1.099; quant[4,4]:=1.437;
    quant[4,5]:=1.844; quant[4,6]:=2.401;
inv_quant[4,0]:=0.1284; inv_quant[4,1]:=0.3881;
    inv_quant[4,2]:=0.6568;
inv_quant[4,3]:=0.9424; inv_quant[4,4]:=1.256;
    inv_quant[4,5]:=1.618; inv_quant[4,6]:=2.069;
inv_quant[4,7]:=2.733;

FUNCTION quantamp(lev:real, pulse:integer):real;

VAR    i,qbits      : integer
sgn    : -1..1;
BEGIN
lev:=lev*adjust[pulse]
IF pulse<3 THEN BEGIN qbits:=4; qlevels:=7 END
    ELSE BEGIN qbits:=3; qlevels:=3 END;
IF lev>0 THEN sgn:=1 ELSE sgn:=-1;
i:=0;
WHILE (abs(lev)>quant[qbits,i]*gfact_leak) and
    (i<qlevels) DO i:=succ(i);
quantamp:=inv_quant[qbits,i]*gfact_leak*
    sgn/adjust[pulse];
gfact_leak:=EXP(0.98*LN(gfact_leak));

IF i=qlevels THEN
    BEGIN
    IF maxadapt THEN gfact_leak:=gfact_leak*
        adapt[qbits,qlevels]; maxadapt:=true
    END ELSE maxadapt:=false;
gfact_leak:=gfact_leak*adapt[qbits,i];
IF gfact_leak>512.0 THEN gfact_leak:=512.0 ELSE
    IF gfact_leak<0.5 THEN gfact_leak:=0.5
END { of quantamp. };
```

Note 1.— This operation is performed for each of the five excitation frames contained within a transmission frame.

Note 2.— The final, post-leakage pulse amplitudes developed within the function quantamp() *are each quantized to a* *fixed value based on internal quantization thresholds; and then converted to corresponding line codes. The quantization and line code generation aspects of the function are, in effect, a table lookup operation which can be visualized by referring to Tables A7-14 and A7-15.*

4.8.5 PULSE POSITION LINE CODE GENERATION

A line code corresponding to the contents of *posns[]* for each excitation frame shall be generated by the table look-up operation defined by Table A7-16.

Note.-- Each pulse position shall be encoded with reference to the beginning of the excitation frame within which it falls. There are 32 possible positions per excitation frame. Positions within each excitation frame are numbered from 0 to 31, with 0 corresponding to the first sample position within each frame and 31 corresponding to the last sample position.

4.9 Local decoder

Note.— The local decoder logic is used to generate a locally derived version of the encoded speech for feedback to the excitation analysis logic defined in 4.8. The local decoder logic is also used in the definition of the decoding process in Section 5.

4.9.1 EXCITATION GENERATOR

For each *posns[]* and *qamp[]*, the vector *s1[]* shall be generated by the operation defined by:

FOR n:=b TO b+31 DO s1[n]:=0;
FOR pulse:=1 TO 3 DO s1[posns[pulse]+b]:= qamp[pulse];

Note 1.— The scalar b is the sample number in the current spch[] *frame corresponding to the start of the current excitation frame and* posns[] *is the vector of pulse positions belonging to the current excitation frame. For the first, second, third, fourth and fifth excitation frames of each speech frame, the value of b equals 0, 32, 64, 96, and 128 respectively.*

Note 2.— The vector s1[] *contains pulses of amplitude* qamp[] *located at positions* posns[], *and having the corresponding quantized amplitudes,* qamp[].

Note 3.— This operation is performed for each of the five excitation frames contained within a transmission frame.

4.9.2 LONG-TERM PREDICTOR

For each *qgain* and *delay*, and for each of the five *s1[]* associated with a transmission frame, the vector *s2[]* shall be generated by the operation defined by:

*FOR n:=b TO b+31 DO s2[n]:=qgain*s2[n-delay]+s1[n];*

Note 1.— Values of the index, n-delay, *are always less than b (the beginning of the current excitation frame) and the index thus points to values in the long term predictor filter memory. For the first* spch[] *frame processed, the contents of* s2[] *shall be set to zero.*

Note 2.— This operation is performed for each of the five excitation frames contained within a transmission frame.

4.9.3 SHORT-TERM PREDICTOR

For each *qtaps[]*, and for each of the five *s2[]* associated with a transmission frame, the vector *synthspch[]* shall be generated by the operation defined by:

```
FOR n:=b TO b+31 DO
BEGIN
sum:=0;
    FOR i:=1 TO 10 DO sum:=sum+qtaps[i]*
        synthspch[n-i];synthspch[n]:
        =s2[n]+sum
END;
```

Note 1.— The index, n-i, *points to values in the short-term predictor memory. For the first* spch[] *frame processed, the contents of* synthspch[] *shall be set to zero.*

Note 2.— This operation is performed for each of the five excitation frames contained within a transmission frame.

4.10 Transmission frame generation

A transmission frame comprising the structure defined in 4.10.1 shall be generated by the voice encoder process every 20 milliseconds.

4.10.1 TRANSMISSION FRAME STRUCTURE

The 192-bit transmission frame structure shall be as defined in Table A7-17.

4.10.2 TRANSMISSION ORDERING AND ALIGNMENT

Commencing with Partial Correlation Coefficient No. 1, the transmission frame shall be rendered as a sequence of 192 bits by aligning each succeeding line code in Table A7-17 in bit serial order. Alignment shall be such that the least significant bit of each line code is followed immediately by the most significant bit of the following line code. Each 192-bit transmission frame shall be aligned with and contained within a 192-bit C channel primary data field as defined in Section 4.

4.10.3 ERROR PROTECTION

The 26 bits designated by underscoring in Table A7-18 shall be protected by the error correction/detection logic defined in 4.10.3.1 and 4.10.3.2.

4.10.3.1 *SINGLE BIT ERROR CORRECTION AND DOUBLE BIT ERROR DETECTION*

The protected bits defined in 4.10.3 shall be used to generate a 5-bit Hamming code word by the operation defined by:

```
TYPE  hamrng = 1..26;
hamword = array [hamrng] of boolean;

FUNCTION hamming (word:hamword):integer;
VAR n,count,ham :integer;
i   :hamrng;
BEGIN
n:=4; count:=3; ham:=0;
FOR i:=1 TO 26 DO
   BEGIN
   IF word[i] THEN ham:=EXOR(ham,count);
   count:=succ(count);
   IF count=n THEN BEGIN n:=n*2;
      count:=succ(count)END
   END

hamming:=ham
END{of hamming.};
```

A sixth bit representing an odd-parity bit of the code word shall be generated and appended to the code word as the most significant bit. The resultant 6-bit value shall be inserted in the transmission frame and submitted to the burst error detection logic defined in 4.10.3.2.

4.10.3.2 *BURST ERROR DETECTION*

The 26 protected bits defined in Table A7-18 and the 6-bit value resulting from the Hamming code word defined in 4.10.3.1 shall be arranged in the order defined by the matrix in Table A7-19 at the locations denoted by 'p' and 'e' respectively.

Each bit 'b' shall be set to make even parity for its respective column. The 8 'b' bits shall then be exclusive-ORed with the binary mask '10101010' and the resulting 8 bits inserted in the transmission frame.

5. DECODING PROCESS DEFINITION

Each transmission frame shall be decoded as per 5.1. The line codes shall be used to generate quantized speech samples as per 5.2.

5.1 Transmission frame decoding

5.1.1 PARTIAL CORRELATION COEFFICIENT DECODING

5.1.1.1 *BURST ERROR DETECTION/ CORRECTION*

The 26 protected bits (Table A7-18), the 6-bit Hamming code word, and the 8 burst error detection bits shall be extracted from the transmission frame and arranged in a burst error detection calculation matrix as per Table A7-19. The burst error detection bits shall then be exclusive-ORed in place with the binary mask '10101010'. Each column of the resulting matrix shall then be examined for a potential lack of even parity. The matrix and the associated column parity error information shall then be submitted to the error detection and correction process defined in Figure A7-2. If that process indicates that the corrected error level of the received coefficient line codes is adequate, the coefficients shall be decoded from the line codes as per 5.1.1.2. However, if the corrected error level is inadequate, the line codes shall be discarded and the output of the decoder shall be muted by the logic defined in 5.1.3.2 and 5.1.3.2.1.

Note.— The purpose of the 8 burst error detection bits is to guard against a pathological case where an extremely long burst error series might render '0' bits in all 40 positions of the calculation matrix. In that case, the exclusive-OR operation on the 'b' bits of the matrix would cause odd parity to be made in four of the columns, thereby forcing the error detection and correction process to discard the transmission frame.

5.1.1.2 *COEFFICIENT DECODING*

If the corrected error level of the line codes corresponding to the 10 coefficients is shown to be adequate (5.1.1.1), the 10 coefficients shall be decoded as per Tables A7-2 through A7-11 and the resulting values inserted into the vector *qparcor[]*. Vector *qparcor[]* shall then be used to generate vector *qtaps[]* by the operation defined in 4.6.

5.1.2 LONG-TERM PREDICTOR PARAMETER DECODING

The long-term predictor parameters *qgain* and *delay* shall be decoded from the received line codes by the table look-up operation defined by Tables A7-12 and A7-13 respectively.

5.1.3 EXCITATION PARAMETER DECODING

5.1.3.1 *PULSE POSITION DECODING*

For each excitation frame, the vector *posns[]* shall be generated from the contents of the three pulse position values. The contents shall be decoded from the received line codes by the table look-up operation defined by Table A7-16.

5.1.3.2 *PULSE AMPLITUDE DECODING*

For each excitation frame, the vector *qamp[]* shall be generated from the contents of the three pulse amplitude values contained in the excitation frame. The contents shall be decoded from the received line codes by the table look-up operation defined by Tables A7-14 and A7-15.

5.1.3.2.1 If muting of the decoder output is indicated (5.1.1), the line codes corresponding to *qamp[1]* and *qamp[2]* shall be forced to '0100' prior to decoding. Similarly, the line code corresponding to *qamp[3]* shall be forced to '010' prior to decoding.

Note.— The contents of qamp[1], qamp[2] *and* qamp[3] *represent the amplitudes of the first through third pulses of the excitation frame respectively.*

5.1.3.3 Beginning with excitation frame no. 1 and continuing in sequence for each of the remaining excitation frames, the contents of the vector *qamp[]* corresponding to each of the five excitation frames shall be modified by the operation defined by:

Note.— This operation compensates for the amplitude normalization and gain adjustment processes performed during encoder pulse quantization (4.8.4.1).

```
{Initialization}

gfact_leak:=1; maxadapt:=false;
adjust[1]:=1; adjust[2]:=1.0/0.625; adjust[3]:=1.0/0.375;

{3 bit initialization}

adapt[3,0]:=0.875; adapt[3,1]:=0.875;
    adapt[3,2]:=1.0; adapt[3,3]:=1.5;
inv_quant[3,0]:=0.2451; inv_quant[3,1]:=0.7560;
    inv_quant[3,2]:=1.344; inv_quant[3,3]:=2.152;

{4 bit initialization}

adapt[4,0]:=0.75; adapt[4,1]:=0.875; adapt[4,2]:=0.875;
    adapt[4,3]:=0.875; adapt[4,4]:=1.0;
adapt[4,5]:=1.25; adapt[4,6]:=1.5; adapt[4,7]:=2.0;
inv_quant[4,0]:=0.1284; inv_quant[4,1]:=0.3881;
    inv_quant[4,2]:=0.6568;
inv_quant[4,3]:=0.9424; inv_quant[4,4]:=1.256;
    inv_quant[4,5]:=1.618; inv_quant[4,6]:=2.069;
inv_quant[4,7]:=2.733;

VAR   i,qbits: integer
sgn   : -1..1;
FOR pulse:= 1 TO 3 DO
BEGIN
IF pulse<3 THEN BEGIN qbits:=4; qlevels:=7 END
    ELSE BEGIN qbits:=3; qlevels:=3 END;
i:=0;
WHILE (abs(qamp[pulse])>inv_quant[qbits,i]) and
    (i<qlevels) DO i:=succ(i);
qamp[pulse]:=qamp[pulse]*gfact_leak/adjust[pulse];
gfact_leak:=EXP(0.98*LN(gfact_leak));

IF i=qlevels THEN
    BEGIN
    IF maxadapt THEN gfact_leak:=gfact_leak*
        adapt[qbits,qlevels]; maxadapt:=true
    END ELSE maxadapt:=false;
gfact_leak:=gfact_leak*adapt[qbits,i];
IF gfact_leak>512.0 THEN gfact_leak:=512.0 ELSE
    IF gfact_leak<0.5 THEN gfact_leak:=0.5
END;
```

5.1.3.3.1 If muting of the decoder output is indicated (5.1.1), the contents of *qamp[]* shall be set to zero **after** the completion of the above operation.

5.2 Generation of the decoded speech output

For each decoded transmission frame, time-ordered speech samples shall be generated by the following operations in sequence:

a) for each of the five vectors *posns[]* and *qamp[]* associated with the current transmission frame, a vector *s1[]* shall be generated by the operation defined in 4.9.1;

b) for each of the five vectors *s1[]* associated with the current transmission frame, and for the scalars *qgain* and *delay* associated with the current transmission frame, a vector *s2[]* shall be generated by the operation defined in 4.9.2; and then

c) for each of the five vectors *s2[]* associated with the current transmission frame, and for the vector *qtaps[]* associated with the current transmission frame, a vector *synthspch[]* shall be generated by the operation defined in 4.9.3.

Note.— The rate at which the vector synthspch[] *is generated by the decoder (5 vectors/frame at 50 frames/second) and the rate of speech samples from each* synthspch[] *(32 samples/vector) will yield an over-all speech sample rate of 8.0 kHz.*

5.3 Speech output transcoding

Each speech sample derived from the vector *synthspch[]* will exhibit the internal floating point numeric range as defined in Section 2. The numeric range of the speech sample stream should be appropriately scaled prior to any subsequent digital transcoding or analog speech reconstruction.

Table A7-1. *pardl[]* (decision levels for the partial correlation coefficient quantizer)

pardl[1,-1], pardl[1,0], pardl[1,1], pardl[1,2]	-0.7512804,	-0.7269750,	-0.7017226,	-0.6755562
pardl[1,3], pardl[1,4], pardl[1,5], pardl[1,6]	-0.6485097,	-0.6206185,	-0.5919189,	-0.5624482
. . . .	-0.5322449,	-0.5013483,	-0.4697985,	-0.4376369
. . . .	-0.4049051,	-0.3716459,	-0.3379026,	-0.3037192
. . . .	-0.2691401,	-0.2342104,	-0.1989756,	-0.1634817
. . . .	-0.1277748,	-0.0919014,	-0.0559084,	-0.0198425
. . . .	0.0162492,	0.0523198,	0.0883222,	0.1241096
. . . .	0.1599351,	0.1954524,	0.2307150,	0.2656771
. . . .	0.3002931,	0.3345180,	0.3683071,	0.4016164
. . . .	0.4344026,	0.4666229,	0.4982354,	0.5291989
. . . .	0.5594731,	0.5890184,	0.6177965,	0.6457698
. . . .	0.6729020,	0.6991577,	0.7245026,	0.7489037
. . . .	0.7723293,	0.7947488,	0.8161331,	0.8364543
. . . .	0.8556859,	0.8738029,	0.8907816,	0.9066001
. . . .	0.9212375,	0.9346749,	0.9468949,	0.9578813
pardl[1,59], pardl[1,60], pardl[1,61], pardl[1,62]	0.9676200,	0.9760983,	0.9833051,	0.9892311
pardl[1,63], pardl[2,-1], pardl[2,0], pardl[2,1]	0.9938684,	-0.9687151,	-0.9600082,	-0.9502578
pardl[2,2], pardl[2,3], pardl[2,4], pardl[2,5]	-0.9394747,	-0.9276705,	-0.9148581,	-0.9010514
. . . .	-0.8862653,	-0.8705161,	-0.8538207,	-0.8361974
. . . .	-0.8176653,	-0.7982445,	-0.7779561,	-0.7568223
. . . .	-0.7348658,	-0.7121107,	-0.6885817,	-0.6643043
. . . .	-0.6393048,	-0.6136106,	-0.5872494,	-0.5602500
. . . .	-0.5326418,	-0.5044546,	-0.4757191,	-0.4464666
. . . .	-0.4167289,	-0.3865382,	-0.3559275,	-0.3249299
. . . .	-0.2935792,	-0.2619094,	-0.2299549,	-0.1977505
. . . .	-0.1653312,	-0.1327322,	-0.0999890,	-0.0671371
. . . .	-0.0342122,	-0.0012501,	0.0317133,	0.0646423
. . . .	0.0975010,	0.1302537,	0.1628649,	0.1952991
. . . .	0.2275210,	0.2594956,	0.2911882,	0.3225643
. . . .	0.3535898,	0.3842311,	0.4144548,	0.4442280
. . . .	0.4735184,	0.5022941,	0.5305240,	0.5581772
. . . .	0.5852238,	0.6116344,	0.6373802,	0.6624333
pardl[2,62], pardl[2,63], pardl[3,-1], pardl[3,0]	0.6867664,	0.7103531,	-0.6209860,	-0.5817980
pardl[3,1], pardl[3,2], [pardl[3,3], pardl[3,4]	-0.5412097,	-0.4993190,	-0.4562265,	-0.4120361
. . . .	-0.3668540,	-0.3207891,	-0.2739522,	-0.2264559
. . . .	-0.1784146,	-0.1299440,	-0.0811606,	-0.0321819
. . . .	0.0168742,	0.0658897,	0.1147467,	0.1633275
. . . .	0.2115152,	0.2591939,	0.3062488,	0.3525667
. . . .	0.3980361,	0.4425475,	0.4859939,	0.5282706
. . . .	0.5692760,	0.6089114,	0.6470813,	0.6836939
pardl[3,29], pardl[3,30], pardl[3,31], pardl[4,-1]	0.7186612,	0.7518988,	0.7833269,	-0.8819578
pardl[4,0], pardl[4,1], pardl[4,2], pardl[4,3]	-0.8576206,	-0.8311930,	-0.8027395,	-0.7723294
. . . .	-0.7400368,	-0.7059404,	-0.6701235,	-0.6326731
. . . .	-0.5936806,	-0.5532411,	-0.5114532,	-0.4684186
. . . .	-0.4242423,	-0.3790320,	-0.3328978,	-0.2859522
. . . .	-0.2383097,	-0.1900863,	-0.1413995,	-0.0923682
. . . .	-0.0431116,	0.0062499,	0.0555963,	0.1048072
. . . .	0.1537625,	0.2023432,	0.2504306,	0.2979076
pardl[4,28], pardl[4,29], pardl[4,30], pardl[4,31]	0.3446585,	0.3905694,	0.4355282,	0.4794255
pardl[5,-1], pardl[5,0], pardl[5,1], pardl[5,2]	-0.5728675,	-0.5044545,	-0.4327131,	-0.3581167
. . . .	-0.2811575,	-0.2023432,	-0.1221939,	-0.0412383
. . . .	0.0399893,	0.1209531,	0.2011188,	0.2799576
. . . .	0.3569492,	0.4315858,	0.5033747,	0.5718424
pardl[5,15], pardl[6,-1], pardl[6,0], pardl[6,1]	0.6365371,	-0.7032794,	-0.6508853,	-0.5951883
. . . .	-0.5364712,	-0.4750316,	-0.4111817,	-0.3452452
. . . .	-0.2775567,	-0.2084599,	-0.1383052,	-0.0674487
. . . .	0.0037500,	0.0749297,	0.1457292,	0.2157892
pardl[6,14], pardl[6,15], pardl[7,-1], pardl[7,0]	0.2847542,	0.3522742,	-0.4617792,	-0.3299494
pardl[7,1], pardl[7,2], pardl[7,3], pardl[7,4]	-0.1913133,	-0.0487307,	0.0948572,	0.2364883
pardl[7,5], pardl[7,6], pardl[7,7], pardl[8,-1]	0.3732410,	0.5022942,	0.6209860,	-0.6287930
pardl[8,0], pardl[8,1], pardl[8,2], pardl[8,3]	-0.5098411,	-0.3801884,	-0.2425563,	-0.0998334
pardl[8,4], pardl[8,5], pardl[8,6], pardl[8,7]	0.0449848,	0.1888589,	0.3287691,	0.4617791
pardl[9,-1], pardl[9,0], pardl[9,1], pardl[9,2]	-0.4259395,	-0.1271548,	0.1839465,	0.4772301
pardl[9,3], pardl[10,-1], pardl[10,0], pardl[10,1]	0.7242872,	-0.4968801,	-0.2763557,	-0.0399893
pardl[10,2], pardl[10,3]	0.1986693,	0.4259395		

Table A7-2. Line codes for partial correlation coefficient No. 1

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
-0.7391278	000000	0.3174056	100000
-0.7143489	000001	0.3514125	100001
-0.6886395	000010	0.3849618	100010
-0.6620330	000011	0.4180095	100011
-0.6345642	000100	0.4505128	100100
-0.6062688	000101	0.4824292	100101
-0.5771836	000110	0.5137172	100110
-0.5473465	000111	0.5443360	100111
-0.5167966	001000	0.5742458	101000
-0.4855734	001001	0.6034074	101001
-0.4537177	001010	0.6317832	101010
-0.4212710	001011	0.6593359	101011
-0.3882755	001100	0.6860299	101100
-0.3547743	001101	0.7118301	101101
-0.3208109	001110	0.7367031	101110
-0.2864296	001111	0.7606165	101111
-0.2516752	010000	0.7835391	110000
-0.2165930	010001	0.8054410	110001
-0.1812287	010010	0.8262937	110010
-0.1456282	010011	0.8460701	110011
-0.1098381	010100	0.8647444	110100
-0.0739049	010101	0.8822923	110101
-0.0378754	010110	0.8986909	110110
-0.0017966	010111	0.9139188	110111
0.0342845	011000	0.9279562	111000
0.0703210	011001	0.9407849	111001
0.1062659	011010	0.9523881	111010
0.1420724	011011	0.9627507	111011
0.1776938	011100	0.9718592	111100
0.2130837	011101	0.9797017	111101
0.2481961	011110	0.9862680	111110
0.2829851	011111	0.9915497	111111

Table A7-3. Line codes for partial correlation coefficient No. 2

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.9643617	000000	−0.2459321	100000
−0.9551330	000001	−0.2138527	100001
−0.9448663	000010	−0.1815409	100010
−0.9335726	000011	−0.1490317	100011
−0.9212644	000100	−0.1163606	100100
−0.9079548	000101	−0.0835630	100101
−0.8936584	000110	−0.0506746	100110
−0.8783907	000111	−0.0177312	100111
−0.8621684	001000	0.0152316	101000
−0.8450091	001001	0.0481778	101001
−0.8269314	001010	0.0810716	101010
−0.8079550	001011	0.1138773	101011
−0.7881004	001100	0.1465593	101100
−0.7673892	001101	0.1790820	101101
−0.7458441	001110	0.2114100	101110
−0.7234883	001111	0.2435083	101111
−0.7003462	010000	0.2753419	110000
−0.6764430	010001	0.3068762	110001
−0.6518046	010010	0.3380771	110010
−0.6264577	010011	0.3689105	110011
−0.6004300	010100	0.3993429	110100
−0.5737497	010101	0.4293413	110101
−0.5464459	010110	0.4588732	110110
−0.5185482	010111	0.4879062	110111
−0.4900868	011000	0.5164090	111000
−0.4610929	011001	0.5443506	111001
−0.4315977	011010	0.5717005	111010
−0.4016336	011011	0.5984291	111011
−0.3712329	011100	0.6245073	111100
−0.3404287	011101	0.6499068	111101
−0.3092546	011110	0.6745999	111110
−0.2777443	011111	0.6985598	111111

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Table A7-4. Line codes for partial correlation coefficient No. 3

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.6013920	00000	0.1390371	10000
−0.5615038	00001	0.1874214	10001
−0.5202643	00010	0.2353546	10010
−0.4777727	00011	0.2827214	10011
−0.4341313	00100	0.3294078	10100
−0.3894451	00101	0.3753014	10101
−0.3438216	00110	0.4202918	10110
−0.2973706	00111	0.4642707	10111
−0.2502041	01000	0.5071322	11000
−0.2024353	01001	0.5487733	11001
−0.1541793	01010	0.5890937	11010
−0.1055523	01011	0.6279963	11011
−0.0566713	01100	0.6653876	11100
−0.0076539	01101	0.7011775	11101
0.0413820	01110	0.7352800	11110
0.0903182	01111	0.7676129	11111

Table A7-5. Line codes for partial correlation coefficient No. 4

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.8697892	00000	−0.2621310	10000
−0.8444068	00001	−0.2141980	10001
−0.8169663	00010	−0.1657429	10010
−0.7875345	00011	−0.1168839	10011
−0.7561831	00100	−0.0677399	10100
−0.7229886	00101	−0.0184309	10101
−0.6880320	00110	0.0309231	10110
−0.6513983	00111	0.0802017	10111
−0.6131769	01000	0.1292848	11000
−0.5734609	01001	0.1780529	11001
−0.5323472	01010	0.2263869	11010
−0.4899359	01011	0.2741691	11011
−0.4463305	01100	0.3212830	11100
−0.4016372	01101	0.3676139	11101
−0.3559649	01110	0.4130488	11110
−0.3094251	01111	0.4574769	11111

Table A7-6. Line codes for partial correlation coefficient No. 5

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.5386610	0000	0.0804712	1000
−0.4685838	0001	0.1610360	1001
−0.3954149	0010	0.2405382	1010
−0.3196371	0011	0.3184534	1011
−0.2417503	0100	0.3942675	1100
−0.1622685	0101	0.4674802	1101
−0.0817161	0110	0.5376085	1110
−0.0006245	0111	0.6041898	1111

Table A7–7. Line codes for partial correlation coefficient No. 6

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.6770824	0000	−0.1733826	1000
−0.6230369	0001	−0.1028770	1001
−0.5658298	0010	−0.0318494	1010
−0.5057514	0011	0.0393399	1011
−0.4431067	0100	0.1103295	1100
−0.3782134	0101	0.1807592	1101
−0.3114009	0110	0.2502717	1110
−0.2430083	0111	0.3185142	1111

Table A7–8. Line codes for partial correlation coefficient No. 7

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.3958643	000	0.1656727	100
−0.2606314	001	0.3048646	101
−0.1200220	010	0.4377676	110
0.0230632	011	0.5616401	111

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Table A7–9. Line codes for partial correlation coefficient No. 8

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.5693170	000	−0.0274243	100
−0.4450148	001	0.1169218	101
−0.3113724	010	0.2588140	110
−0.1711949	011	0.3952741	111

Table A7–10. Line codes for partial correlation coefficient No. 9

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.2765472	00	0.3305883	10
0.0283959	01	0.6007586	11

Table A7–11. Line codes for partial correlation coefficient No. 10

QUANTIZER LEVEL	LINE CODE	QUANTIZER LEVEL	LINE CODE
−0.3866179	00	0.0793400	10
−0.1581725	01	0.3123044	11

Table A7-12. Line encoding for quantized long-term predictor *qgain*

qgain	LINE CODE
0.100	00
0.325	01
0.600	10
0.900	11

Table A7-13. Line encoding for the long term predictor *delay*

delay	LINE CODE
32	000000
33	000001
34	000010
35	000011
...	...
63	011111
64	100000
65	100001
66	100010
...	...
92	111100
93	111101
94	111110
95	111111

Table A7-14. Line codes for the first and second pulse amplitudes of each excitation frame

DECISION THRESHOLD	CONTENTS OF *QAMP[1]* AND *[2]*	LINE CODE
−2.4010	−2.7330	1111
−1.8440	−2.0690	1110
−1.4370	−1.6180	1101
−1.0990	−1.2560	1100
−0.7996	−0.9424	1011
−0.5224	−0.6568	1010
−0.2582	−0.3881	1001
−0.0000	−0.1284	1000
0.0000	0.1284	0000
0.2582	0.3881	0001
0.5224	0.6568	0010
0.7996	0.9424	0011
1.0990	1.2560	0100
1.4370	1.6180	0101
1.8440	2.0690	0110
2.4010	2.7330	0111

Table A7-15. Line codes for the third pulse amplitude of each excitation frame

DECISION THRESHOLD	CONTENTS OF *QAMP[3]*	LINE CODE
−1.7480	−2.1520	111
−1.0500	−1.3440	110
−0.5006	−0.7560	101
−0.0000	−0.2451	100
0.0000	0.2451	000
0.5006	0.7560	001
1.0500	1.3440	010
1.7480	2.1520	011

Table A7-16. Line codes for the three pulse positions within each excitation frame

PULSE POSITION	LINE CODE
0	00000
1	00001
2	00010
3	00011
4	00100
...	...
15	01111
16	10000
...	...
29	11101
30	11110
31	11111

Table A7-17. Transmission frame structure

FRAME COMPONENT (line code)	REFERENCE	LENGTH (bits)
Partial correlation coefficient No. 1	Table A7-2	6
Partial correlation coefficient No. 2	Table A7-3	6
Partial correlation coefficient No. 3	Table A7-4	5
Partial correlation coefficient No. 4	Table A7-5	5
Partial correlation coefficient No. 5	Table A7-6	4
Partial correlation coefficient No. 6	Table A7-7	4
Partial correlation coefficient No. 7	Table A7-8	3
Partial correlation coefficient No. 8	Table A7-9	3
Partial correlation coefficient No. 9	Table A7-10	2
Partial correlation coefficient No. 10	Table A7-11	2
Hamming code word (5 bits plus odd parity)	4.10.3.1	6
Burst error detection	4.10.3.2	8
Long term correlation gain	Table A7-12	2
Long term correlation delay	Table A7-13	6
Excitation frame No. 1 (pulse no. 1 position)	Table A7-16	5
Excitation frame No. 1 (pulse no. 1 amplitude)	Table A7-14	4
Excitation frame No. 1 (pulse no. 2 position)	Table A7-16	5
Excitation frame No. 1 (pulse no. 2 amplitude)	Table A7-14	4
Excitation frame No. 1 (pulse no. 3 position)	Table A7-16	5
Excitation frame No. 1 (pulse no. 3 amplitude)	Table A7-15	3
Excitation Frame No. 2 (identical to No. 1)	-	26
Excitation frame No. 3 (identical to No. 1)	-	26
Excitation frame No. 4 (identical to No. 1)	-	26
Excitation frame No. 5 (identical to No. 1)	-	26

Table A7-18. Protected partial correlation coefficient line code bits

	Parcor coefficient									
	1	2	3	4	5	6	7	8	9	10
Protected bits ( )	5 4 3 2 1 0	5 4 3 2 1 0	4 3 2 1 0	4 3 2 1 0	3 2 1 0	3 2 1 0	2 1 0	2 1 0	1 0	1 0

Table A7-19. Burst error detection calculation matrix

pppppppp
pppppppp
pppppppp
ppeeeeee
bbbbbbbb

9/11/95

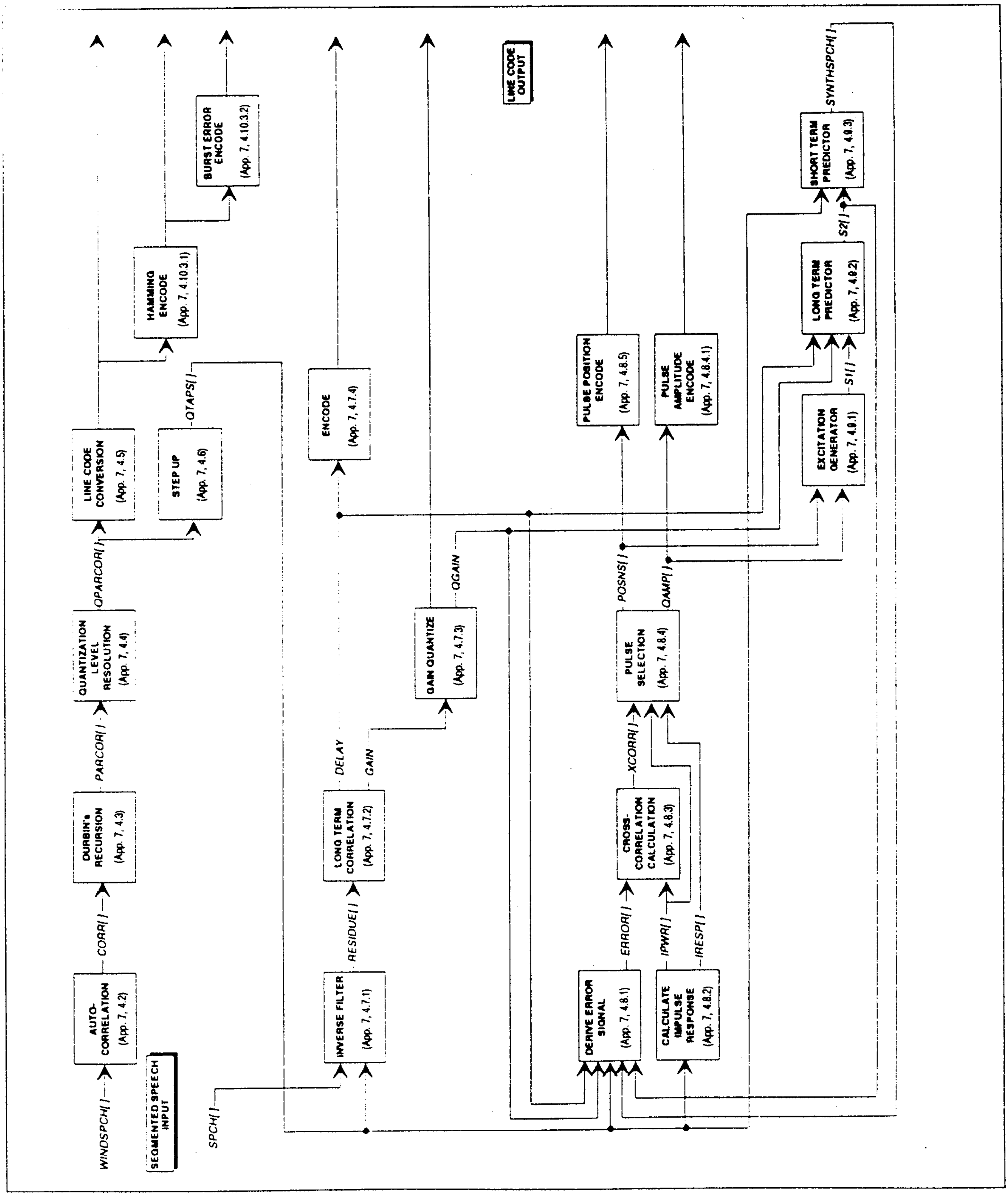


Figure A7-1. AMSS voice encoding algorithm

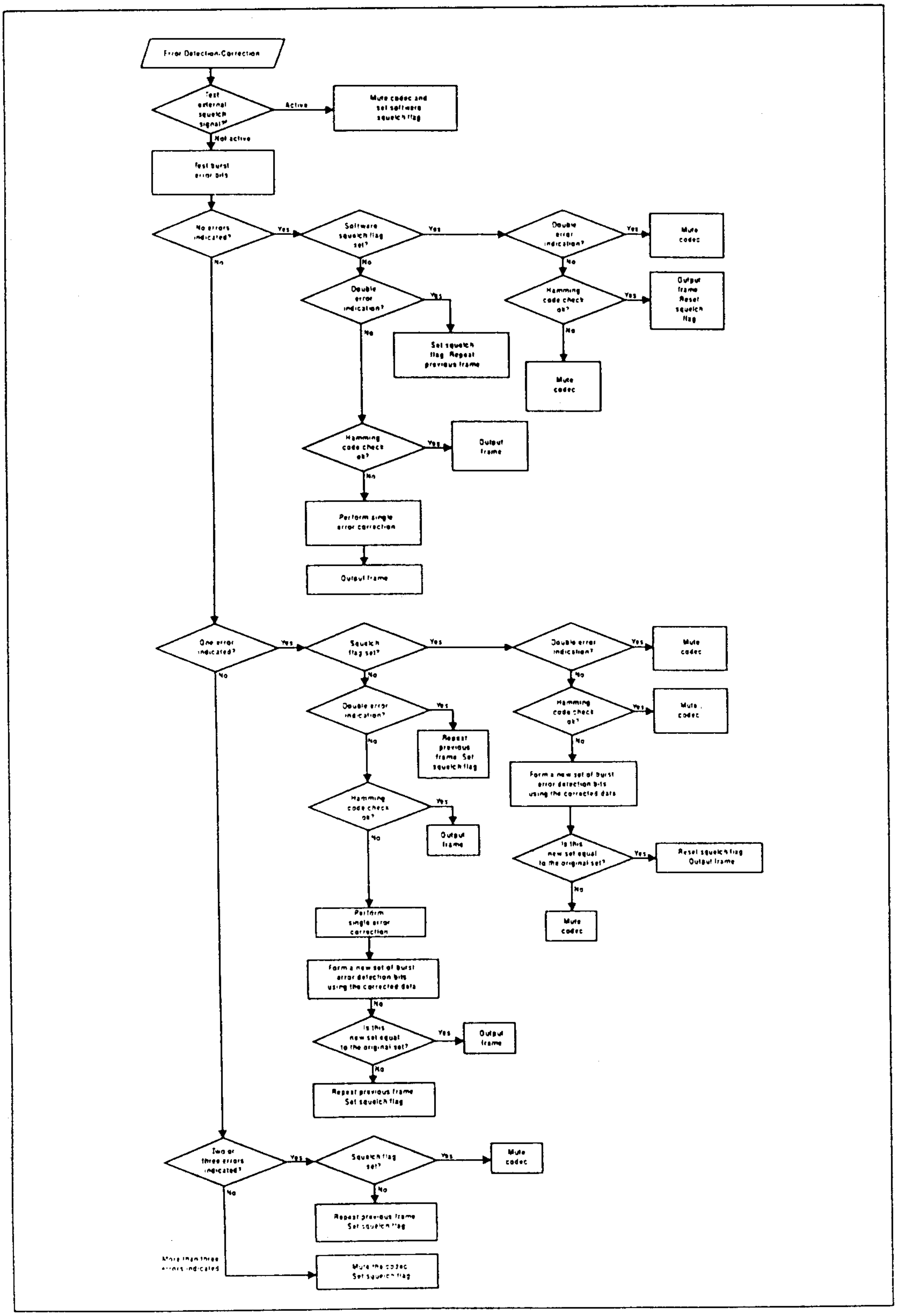


Figure A7-2. Error detection/correction process

CHAPTER 5. SSR MODE S AIR-GROUND DATA LINK

[to be developed]

CHAPTER 6. VHF AIR-GROUND DATA LINK

[to be developed]

CHAPTER 7. SUBNETWORK INTERCONNECTION

[to be developed]

CHAPTER 8. AFTN NETWORK

[to be developed]

CHAPTER 9. AIRCRAFT ADDRESSING SYSTEM

[to be developed]

CHAPTER 10. POINT TO MULTI-POINT COMMUNICATIONS

[to be developed]

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

PART II — VOICE COMMUNICATION SYSTEMS

CHAPTER 1. DEFINITIONS

[to be developed]

CHAPTER 2. AERONAUTICAL MOBILE SERVICE

[to be developed]

CHAPTER 3. SELCAL

[to be developed]

CHAPTER 4. AERONAUTICAL SPEECH CIRCUITS

[to be developed]

CHAPTER 5. EMERGENCY LOCATION TRANSMITTER

[to be developed]

Attachment A to Part I

GUIDANCE MATERIAL FOR AERONAUTICAL MOBILE-SATELLITE SERVICE

1. INTRODUCTION

Note.— The aeronautical mobile-satellite service (AMSS) Standards and Recommended Practices (SARPs) referred to are contained in Annex 10, Volume III, Part I, Chapter 4.

1.1 Overview

1.1.1 The major elements of the aeronautical mobile-satellite service (AMSS) are the space segment (the satellites and their controlling earth stations); the ground earth stations (GESs) that provide interfaces between the satellite and fixed terrestrial voice and data networks; and the aircraft earth stations (AESs) that comprise the avionics and antenna systems on-board the aircraft.

1.1.2 The system architecture is capable of meeting a range of communication requirements which may include ATS, AOC, AAC and APC. The same system architecture is used for various service levels, from the basic low data-rate service to a multi-channel high data-rate service.

1.1.3 The level of capability of an AMSS system can be chosen to suit the performance required by the application.

Note 1.— The performance of a service will be set by the lowest level of capability available in the chain of GES, space segment and AES.

Note 2.— While a low level of capability service will have lower capital costs, it may have higher satellite user charges for the same data flow.

1.1.4 The capabilities are summarized in Table A-1* of this guidance material.

1.1.5 The examples of performance given in this section are to give a quick look at the over-all system performance. If exact figures are required, the relevant paragraphs of Annex 10, Volume III, Part I, Chapter 4 should be studied.

System capabilities: Annex 10, Volume III, Part I, Chapter 4, 4.1.3

Packet data performance: Annex 10, Volume III, Part I, Chapter 4, 4.7.2

1.1.6 CIRCUIT MODE VOICE PERFORMANCE

Assuming that the AES is logged on to a GES, the AMSS will typically take the following times to set up a call:

from-aircraft: 10 to 14 seconds (average)

to-aircraft: 9 to 11 seconds (average).

Note.— The call set-up time may be affected by the performance of the associated terrestrial network.

1.2 Levels of capability

1.2.1 The various levels of capability for the aircraft earth station (AES) and ground earth station (GES) defined in Annex 10, Volume III, Part I, Chapter 4, 4.1.3 allow various capabilities to exist which have different performance characteristics. A Level 1 capability is the minimum capability required for aeronautical mobile-satellite (route) service (AMS(R)S) providing basic packet data communications. A Level 3 is required as a minimum when, in addition to packet communications, circuit voice communications are required. All levels of capability require that the AES be under positive control either by receiving a P channel signal or through the C channel sub-band. Only one of the channel rates indicated below is required to operate at any given time.

1.2.2 The Level 1 capability provides for basic packet data communications by requiring an AES to receive and process a P channel signal operating at channel rates of 0.6 and 1.2 kbits/s. It also requires the capability for an AES to transmit on an R channel or on a T channel at these channel

* All tables are located at the end of this attachment.

rates. Both R and T channel capabilities are required. The channel rate used will depend on the link quality determined by the GES measurement of bit error rate (BER) or the estimate of that BER. Major factors that determine the channel rate are the antenna gain of the satellite and AES, and the RF power output of the satellite and AES. Level 1 requires one transmit channel (for R or T channel) and one receive channel (for P channel).

1.2.3 The Level 2 capability provides for channel rates of 0.6 and 10.5 kbits/s for the P channel; and 0.6 and 10.5 kbits/s for the R channel and the T channel. The major factor determining when to use these channel rates is the AES antenna gain, which must be at least 12 dBic when working with a "global" beam satellite. This capability provides greater data communications throughput, faster message delivery and may decrease operational cost. Level 2 requires one transmit channel and one receive channel as in Level 1.

1.2.4 The Level 3 capability adds to Level 2 packet data communications a circuit capability for voice or communications using a transmit and a receive C channel. These C channels are capable of operating at channel rates of 10.5 or 21.0 kbits/s to support 9.6 kbits/s vocoders for voice communications. The C channel can also provide circuit-mode data communications but this is not considered part of the safety services. The C channel rate used depends on the use of 1/2 rate forward error correction (FEC) coding (1/2 rate coding requires 21.0 kbits/s). Provision has been made to allow use of lower vocoder rates that could operate at channel rates of 5.25 or 6.0 kbits/s. Level 3 requires one transmit channel (R, T or C channel) and two receive channels (P channel and C channel). Simultaneous operation of two-way packet and circuit communications is not possible, but near-simultaneous operation is possible by switching between transmit channel types.

1.2.5 Level 4 capability adds to Level 3 capability additional transmit channel capability to provide simultaneous operation of two-way packet and circuit communications. Level 4 capability requires two or more transmit channels (R or T, and C channel) and two or more receive channels (P channel and C channel), power control for each channel carrier and a linear power amplifier. Channel rates are the same as Level 3. Both R and T channel capabilities are required on a transmit channel but not simultaneously.

1.2.6 The AMS(R)S is the first aeronautical safety communications service which integrates both voice and data, as well as non-safety services. This integration of services must respect message priority. Pre-emption of one data message by another data message of higher priority is handled easily within the system without loss of information. Pre-emption of a voice call by a higher priority data call, or vice versa, will not normally be necessary in an AES which has two transmitters. However, in a Level 3 AES which has only one transmitter such a pre-emption may occasionally be necessary.

1.2.7 Although a Level 4 AES is not required to provide simultaneous packet data communications with more than one GES, such a capability is not precluded.

2. BROADBAND RF CHARACTERISTICS

2.1 Use of AMS(R)S bands

2.1.1 *Message categories.* The transmission sequence at any aircraft earth station (AES) or ground earth station (GES) will be ordered in accordance with a given priority scheme. At the subnetwork interface to the AMSS, the priority scheme for packet data is as described in Annex 10, Volume III, Part I, Chapter 4, Table 4-26. Within the AMSS, this external priority scheme is augmented with internal priorities assigned to various signalling and voice-related functions. At the link layer this augmented priority scheme is referred to as the Q-precedence number and the resulting internal priority scheme is given in Table A-3 of this guidance material. This "Q-precedence" number list conforms to Annex 10 priorities, which in turn are derived from Article 51 of the ITU Radio Regulations. The single Q-precedence list includes both voice and data traffic, and also includes the signalling necessary to integrate voice and data. The Q-precedence numbers associated with the signalling were chosen to optimize the over-all system performance and integrity.

2.1.2 *Receive frequency band.* For historical reasons, most AESs may be capable of receiving more than the required band of 1 544 to 1 555 MHz but not the full band suggested by the recommendations. Typically, they cover the frequency band 1 530 to 1 559 MHz, and may not cover 1 525 to 1 530 MHz.

2.2 Frequency accuracy and compensation

2.2.1 *Frequency accuracy.* The Standard contained in Annex 10, Volume III, Part I, Chapter 4, 4.2.2 reflects a requirement on the signal received by the GES. There are several contributors to the frequency error observed at the GES. These include frequency errors due to the satellite oscillator, due to relative motion between the aircraft and spacecraft, due to the local oscillator of the GES (for a closed loop compensation system) and the local oscillator of the AES. Efforts are made to reduce the error caused by the first two as described below. This Standard characterizes that portion of the frequency error which is due to the AES and the aircraft motion relative to the satellite. Consequently, the proper frame of reference for measuring the transmit frequency is the satellite. A practical test of this requirement would use the AES frame of reference, and the corresponding value in the satellite frame of reference would be calculated based on the aircraft position and velocity, and the satellite position.

2.2.2 *Frequency compensation by the GES.* To reduce the error due to the spacecraft oscillators, the GES should listen to an L-band pilot frequency transmitted (at C-band) by a designated GES and correct its transmission frequency to minimize the frequency error at L-band. In the from-aircraft direction a designated GES transmits an L-band pilot frequency which all GESs listen to at C-band and adjust their receiver local oscillators accordingly. This approach may not be possible in the case of satellite spot beams where the GES is not within the footprint of the spot beam of interest.

2.2.3 *Doppler shift compensation by the AES.* There are at least two methods of implementing Doppler-shift compensation. One approach is to use aircraft navigational aids to estimate the velocity of the aircraft in the direction of the satellite and then, estimate the Doppler shift from this. A second approach is to estimate the Doppler shift by measuring the frequency offset of the received P channel or C channel. For this latter approach, the frequency of any transmission to that ground earth station is then the basic channel frequency offset by the receive frequency, offset with opposite sign and a scaling factor of approximately 1.07. This approximately corrects the component of the frequency error due to aircraft motion (Doppler shift) but does not correct errors in the AES local oscillator.

2.2.4 *Frequency error budget.* The frequency error budgets used in arriving at the accuracy requirements for the GES-AES link are presented in Tables A-4 and A-5 of this guidance material. Note that in Table A-4 the Doppler shift due to aircraft motion is not included, and in Table A-5 it is assumed to be compensated for.

2.3 Aircraft earth station antenna characteristics

2.3.1 *Antennas and level of capability.* The Standards contained in Annex 10, Volume III, Chapter 4 specify high and low-gain antenna systems, but one should note that these are not linked directly to a level of capability of AES. A high-gain antenna, with the supporting avionics, will mean a Level 2, 3 or 4 AES installation; and a low-gain antenna, with the supporting avionics will always lead to at least a Level 1 AES installation. In the future, different system characteristics may be capable of providing a Level 2 or higher service. For example, the combination of satellite spot beam antennas and a medium gain aircraft antenna may be capable of providing a Level 2 or higher service. The level of service provided to an aircraft will depend not only on its capabilities but those of the service providers as well.

2.3.2 *Mid-gain antennas.* AES antennas may be desirable for AMSS use that do not conform strictly with "0 dB" or "12 dB" standards as inferred by the AMSS SARPs EIRP and G/T parameters. Where aircraft are limited to mounting a small antenna even for voice services, the SARPs would not preclude use of a medium-gain AES antenna.

2.3.2.1 Considering available AES HPA power, a medium-gain antenna could be used while maintaining necessary channel quality; e.g. an 8-11 dB gain would have ample EIRP to operate at 10.5 kbits/s, and an antenna with a 5-8 dB gain could operate at 4.8 kbits/s — given that satellite P channels are operated with sufficient power.

2.3.2.2 Higher-gain future satellites could serve AESs with lower G/T and EIRP, but may have an effect of potentially higher service costs and reduced system capacity. AES antennas with gain less than 12 dBic may be considered similar operationally to low-gain antennas because they have too broad a beam to discriminate against other satellite interference. The breadth of their use will depend on user requirements for medium-gain antenna installations and acceptance of resulting limitations.

2.4 Receiver requirements

2.4.1 *Gain-to-noise temperature ratio.* The following factors influence the aircraft earth station receive system gain-to-noise temperature ratio (G/T):

a) climatic conditions;

b) antenna elevation angles to the satellite;

c) residual antenna pointing errors (including the effects of errors introduced by the antenna beam steering system);

d) the noise contribution of the receiver low noise amplifier at the operating temperature;

e) the transmitter power amplifier output level;

f) the attenuation and noise temperature contributions of a radome, where a radome is fitted; and

g) the RF environmental conditions in which the aircraft earth station is intended to operate.

2.4.2 *Typical link carrier to noise densities.* Tables A-6, A-7 and A-8 of this guidance material show typical carrier-to-noise spectral density ratios (C/N_0's) for the P, R, T and C channel services. In these tables modem implementation losses refer to losses in the practical implementation of a modem relative to ideal. This includes the effects due to non-ideal filtering, non-ideal synchronization in either time or frequency, non-ideal modulation, and non-linearities in the up- and down-converter chains. The analysis of the RF link is provided in the appendix to this guidance material.

2.4.3 *Receiver linearity*. There are multiple satellite systems being planned which have maximum L-band EIRP of 58 dBW at the centre of the antenna beam. Considering the worst case where the antenna beams of two such satellite systems overlap, the receiver must tolerate a total in-band power flux density of -100 dBW/m^2. This is derived from the combined two-satellite EIRP (62 dBW), minus a spreading loss of 162 dB.

2.4.4 *Receiver out-of-band performance*. Potential threats to receiver performance include terrestrial mobile communications systems and high-power sources, including television transmitters with EIRP in the megawatt range and surveillance radars which are naturally located at airports and may occur along the flight route.

2.4.4.1 Under radio environmental conditions where high-power, out-of-band signals may be near the flight path, the receiver's RF filter should protect against receiver saturation, which could reduce gain and degrade performance. Additionally, performance may be affected by such sources due to receiver image and spurious responses. As an example, a power flux density at the AES antenna of +3 dBW/m^2 could occur at a distance of a kilometre from a multi-megawatt transmitter such as permitted for television at frequencies from 470 to near 800 MHz. To protect from saturation, the RF filter would need a minimum of 75 dB rejection. Protection from degradation due to image and spurious responses is specific to the receiver design.

2.4.4.2 For a 5 000 kW peak power radar with a boresight gain of 34 dB, power levels can reach 100 dBW in the main beam. It has been calculated that, for an AES located 500 metres from an airport-located weather radar, the flux density could be as high as 30 dBW/m^2 below 1 459 MHz, and 38 dBW/m^2 from 1 675 to 18 000 MHz. It is not necessary to operate under these levels, but the equipment should survive without damage.

2.4.5 *Received phase noise*. The phase noise that the AES receiver must tolerate while operating within the AMSS SARPs is illustrated in Figure A-1* of this guidance material. This mask includes phase noise contributions of the transmitter and of the satellite. In practice, the receiver must be able to tolerate larger amounts of phase noise that are due to fading of the received signal.

2.5 Transmitter requirements

2.5.1 *EIRP limits*. An AES that is capable of an EIRP of 13.5 dBW should always be able to use the 0.6 kbit/s R and T channels when the satellite elevation angle exceeds 5 degrees. An AES that is capable of an EIRP of 25.5 dBW, and has the supporting avionics, will be capable of Level 2, 3 and 4 service grade portions of Levels 3 and 4. In practice, the transmitted power will usually be backed off from these settings, by an amount that depends on the system configuration.

2.5.1.1 The "maximum allowable operating EIRP" is based on a limit established from combined effects of HPA IM (active) and passive-component IM.

2.5.2 *EIRP control*. The requirement for control for the AES EIRP by the GES is for two reasons. The first reason is for dynamic power control of the C channel to optimize the system capacity. The second is to make optimal use of future spot beam satellite systems.

2.5.2.1 In initial AMSS operations using satellites with global beam coverage, an AES EIRP control range of 16 dB is required for both Class C (Levels 1-3) and Class A (Level 4 multi-channel) high-power amplifiers to cover selectable channel rates and variables in AES antenna gain. In C channel operation the AES EIRP is also frequently adjusted according to the GES-measured bit error rate. Therefore, for Level 4 AESs an additional 16 dB of control is presently required.

2.5.2.2 In future systems, AES transmission within an EIRP range satisfactory to satellite service operators may require a different control range. For example, the higher G/T of future spot beam satellites could require less AES EIRP, leading to a need for a larger control range. The range cannot be closely predetermined because spot beam size that affects satellite G/T is a future operator design choice.

2.5.3 *Out-of-band EIRP spectral density*. The out-of-band EIRP including spurious, harmonics, intermodulation products and noise radiated by the AES should not cause harmful interference to other radio services. In particular, they should not interfere with other aeronautical communications/ navigation radio services such as global positioning system (GPS) which operates in the band 1 565 to 1 585 MHz, global orbiting navigation satellite system (GLONASS) operating in the band 1 598 to 1 609 MHz, the AMSS receive band 1 525 to 1 559 MHz, and the VHF band 108 to 137 MHz.

2.5.3.1 Table 4-3 contained in Annex 10, Volume III, Part I, Chapter 4, provides for a maximum EIRP density of -155 dBc/1 MHz in the 1 565 to 1 585 MHz band, which protects GPS receiver operation on the same aircraft as AMSS, and also GPS operation on nearby aircraft.

* All figures are located at the end of this attachment.

2.5.3.2 Table 4-3 contained in Annex 10, Volume III, Part I, Chapter 4, also indicates that the maximum EIRP spectral density should be −105 dBc/1 MHz in the 1 602 to 1 605 MHz band and −85 dBc/1 MHz in the 1 605 to 1 610 MHz band. These limits will improve protection for GLONASS receiver operation (assuming a future move downward in frequency of the upper edge of the GLONASS band) on nearby aircraft. The AMSS Recommendation for a maximum density of −140 dBc/1 MHz, contained in Annex 10, Volume III, Part I, Chapter 4, 4.2.3.5.8.2, is intended to protect GLONASS receiver operation on the same aircraft as AMSS assuming 40 dB of antenna isolation. The EIRP density should not be greater than −105 dBc/MHz to protect navigation equipment in that band on other nearby aircraft.

2.5.4 *Intermodulation (IM) products.* Control of unwanted emissions from the AES is important to system operations in order to avoid blocking channels and reducing needed spectrum. Intermodulation occurs during multicarrier (Level 4) operation on predictable frequencies related to wanted signals due to component non-linearities. Potential sources are many, but can be controlled. Minimizing IM effects is accomplished both in AES design for linearity meeting the standards and in operation.

2.5.4.1 Intermodulation products (IM) that may be emitted by a Level 4 AES in multicarrier operation arise both from the high-power amplifier (HPA) and from other passive components that are subject to high AES RF power levels. Passive components causing IM may include connectors, particularly if they are subject to corrosion or looseness; and the diodes used in phased-array antennas. Depending on the choice of frequencies and levels in the GES, such IM can appear at frequencies and levels in the AES receiver that will degrade BER, disable reception, or affect reception of signals by other aircraft equipment.

2.5.4.2 AES-transmitted IM can block GES receivers. The HPA is a primary IM source because its linearity is limited by technology and heat dissipation.

2.5.4.3 Intersystem effects may arise from Level 4 AESs that may radiate IM. An AES operating with a global beam satellite must transmit higher EIRP than an AES operating with a more sensitive spot beam satellite. Therefore, this higher level of IM would be more readily received by the spot beam satellite for relay to its GES, where it could impair reception of that channel. Even if the two satellites are using separated portions of the frequency band and therefore cannot reuse the same assigned channel frequencies, the global beam AES transmitter's IM that is out of assigned channels could fall into the spot beam satellite's band. All GES frequency and EIRP level assignments should account for this possibility.

2.5.5 *Frequency management.* Careful frequency management is needed because:

a) AMSS includes safety services;

b) there is concern about the availability of adequate AMSS spectrum, and adequate capacity for AMSS safety services; and

c) the difficulty in co-ordinating mobile satellite networks due to the poor discrimination characteristics of mobile station antennas.

Guidelines that should be considered when co-ordinating frequency plans to minimize intra and interservice interference include:

a) compliance with the relevant ITU Radio Regulations;

b) each provider should provide monitoring facilities to identify the actual usage of AMS(R)S and non-AMS(R)S communications;

c) in those AMSS systems with global and spot beams, operational measures to minimize the amount of global bandwidth used and to maximize the use of spot beams;

d) using the International Radio Consultative Committee (CCIR) three-phase technical co-ordination method, wherever possible (see CCIR Report 1185);

e) efficient spectrum use including the following:

   1) using other system providers' satellite transponder guard bands;

   2) using frequency assignment by aircraft location;

   3) taking advantage of improvements in aircraft earth station antenna sidelobe discrimination;

   4) using offset and interleaved carriers;

   5) using satellite spot/shaped beams;

   6) reducing spacecraft antenna sidelobe levels;

   7) increasing the resistance of systems to interference;

   8) using earth station power control;

   9) using satellite transponder adjustable gain setting;

   10) using knowledge of operational schedules to take advantage of the difference in time zones;

   11) appropriately grouping carriers;

12) repositioning satellites; and

13) taking advantage of high-gain AES antennas and the resulting ability to use lower carrier powers.

2.5.6 *Transmitted phase noise.* The phase noise mask that the AES transmitter must meet is illustrated in Figure A-2 of this guidance material. The purpose of this mask is to minimize the contribution of the AES transmitter phase noise to the degradation of GES performance.

2.6 Interference

2.6.1 *Intrasystem interference.* Intrasystem interference refers to interference among AMS(R)S services. Some examples would be co-channel, adjacent channel interference and intermodulation noise. Due to disparate satellite system designs, there is no single specification for intrasystem interference. Each satellite system operator must be able to show that intrasystem interference to AMS(R)S services, when combined with other noise sources in the link, does not degrade the achieved link C/N_0 below the required C/N_0 for a given performance.

2.6.2 *Intersystem interference.* Intersystem interference refers to interference to an AMS(R)S service from any other system, whether it is providing AMS(R)S services or otherwise. Required performance should be maintained at whatever level of interference is adopted as operable through co-ordination among the particular satellite system operators. As a minimum, the AMSS satellite system should provide adequate performance in the presence of single-entry interference resulting in a $\Delta T/T$ of 6 per cent, as adopted by WARC-ORB-88 as the threshold requiring co-ordination between satellite systems. A suggested criterion for aggregate interference due to all sources, including intrasystem interference, is a $\Delta T/T$ of 20 per cent.

3. RF CHANNEL CHARACTERISTICS

3.1 Modulation characteristics

3.1.1 *Modulation types.* Two modulation types are used in aeronautical mobile-satellite service (AMSS), each providing a system advantage. A form of binary phase shift keying (BPSK) is used for channel rates up to 2.4 kbits/s, providing more robustness against phase noise generated in frequency conversion processes in the aircraft earth station (AES), satellite, and ground earth station (GES). Above 2.4 kbits/s, phase noise effects on the demodulation process are diminished, and conservation of bandwidth at these higher channel rates becomes important. Therefore, a more bandwidth-efficient modulation type, quaternary phase shift keying (QPSK), is used.

3.1.2 *Aviation BPSK.* Aviation BPSK is a form of phase shift keyed modulation with shaped filters especially adapted to perform in an RF environment subject to fading. It has four possible phase states of which only two are permissible during any symbol period. The modulation technique maps binary "0"s into a phase shift of −90° and binary "1"s into +90°. This results in differential encoding of the transmitted data, and implies that during any symbol period two decisions separated by 180° are possible, and that these two decisions are rotated by 90° from the possible decisions in the previous symbol period. This modulation strategy is illustrated conceptually in Figures A-3 and A-4 of this guidance material. Consequently, A-BPSK is almost identical to minimum shift keying (MSK), except that the pulse shaping has a 40 per cent root raised cosine spectral shape, as opposed to sinusoidal weighting. The amplitude and phase masks which this pulse-shaping filter must satisfy are illustrated in Figures A-5 and A-7 of this guidance material. These correspond to the transmit filter requirements given in the definition of A-BPSK. Those requirements apply to the transmitted signal before it undergoes any non-linear amplification; their purpose is to limit and control the distortion and corresponding degradation in performance caused by nonlinear amplification. A-BPSK is a linear modulation with nearly constant envelope. Consequently, it may be transmitted through a "Class C" amplifier with little spectral spreading and performance degradation.

3.1.3 *Aviation QPSK.* Aviation QPSK is a form of offset QPSK modulation that is used for data rates above 2.4 kbits/s and is illustrated conceptually in Figures A-3 and A-4 of this guidance material. The A-QPSK data encoder is driven by a binary data sequence (a_i) at the bit rate 2/T. The "even" bits are switched onto the I line and the "odd" bits onto the Q line, generating two data streams at rate 1/T. The synchronous samplers S operate at rate 1/T and generate ideal positive and negative impulses depending on whether the data bits are "1" or "0". The pulse shaping filters in each channel have a 100 per cent root raised cosine spectral shape. The outputs of the I and Q pulse shaping filters modulate the same carrier in quadrature and are combined linearly. The amplitude and phase masks that the pulse shaping filter must satisfy are shown in Figures A-6 and A-7 of this guidance material. These correspond to the transmit filter requirements given in the definition of A-QPSK. Those requirements apply to the transmitted signal before it undergoes any non-linear amplification; their purpose is to limit and control the distortion and corresponding degradation in performance caused by non-linear amplification. There is no requirement for actual modulators to be implemented in this way, as long as the modulated RF signal is indistinguishable from one that was generated by an ideal modulator.

3.2 Bounds on radiated power spectral density

3.2.1 *Spectrum masks.* These spectrum masks allow for degradation from the ideal Nyquist model that could occur due to non-ideal system characteristics, e.g. saturation in the amplifier chain.

3.2.2 *From-aircraft.* The spectral mask that must be satisfied by any A-BPSK signal transmitted in the from-aircraft direction is shown in Figure A-8 of this guidance material. This was derived assuming a non-linear amplifier (Class C) is used on board the AES, but it is applicable to Class A linear amplifiers as well. The same spectral mask (Figure A-8) applies to A-QPSK except that the frequency axis is scaled by the symbol rate.

3.2.3 *To-aircraft.* The spectral mask that must be met in the to-aircraft direction with A-BPSK is shown in Figure A-9 of this guidance material. This was derived assuming that all amplifiers in the to-aircraft transmission path are operating linearly. The corresponding spectral mask for A-QPSK is shown in Figure A-10 of this guidance material.

3.3 Demodulator performance

3.3.1 The performance specified in the Standards can be attained using coherent detection and a Viterbi decoder with 3-bit soft decisions. The R and T channel demodulators are allowed more E_b/N_0 to achieve the bit error rate of 10^{-5} because of the short bursty nature of communications over these channels. The theoretical performance of A-QPSK in additive white Gaussian noise is better than that of A-BPSK because the bits are not differentially encoded. However, for A-QPSK modulation, more margin is included (relative to theoretical) because of its poorer performance over fading channels.

3.3.2 The relative motion of the aircraft and the satellite means that any signal reflections from aircraft wings or tail, or the sea or ground below can result in time-varying multipath. This is in part due to the rather broad beamwidth of the AES antenna. The characteristics of this multipath depend on a number of characteristics including the aircraft velocity, the look-angle of the satellite with respect to the aircraft and the slope of the reflecting surface. The rate of these variations (Doppler bandwidth) increases with aircraft velocity and elevation angle to the satellite. However, the multipath intensity is inversely proportional to the aircraft velocity and the satellite elevation angle. Consequently, it is primarily below elevation angles of 20 degrees that multipath is a significant problem. At elevation angles of 5 to 20 degrees the Doppler bandwidth can vary from 20 to 100 Hz or more and the multipath power can be as much as −7 dB relative to the direct path signal.

3.4 Acquisition delay

This delay requirement is a high-level specification composed of a number of components due to various sub-systems including satellite acquisition, frequency and bit acquisition, and frame synchronization. The total delay of 16 seconds is the worst-case delay allowed. This is the time from when one first commands the AES to find the satellite until the time at which the AES can attempt to log-on. Once logged on, typical times for setting up a voice call or transmitting a packet data message will be much less than this.

4. CHANNEL FORMAT TYPES AND DATA RATES

4.1 General

4.1.1 *System timing.* All timing of the different transmission channels is derived from the P channel. If required, synchronization of the P channels of each ground earth station (GES) to universal co-ordinated time (UTC) is one way of ensuring a world-wide timing reference for all aircraft using aeronautical mobile-satellite service (AMSS). The synchronization of all P channels to UTC is currently not required because there has not been an application identified which would benefit significantly enough to warrant the increased cost.

4.1.2 *Channel spacings.* The channel spacings in Table A-9 of this guidance material make adequate provision for separation to reduce adjacent channel interference and to ensure correct channel tuning in the presence of Doppler shifts due to all causes. In the case of the channels at the lowest bit rate, the possible spacings for the to-aircraft direction (P channels) and from-aircraft directions (R and T channels) are different. This is due to the uncorrected Doppler shift on to-aircraft channels, and the use of automatic frequency control (AFC) to minimize Doppler shift in the from-aircraft direction. Note that the requirement on the aircraft earth station (AES) to be capable of tuning in steps of 2.5 kHz accommodates all the potential channel spacings listed below and allows the interleaving of channels between adjacent satellite spot beams.

4.1.3 *P channel synchronization/loss/degradation.* Actions by the AES management depend upon indications of the signal quality of the received P channel. These include an indicator of when the AES is synchronized to the P channel, and when it is degraded and/or lost. The AES must synchronize to a P channel before it can receive P channel signal units, or transmit over the R or T channel. A degraded/lost P channel indicates reduced operational performance and is usually an indication that a switching operation, for example, a satellite or spot beam handover, should be performed.

4.1.3.1 These indicators of signal quality generally are based on physical measurements exceeding a threshold. However, the measurements used and the threshold settings depend upon the AES implementation. P channel synchronization is declared whenever the P channel unique word is detected reliably. Synchronization is lost whenever the unique word is not detected reliably.

4.1.3.2 Either of two conditions will cause a declaration of degradation/loss of the P channel. The first condition corresponds to a "degraded" P channel and has two cases: 1) if the bit error rate rises above 10^{-4} in a three-minute averaging period; and 2) if synchronization is lost ten or more times during a three-minute period. This three-minute averaging period provides confidence that the degradation is not temporary, due, for example, to an aircraft manoeuvre. The second condition corresponds to a "lost" P channel, which is declared if synchronization is lost continuously for ten seconds. There is a single indicator for either of these conditions and, consequently, the action by the AES management for either event is the same.

4.2 P channel

4.2.1 *General.* At least one P channel is transmitted continuously by each GES that forms part of the AMSS service. Each AES must continuously monitor the P channel transmitted by the GES to which it is logged on. The P channel implements a time division multiplexing strategy to send small packets of information to the AESs that are monitoring it. The functional blocks at the GES end of each P channel are as follows:

a) data scrambler;

b) forward error correction (FEC) encoder;

c) interleaver;

d) timing mark inserter (unique word); and

e) modulator.

The functional blocks at the receive end of each P channel are complementary to those at the transmit end. The complete series of functional blocks from transmit end to receive end is shown in Figure A-11 of this guidance material.

4.2.2 FUNCTIONAL BLOCKS

4.2.2.1 *Data scrambler.* A data scrambler is a logical device which multiplies the data sequence by a known pseudo-random sequence. The data is unscrambled at the receiver by multiplying by the same sequence of random bits. This has no direct effect on the bit error rate performance on the link. However, it prevents the possibility of transmitting long sequences of 1's or 0's over the link. The latter could be detrimental to the performance of acquisition and tracking circuitry.

4.2.2.2 *Forward error correction coding.* Satellite communications are, in general, power-limited due to the limited resources at the satellite. One can reduce the amount of power required for communications by introducing forward error correction coding, which adds redundancy to the transmitted signal at the expense of requiring more bandwidth. At the receiver, a decoder uses the redundancy to correct those errors which normally occur when transmitting at a lower power.

4.2.2.3 *Interleaving.* Mobile communications are generally subject to fading due to reflections from nearby objects. The fading is correlated with time and when it occurs, can cause a sequence of correlated errors in the data detected at the receiver. These errors can be corrected by the forward error correction coding. However, most decoders work best with uncorrelated errors. The purpose of the (transmit) interleaver and its inverse, the (receive) de-interleaver, is to randomize the order of bits presented to the channel compared to those presented to the decoder, thus reducing any correlation between the errors which may be caused by the channel.

4.2.2.4 *Timing mark.* A unique word is inserted in each data stream, at periodic intervals, to provide timing information to the receiver. This timing information is needed in order to properly synchronize the de-scrambler, the decoder, and the de-interleaver with their counterparts on the transmit side. It also allows recovery of this synchronization if the signal happens to be lost momentarily.

4.2.3 *P channel frame duration.* The frame duration is either 500 milliseconds (channel rates of 2.4 kbits/s and higher) or a multiple of 500 milliseconds to provide simple derivation of a superframe used for R channel slotting and the reservation TDMA T channel. Scrambling and FEC coding of rate 1/2 is used on all P channels. The FEC encoder is not reset between frames, but starts a new frame in the state resulting from the previous frame. With the exception of the 0.6 kbits/s P channel, the duration of the interleaver is 500 milliseconds. For the 0.6 kbits/s, the interleaver is 384 bits corresponding to 2/3 second.

4.2.4 *P channel frame format.* All P channel frame formats include a 16-bit field (uncoded) as a format identifier and for derivation of the superframe that has a duration of 8 seconds. The format identifier is a 4-bit field and is always set to the value 0001 when the channel is a P channel. The remaining 12 bits of this field are used as a superframe counter. To achieve this, the field is subdivided into three 4-bit fields, of which the first is used to indicate the start of a new superframe, while the remaining two are used to indicate the frame number. It is advisable for AES implementations to make use of all 12 bits to achieve reliable superframe synchronization in the presence of bit errors.

4.2.5 For P channels of 4.8 and 10.5 kbits/s, a small number of "dummy" bits are included in the frame just after the framing bits. This matches the number of bits of the interleaver to the number of bits required to be transmitted on the channel.

4.2.6 To facilitate the re-synchronization of an AES transferring from one P channel to another on the same GES, all P channels transmitted by the same GES are synchronized.

4.3 R channel

4.3.1 *General.* All AESs will log on to AMSS using an R channel that has been designated for that purpose in the particular service area of the AES. For the duration of its log-on period an AES will be assigned one or more R channels (at the appropriate channel rates). Over these R channels, the AES can transmit signalling, short data packets, and requests for additional capacity on the T channel. The burst mode data channel characteristics for the R channel have been specified in the AMSS SARPs as has been the slot structure used for its slotted-ALOHA random access protocol. The functional blocks at the transmit (AES) end of each channel are as follows:

a) data scrambler;

b) FEC encoder;

c) interleaver;

d) preamble and unique word generator; and

e) modulator.

The functional blocks at the receive end of each R channel are complementary to those at the transmit end. The complete series of functional blocks form transmit end to receive end is shown in Figure A-12 of this guidance material.

4.3.2 *R channel transmit timing.* The R channel transmits in slots derived from the P channel superframe. The R channel slot length varies according to the channel bit rate. The start of any given R channel slot is referenced to the leading edge of the first bit in the P channel format identifier field. An R channel burst may begin at an integer number of slot durations after this time. For the R channel, the nominal starting instant of the first bit of the preamble is the beginning of the slot.

4.4 T channel

4.4.1 *General.* For the duration of its log-on period an AES will be assigned one or more T channel frequencies (at the appropriate channel rates). These channels are shared with a number of other AESs on a demand-assigned basis. That is, these channels are assigned on a conflict-free basis to individual AESs by the GES for short periods of time. The requests for T channel capacity can be made over the R channel, or over the T channel, if capacity has already been assigned. The burst mode data channel characteristics for the T channel have been specified in the SARPs, as has been the slot structure used for its reservation TDMA protocol. The functional blocks at the transmit (AES) end of each channel are as follows:

a) data scrambler;

b) FEC encoder;

c) interleaver;

d) preamble and unique word generator; and

e) modulator.

The functional blocks at the receive end of each T channel are complementary to those at the transmit end. The complete series of functional blocks form transmit end to receive end is shown in Figure A-12 of this guidance material.

4.4.2 *T channel format.* The T channel burst length can vary from 2 to 31 signal units. The number of columns used in the interleaver varies with the transmission bit rate and the burst length according to the AMSS SARPs. Each burst includes a special short signal unit, the burst identifier, which ensures that the originating AES and destination GES are always known. If a GES receives a burst in which the burst identifier is lost, absent or indicates a different GES, the GES would discard the burst.

4.4.3 *T channel transmit timing.* The T channel is also synchronized to the P channel superframe, but in this case the superframe is subdivided into 1 024 slots of approximately 7.8 milliseconds. The shortest guard time between the burst of two different AESs is under control of the receiving GES and is set to approximately 39 milliseconds (5 slots).

4.5 C channel

4.5.1 *General.* The C channel is a circuit-mode channel used for digital voice or data communications. A C channel can be requested by an AES over the R channel, and assigned by the GES over the P channel. The functional blocks at the transmit end of each C channel are as follows:

a) interfaces for primary (e.g. voice) and sub-band channel;

b) primary channel/sub-band channel data multiplexor;

c) data scrambler;

d) FEC encoder (unless it is not used);

e) interleaver (unless FEC is not used);

f) preamble and unique word generator; and

g) modulator.

The functional blocks at the receive end of each C channel are complementary to those at the transmit end. The complete series of functional blocks from transmit end to receive end is shown in Figure A-13 of this guidance material.

4.5.1.1 The C channel has been specified at a number of different channel rates: 5.25, 6.0, 10.5 and 21.0 kbits/s. The underlying motivation is to allow the evolution of the system to lower channel rates as voice processing technology improves. Two of these channel rates, 5.25 and 10.5 kbits/s, do not include coding. Potential applications of these uncoded channels include transmitting 4.8 and 9.6 kbits/s vocoded speech in satellite systems that have limited spectrum but are not power limited. Alternative applications could include the use of vocoders that include their own coding, protecting the important bits more than the others; this could eliminate the need for coding in the channel modem.

4.5.2 *C channel frame.* The frame duration at all channel rates is 500 milliseconds. Carrier activation (burst mode) based on speech activity is used in the to-aircraft direction. At each activation, a preamble and unique word are transmitted to commence the burst, and from then on further unique words occur every 500 milliseconds. Thus the phasing of the unique word depends on the instant when activation commences. A postamble is sent when there is no voice content in the interleaver block.

4.5.3 *Voice activation.* In the to-aircraft direction, carrier activation is controlled by an electrical signal at the C channel interface. When the C channel is used for voice, this signal is controlled by the voice encoder. The voice encoder turns the signal on as soon as it detects voice, but applies a hangover time before turning the signal off to avoid excessive turn-offs between syllables. In addition, the forward carrier is activated by sub-band channel signalling as required.

4.5.3.1 The channel unit starts a new burst immediately after the "active" state is signalled. When the "not active" state is signalled, the channel unit continues transmission for a period and then drops the carrier. In the case of channels with FEC and an interleaver, the channel unit completes transmission of the current interleaver block, plus another complete interleaver block, which ends with a postamble to terminate the C channel carrier burst. In the case of channels with no FEC or interleaver, the channel unit continues transmission for 20 milliseconds. For both cases, during this period the required bits are taken from the primary channel interface as usual.

4.5.3.2 The same timing rules apply to the corresponding control signal from the sub-band signalling channel equipment.

4.5.3.3 In the from-aircraft direction, the carrier is transmitted continuously during the call regardless of speech activity. The start of the transmission is the same as for the forward direction, with a preamble and unique word transmitted at the beginning, followed by further unique words at 500 millisecond intervals.

4.5.4 *Data activation.* The capability to use the C channel for data other than vocoded speech is not required for safety applications. However, the C channel may be used for the transmission of data by non-safety services and some details of its operation are included here. In the to-aircraft direction the forward carrier is operated in burst mode for circuit-mode data transfer. Circuit 109 (CF) as defined in CCITT Recommendation V.24 (termed DCD in EIA RS-232C), from the GES voice band modem controls the activation interface of the C channel. The interface is initially activated when the call enters data mode, which is indicated by the circuit 109 transition to ON state. The interface normally remains activated until deactivation of data mode by the AES. If the circuit 109 changes to the OFF state indicating loss of received carrier from the far-end modem, the transmit circuit-mode interface unit finishes sending the contents of the plesiochronous buffer and then changes to "not active". The C channel activation interface is reactivated again when (if) the circuit 109 changes to the ON state.

4.5.5 *Interleaver size.* In any data transmission system where interleaving is required to randomize the errors, the interleaver size is always a trade-off between the delay incurred and its effectiveness at randomizing the errors. The interleaver blocksize for the 21 kbits/s C channel is 384 bits, which corresponds to 192 information bits. This 192 bits is the frame size (20 milliseconds) of most 9.6 kbits/s vocoders. This direct mapping between vocoder frames and interleaver buffers minimizes the delay caused by interleaving and its effect on voice communications. The resulting over-all transmission delay is around 30 milliseconds (rising to 50 milliseconds at the lowest channel rate). To match the number of interleaver bits to the required number of channel bits, a small number of "dummy" bits are included in the frame just after the framing bits.

4.5.5.1 The delay at the transmitter arising from the interleaver depends on the relationship between the voice frame and the interleaver size. The full de-interleaver delay of around 20 milliseconds will be experienced at the receiving end.

4.5.6 *Voice channel delay.* To maintain voice circuit quality, the CCITT recommends that the end-to-end delay should be limited to 440 milliseconds or less. Given that the nominal satellite delay is 270 milliseconds, the voice processing system delay should not exceed 65 milliseconds. This assumes that the terrestrial network is allotted 40 milliseconds of delay, and the modem and RF sub-systems are allotted 65 milliseconds of delay. It is to be noted that with current voice processing algorithms, the processing delay tends to increase as the vocoder rate decreases. Consequently, this end-to-end delay objective may be difficult to meet with low-rate vocoders, e.g. 2.4 and 4.8 kbits/s.

4.5.7 *Sub-band C channel.* The data transferred by the sub-band C channel includes control and signalling for the call set-up of the C channel, continuity checks, and power control. In each frame, the first 24 half-octets of the sub-band C channel are combined to form a standard length 96-bit signal unit. Successive groups of 24 half-octets are combined in the same way, if available. The 25th data field of the last voice/data block in the frame is discarded. When the C channel is activated, and there are no other signal units to be sent, fill-in signal units are sent.

5. LINK LAYER P CHANNEL AND R CHANNEL PROTOCOLS

5.1 General

The P and R channels are used for signalling and data communications in the to-aircraft and from-aircraft directions, respectively. Data transmission on the R channel is restricted to short messages (less than 33 octet link service data units (LSDUs)). This section of the guidance material describes issues related to the R and the P channel link layer protocols.

5.2 SU set generation

5.2.1 In both the aircraft earth station (AES) and the ground earth station (GES) link layers, an SU set cannot be generated from a received LIDU as described in Annex 10, Volume III, Part I, Chapter 4, 4.5.3.2.3 until a reference number is assigned to it, except for system table broadcast LIDUs and LIDUs received from the circuit-mode service entities to be transmitted, either on the R channel at the AES, or the P channel at the GES. System table broadcast LIDUs do not require reference numbers. Circuit-mode services LIDUs are assigned application reference numbers by the circuit-mode service entities at the AES and the GES, thus an SU set is generated upon receipt of the LIDU. For all LIDUs exchanged between the link layer, at the AES or the GES, and any of its service users, no formats have been specified in the SARPs. Such formats are implementation dependent.

5.2.2 When an LIDU received from the subnetwork layer is assigned a reference number, the LSDU of the LIDU is encoded in the data field of the ISU/SSU(s) of a P channel SU set or in the data field of the SUs of an R channel SU set. The number of SUs needed in the SU set depends on the LSDU length. Each SU, except the last one, will contain the maximum permitted number of user data octets. The number of user data octets in the last SU which belong to the set may have less than the maximum length. In a P channel SU set, the number of octets in the final SU (ISU or SSU) is encoded in the "No. of octets in the final SSU" field of the ISU. On the R channel, the number of octets in the last SU is encoded in the SU's "SU type" field (Annex 10, Volume III, Part I, Appendix 3 to Chapter 4, Item 67).

5.3 SUs transmission according to precedence

At the AES and the GES, in order to meet the SUs transmission requirements of Annex 10, Volume III, Part I, Chapter 4, 4.5.8.2.3, the R and P channel protocols may employ several first-in-first-out (FIFO) queues, one queue per valid Q number, to store the SUs prior to transmission. For the R channel, the SUs of an SU set would be queued according to the ascending order of their sequence indicators (Annex 10, Volume III, Part I, Appendix 3 to Chapter 4, Item 58). For the P channel, the SUs of an SU set would be queued with the ISU, or RTX SU for a retransmission set, first followed by the SSUs according to the descending order of the SSUs sequence numbers. At the instance of transmission, an SU would be selected from the highest priority queue with one or more SUs in it.

5.4 P channel protocol

5.4.1 The P channel link layer protocol is used in the to-aircraft direction for processing the transmission of: 1) the LIDUs received from the GES management, 2) the LIDUs received from the circuit-mode services with routing parameters indicating transmission on the P channel, and 3) all LIDUs received from the subnetwork layer. The P channel protocol reliable link service (RLS) is used for processing the transmission of the LIDUs received from the subnetwork layer only. The transmission of all other LIDUs is processed according to the P channel protocol direct link service (DLS). The P channel is also used for the transmission of the following link layer signalling SUs:

a) T channel reservation (RES) and reservation forthcoming (RFC) SUs associated with the T channel reservation protocol (Annex 10, Volume III, Part I, Chapter 4, 4.6);

b) T channel acknowledgement (TACK) SU; and

c) R channel acknowledgement (RACK) SU.

The above SUs are transmitted in accordahce with the P channel protocol DLS service.

5.4.2 At a given time, the P channel protocol may be processing the transmission of several LSDUs (a reference number has been assigned and an SU set has been generated from each LIDU to transmit the LSDU). However, for RLS, at each Q number only one LSDU of the LSDUs destined to the same AES is permitted to be in process for transmission at one time. The other RLS LSDUs with the same Q number and destined to the same AES will be stored until the transmission of the current LSDU at that Q number is over, either successfully or unsuccessfully. Thus, at the AES, only one RLS SU set per Q number could be in the reassembly process at a given time and the AES will discard an incomplete RLS SU set if it starts receiving another RLS SU set with the same Q number and a different reference number. After either a successful or an unsuccessful transmission of an SU set, the GES link layer releases all link layer resources associated with that SU set, i.e. the assigned reference number, activated timers, memory allocation, etc.

5.4.3 For RLS, the P channel protocol implements a selective-repeat-ARQ scheme for error control. Accordingly, upon transmitting an SU set the GES expects to receive a P channel acknowledgement (PACK) SU from the AES. The PACK SU may indicate either complete or incomplete reception of the SU set using its acknowledgement control field. In the latter case, this field also indicates whether a complete or a partial retransmission of the SU set is required. For a partial retransmission request, this field, which is present in every PACK SU, further indicates the number of PACK SUs identifying the remainder of the missing SSUs of the SU set to follow; each PACK SU can identify, at most, three missing SSUs. A partial retransmission from the GES is assembled by the AES as any other SU set; however, a retransmission SU set is headed by an RTX SU rather than an ISU and the retransmitted SSUs' Sequence Numbers are as prescribed in Annex 10, Volume III, Part I, Appendix 3 to Chapter 4, Item 59. Failure to receive an acknowledgement from the AES would cause the GES to solicit such acknowledgement by sending a request for acknowledgement (RQA) SU to that AES. The AES keeps track of the status of the RLS SU set that the AES is currently processing at a given Q number in order to correctly respond to an RQA.

5.4.4 In an SU set, original or retransmitted, only the ISU, or the RTX SU, identifies the destination AES ID. In order to avoid erroneous processing due to the broadcast nature of the P channel, the AES discards an SSU if received without previously receiving the corresponding (same reference number and Q-number) ISU or RTX SU.

5.5 R channel protocol

5.5.1 The R channel link layer protocol is used in the from-aircraft direction for processing the transmission of: 1) the LIDUs received from the AES management, 2) the LIDUs received from the circuit-mode services with routing parameter indicating transmission on the R channel, and 3) some of the LIDUs carrying LSDUs of 33 or less octets received from the subnetwork layer. The R channel protocol reliable link service (RLS) is used for processing the transmission of the LIDUs received from the subnetwork layer only. The transmission of all other LIDUs is processed according to the R channel protocol direct link service (DLS).

5.5.2 The R channel is also used for the transmission of the following link layer signalling SUs:

a) P channel acknowledgements (PACKs);

b) T channel request for acknowledgement (RQA); and

c) T channel request for reservation (REQ).

The above SUs are transmitted in accordance with the R channel protocol DLS service.

5.5.3 At a given time, the R channel protocol at the AES may be processing the transmission of several LSDUs (reference number is assigned and an SU set is generated from each LIDU to transmit the LSDU). However, for RLS, at each Q number only one LSDU is permitted to be in process for transmission to the GES at one time. Other RLS LSDUs with the same Q number will be stored in the AES until the transmission of the current RLS LSDU at that Q number is over, either successfully or unsuccessfully. Thus, at the GES, only one RLS SU set per Q number per AES could be in the reassembly process at a given time and the GES will discard an incomplete RLS SU set if it starts receiving another RLS SU set with the same Q number from the same AES. After either a successful or an unsuccessful transmission of an SU set, the AES link layer releases all link layer resources associated with that SU set, i.e. the assigned reference number, activated timers, memory allocation, etc.

5.5.4 For RLS, the R channel protocol implements a selective-repeat-ARQ scheme for error control. Accordingly, upon transmitting an SU set, the AES expects to receive an R channel acknowledgement (RACK) SU from the GES. The RACK SU may indicate either complete or incomplete reception using its acknowledgement control field. In the latter case, the RACK SU also indicates the missing SUs of the SU set by identifying their sequence indicators. The AES transmits the indicated missing SUs without any alterations to their contents. The largest SU set on the R channel contains three SUs, thus, the GES may identify at the most two missing SUs in a RACK SU, one SU of the set must be correctly received at the GES in order to detect an attempt of an SU set transmission.

5.5.5 The R channel is a multiple access channel, therefore, the GES concurrently receives SUs from all AES assigned to one set of R channel frequencies. Each received SU contains the source AES ID. Thus, the received SUs are first sorted out according to their AES IDs and then independently processed. Annex 10, Volume III, Part I, 4.5.8.3 contains the R channel protocol requirements corresponding to the processing of SUs from a given AES.

6. LINK LAYER T CHANNEL AND SUB-BAND C CHANNEL PROTOCOLS

6.1 General

The link layer T channel protocols specified in Annex 10, Volume III, Part I. Chapter 4, 4.6 applies to link service data units (LSDUs) in the from-aircraft direction which cannot be transmitted via the R channel (e.g. because its length exceeds 33 octets). There are two T channel protocols: one for requesting the T channel capacity and the other for the transmission of SUs in assigned capacity. The link layer sub-band C channel protocol specified in Annex 10, Volume III, Part I, Chapter 4, 4.6 applies to the transmission of signalling SUs corresponding to the circuit-mode services in the to-aircraft and from-aircraft directions.

6.2 SU set generation

An SU set cannot be generated from the received LIDU as described in Annex 10, Volume III, Part I. Chapter 4, 4.6.4.2.1 until a reference number is assigned to it by the T channel reservation protocol. The LSDU (used data) is encoded in the user data field of the ISU/SSU of a T channel SU set. The number of SUs needed in the SU set depends on the LSDU length. Each SU, except the last one, will contain a maximum permitted number of user data octets. The number of user data octets of the last SU which belongs to the set may have less than the maximum length; unused octets are then padded with dummy bits. The number of octets in the final SSU is encoded in the "No. of octets in the final SSU" field of the ISU.

6.3 T channel transmission protocol

6.3.1 GENERAL

6.3.1.1 The T channel transmission protocol is used when there are LSDUs present for transmission on the T channel and the AES has received a requested T channel burst reservation. The T channel transmission protocol specifies reliable link service (RLS) for data transfer.

6.3.2 AIRCRAFT EARTH STATION (AES)

6.3.2.1 The aircraft earth station (AES) is the transmitting end of the T channel transmission protocol. The oldest SU of the SUs with the highest Q number is transmitted first. If an SU set is waiting for transmission in an allocated burst reservation and a higher precedence SU set is submitted for transmission then the higher precedence SUs will displace the lower precedence SUs. Thus, a burst reservation may carry SUs corresponding to an LSDU other than the one which initiated the original request for reservation.

6.3.2.2 The AES, after transmitting the SU set to the ground earth station (GES), waits for T channel acknowledgement (TACK) SU(s) from the GES. The TACK SUs are received at the AES by the receiving end of the P channel protocol, which then passes them to the T channel transmission protocol. The AES may receive more than one TACK SU indicating the missing SUs of an SU set at the GES. Each TACK SU can identify up to three missing SUs. The receipt of a TACK SU of the TACK SU set identifying the missing SUs, initiates a timer tA5 in the AES and indicates the number of additional TACK SUs that are expected. If the timer tA5 expires before another TACK SU of the TACK SU set is received, the AES transmits the missing SUs identified in the so far received TACK SUs. If TACK SU(s) are received after the corresponding timer tA5 has expired and the AES has not yet transmitted the retransmission SU set identified in the received TACK SU(s), the AES discards the received TACK SU(s).

6.3.2.3 The AES computes the length of the expected reservation for retransmission based upon the number of missing SUs indicated in the received TACK SUs of the TACK SU set. This length is associated with the timer tA8 initiated by the T channel reservation protocol to supervise the receipt of reservation for retransmission. This length may be less than the length of the reservation actually assigned for retransmission by the GES if, for example, some TACK SUs of the TACK SU set are not received by the AES.

6.3.2.4 The AES saves a copy of an SU set for retransmission purposes. After passing the transmission status indication LIDU to the subnetwork layer indicating success or failure, the AES destroys the saved copy.

6.3.2.5 If after several retries, an expected reservation from the GES is not received, the AES discards at least the number of SUs for which the reservation was requested. The

SUs discarded may not be those which initiated the original request for reservation because of the fact that the transmission of SUs is based upon the precedence described in Annex 10, Volume III, Part I, Chapter 4, 4.6.4.2.2, but will be of equal or lower precedence. If an ISU is among the SUs discarded at the AES, the complete SU set headed by the discarded ISU is discarded. This may result in discarding more SUs than required. If the SU discarded is a REQ SU, then the AES retransmits the REQ SU on either the T or R channel. If the SU discarded is a last SU of an SU set, then the AES starts a timer for the supervision of TACK SU(s) for that SU set.

6.3.3 GROUND EARTH STATION (GES)

6.3.3.1 This is the receiving end of the T channel transmission protocol. The GES, upon receipt of an SU set, reassembles it into an LSDU. Before reassembling the SU set, the GES checks whether or not all the SUs of the SU set have been received. If the SU set is not complete after no more SUs of the SU set are expected (determined by the criterion specified in the AMSS SARPs), the GES requests for the retransmission of the missing SUs by transmitting appropriate number of TACK SUs, indicating error, on the P channel to the AES.

6.3.3.2 If while waiting for retransmissions from the AES, the GES receives an ISU with the same AES ID and Q number as the SU set awaiting completion and with a reference number belonging to a pair whose other member is the reference number of the SU set awaiting completion, the GES discards the SU set awaiting completion and proceeds with the new SU set. The receipt of the ISU with the parameters described above indicates that the AES has given up on the transmission of the previous SU set and has released the reference number, thus making available the other member of the pair for assignment.

6.3.3.3 The GES may receive an RQA SU from the AES in the following circumstances:

a) initial SU set loss (i.e. loss of at least the ISU): the RQA SU does not refer to an SU set which has been processed just before;

b) negative acknowledgement loss or retransmission loss: the RQA SU refers to an SU set under correction; and

c) positive acknowledgement loss: the RQA SU refers to an SU set which has been processed just before.

When the initial SU set has been lost, the GES determines the initial SU set length from the message length parameter in the RQA SU in order to reserve and send the correct T channel capacity along with the request for complete retransmission.

6.4 T channel reservation protocol

6.4.1 GENERAL

The T channel reservation protocol is used to request reservations for the transmission of data on the T channel.

6.4.2 AIRCRAFT EARTH STATION (AES)

6.4.2.1 The T channel reservation protocol in the AES assigns reference numbers to the LIDUs received from the subnetwork layer for transmission on the T channel. The reference numbers are assigned in such a way that no two consecutive LIDUs with the same Q number transmitted from an AES to a GES have the same reference number. The reference number assigned to an LSDU is used by the T channel reservation protocol in the request for reservation (REQ) SU and by all the associated signalling and by the T channel transmission protocol in the data SUs and by the associated acknowledgements and request for acknowledgement SUs.

6.4.2.2 The REQ SU is transmitted to the GES on the T channel or on the R channel. Every time the REQ SU is transmitted on the T channel, the requested length in the REQ SU is incremented by one in order to account for the T channel capacity used to transmit the REQ SU.

6.4.2.3 The timer tA8 in the AES is used to supervise the receipt of expected T channel reservation (RES) SUs associated with either previously received reservation forthcoming (RFC) SUs or received TACK SUs. Due to the priority scheme for the transmission of SU sets, resulting in higher priority SU sets potentially occupying reservation assignments for lower priority SU sets, there will be instances of time where multiple tA8 timers associated with the same SU set might have been initiated at the AES. Upon receipt of an awaited RES SU for that SU set, the AES must stop the corresponding tA8 timer (Annex 10, Volume III, Part I, Chapter 4, 4.6.5.2.6 and 4.6.5.2.7). However, since a one-to-one correspondence between a tA8 timer and a received RES SU is not guaranteed, a selection of a most suitable tA8 timer must be made. Such selection is implementation dependent. For instance, the selection could be made dependent on the time-out values of all outstanding tA8 timers, such that the tA8 timer with the shortest remaining time to time-out is selected regardless of the size of reservation in the received RES SU. In this case, care must be taken in the implementation to request reservations for any resulting deficit in the total size of outstanding reservations associated with an SU set at the AES when all tA8 timers have been stopped. Other criteria for the selection may be used; however, the constraint that at least the total size of all outstanding reservations associated with any given SU set must be received prior to releasing the reference number assigned to that SU set must always be observed.

6.4.2.4 Reservations may not be received in chronological order. The minimum inter-reservation gap between two reservations on two different T channels is made adequate to allow for frequency (T channel) switching at the AES. A reservation (RES) SU defines one or more burst allocations on one T channel. The starting frame number of the initial burst is encoded within the RES SU and is known as belonging to one of the sixteen frames following the reception of the RES SU (the time window). Thereafter, further reservations (if any) occur every 2BI frames until the number of reserved bursts is reached. BI is the encoding of the burst interval information element within the RES SU. The AES computes the starting frame for each reserved burst using both the starting frame number of the initial burst and the burst interval information. Once a reserved burst has elapsed, the AES deletes it from its time plan.

6.4.3 Ground earth station (GES)

6.4.3.1 The GES assigns reservations in response to requests for reservations from its logged-on AESs. The GES also assigns reservations for retransmissions of missing SUs of an SU set transmitted by the AES. So, whenever the T channel transmission protocol at the GES transmits a TACK SU set comprised of one or more TACK SUs indicating errors, the T channel reservation protocol at the GES makes reservations for the retransmissions.

6.4.3.2 The GES assigns reservations to an AES for any one of the four T channels that may have been assigned to the AES at the time of log-on. The GES indicates the T channel on which the reservation has been made to the AES in the RES SU. A procedure to select a T channel, out of the possible four assigned to the AES at the time of log-on, is implementation dependent. The following methods may be utilized for selecting the T channel:

a) all T channels available to a particular AES are polled. Reservations are assigned to any T channel on which the minimum allowable reservation delay is achievable, or to the channel offering the shortest reservation delay if no T channel offers the minimum allowable reservation delay;

b) each T channel assigned to a particular AES is associated with one or more message precedence. A T channel is selected according to the precedence of the message identified in the REQ SU; and

c) reservations for all non-safety messages are made on a single T channel; reservations for all safety messages are made on a T channel which offers a shortest reservation delay.

6.4.3.3 The GES transmits the RES SU to the AES whenever the start of the reservation is within eight seconds of the current time. This is done to avoid any misinterpretation of the reservation start time at the AES. The reservation start time in the RES SU is specified in terms of start frame number within a superframe. The superframe number is not specified. So, if the RES SU is not received by the AES within the superframe which actually includes the start frame number, the AES will apply the information incorrectly to the superframe within which the RES SU is received by the AES. If the frames in this superframe have been assigned to another AES, then there could be a collision of the T channel transmissions from the two AESs. Because of the fact that the RES SU should be received by the AES within the correct superframe, the precedence of the RES SU is set to 15 in order to minimize the P channel queuing delays that otherwise can be experienced by the RES SU.

6.4.3.4 If the start of the burst reservation is outside the eight second time window from the time the reservation was made, the GES transmits a reservation forthcoming (RFC) SU to the AES in order to prevent a timeout resulting in another request for reservation. The RFC SU gives an upper limit for the delay to the start of burst reservation in entire number of super frames (8 seconds). The time-plan in the GES is limited in length. Whenever the GES is not capable to assign a reservation within its current time-plan, it sends an RFC SU with the delay to RES set equal to its maximum time-plan length and saves the request for later assignment. Subsequently, when the GES is capable of serving the request, the GES sends a further RFC SU giving the delay to reservation which is now known. The size of the GES time-plan is implementation dependent and has not been specified in the AMSS SARPs.

6.4.3.5 The TACK SUs transmission must always precede the associated T channel reservation. As the precedence level of an RES SU is higher than the one of the TACK SU, the GES must wait until all TACK SUs have been effectively transmitted before allocating a reservation for retransmission. The TACK SUs transmitted to the AES by the T channel transmission protocol in the GES includes an estimation for the delay before the RES SU will be sent to the AES by the GES; this estimation is a function of the T channel(s) loading. Subsequently, if the reservation cannot be assigned within the estimated delay specified in the TACK SU, the GES transmits an RFC SU with the actual delay or with the maximum delay value corresponding to its time-plan length if it has not been able to assign a reservation within its current time-plan. In the latter case, the GES will delay T channel burst assignment until capacity is available. The length of the reservation for retransmission is the number of missing SUs identified by the TACK SU set indicating missing SUs at the GES plus one.

6.4.3.6 The GES assigns reservations such that no two AESs use the same T channel for transmission at the same time. The length of a reservation is such that the AES is always capable to send at least one REQ SU in addition to the SUs for which the reservation is made. This prevents delaying either the transmission of an REQ SU when its precedence level is lower than the precedence level of the SUs awaiting transmission, or the transmission of the complete SU set when interrupted by a single REQ SU. Long LSDUs are assigned burst reservation in multiple bursts of equal length, each burst being separated from the precedent one by a fixed burst interval. The intervals between bursts can be assigned to AESs for transmission or retransmissions. The burst interval between two bursts and the burst length of each burst corresponding to the same LSDU are made such that the transfer delay for the entire LSDU meets the performance requirements specified in Annex 10, Volume III, Part I, Chapter 4, 4.7. Since the transmitter in the AES could be shared between the R and T channels and the T channel mode of the transmitter has higher priority than its R channel mode, the assignment of reservations on the T channel will affect the R channel transmissions. The reservations are assigned on the T channel in such a way that most of the time there is at least one R channel burst every eight seconds from each AES logged on to the GES assigning reservations. The burst length and burst interval are not specified in the AMSS SARPs; they are implementation dependent.

6.4.3.7 Typical values for the length of an individual burst are as follows:

a) 18 SUs for a T channel operating at 600 bits/s;

b) 17 SUs for a T channel operating at 1 200 bits/s;

c) 31 SUs for a T channel operating at 2 400 bits/s; and

d) 31 SUs for a T channel operating at 10 500 bits/s.

Typical values for the burst interval are as follows:

a) 16 frames for a T channel operating at 600 bits/s;

b) 8 frames for a T channel operating at 1 200 bits/s;

c) 4 frames for a T channel operating at 2 400 bits/s; and

d) 1 frame for a T channel operating at 10 500 bits/s.

6.4.3.8 The earliest starting time that a reservation can be made by the GES must be such that the AES can receive the reservation in time to transmit at the start of the assigned reservation. This time takes into account the processing time at both the GES and the AES as well as coding and decoding delays. The value for the earliest starting time is implementation dependent and is computed according to the formula given below:

Minimum delay to start of reservation = P channel unit delay + GES processing delay + P channel queuing delay + R-slot duration + 0.2 sec(*) + propagation delay + AES processing delay.

* 0.2 seconds is the R/T channel switching time.

A system implementor has obtained the typical values shown in Table A-10 for some of the components. A typical value for GES processing delay is in the order of 200 msec.

6.4.3.9 The GES, upon receipt of either a log-on to another GES or log-off information about an AES which was logged on to it, may discard the reservations assigned to the AES, making the slots available for assignment to its other logged on AESs.

6.5 Sub-band C channel to-aircraft and from-aircraft protocol

6.5.1 GENERAL

The sub-band C channel protocol defined in AMSS SARPs contained in Annex 10, Volume III, Part I, Chapter 4, 4.6 specifies direct link service (DLS) for signalling SUs. The sub-band C channel carries signalling for circuit-mode services to set-up, maintain or release the C channel.

7. SATELLITE SUBNETWORK LAYER

7.1 General provisions

7.1.1 ARCHITECTURE

To facilitate the development of interoperability specifications, the subnetwork layer has been divided into functional areas. This functional division is not intended to preclude implementations that aggregate functions in other ways, so long as the airborne and ground implementations of the subnetwork layer each behaves (to an external observer) as if it conformed with the provisions of this section.

7.1.1.1 *SSND function*

Each SSNDPX function contains one or more SSNDPX entities. Each entity communicates with the peer SSNDPX entity using the SSNDP.

7.1.1.2 *SNAc function*

Each SNAc function contains one or more ISO 8208 DCE entities. Each ISO 8208 DCE entity communicates with the peer ISO 8208 data terminal equipment (DTE) entity in the attached aeronautical telecommunication network (ATN) router using the ISO 8208 protocol.

7.1.1.3 *CN function*

Each CN function contains one CN entity. This entity sends CN event messages to the attached ATN routers through the ISO 8208 DCEs.

7.1.1.4 *IW function*

Each IW function contains one IW entity. The IW function performs the necessary harmonization between the SSND, SNAc and CN functions. It forwards ISO 8208 packets between the ISO 8208 DCE and SSNDPX entities. It also forwards CN event messages to the ISO 8208 DCE entity.

7.1.2 BACKGROUND FOR THE USE OF ISO 8208 AND THE ASSOCIATED SUBNETWORK DEPENDENT PROTOCOL

In the satellite subnetwork, data may be received out-of-sequence or duplicated. The subnetwork dependent convergence function (SNDCF) in the ATN router which uses the services provided by the satellite subnetwork assumes an underlying connection-mode service which provides sequenced delivery of data. The SNDCF does not perform any error recovery function to handle data duplication and data received out-of-sequence. Therefore, it requires a reliable connection-mode service which is provided by the ISO 8208 and SSND protocols. Furthermore, for the satellite subnetwork, it is more efficient to use these connection-mode protocols. Finally, ISO 8208 is the most mature connection-mode protocol available.

7.1.3 SERVICES

7.1.3.1 The packet data interface allows AMSS to function as the satellite subnetwork of the ATN. The satellite subnetwork transfers data packets from air to ground and from ground to air. Packet data transfers are provided in the form of connection-mode service, using ISO 8208 as a subnetwork access protocol (see Figure A-14 of this guidance material).

7.1.3.2 The subnetwork user must initiate the set-up of each connection by sending an ISO 8208 CALL REQUEST packet. In normal operation, this action results in the establishment of a switched virtual circuit (SVC) between the calling subnetwork user and the called subnetwork user. SVCs can be released by either subnetwork user (when the connection is no longer needed) or by the subnetwork (when the connection is no longer supportable).

7.1.3.3 One or more subnetwork users on an aircraft may be connected to one or more subnetwork users on the ground, but all ground users will normally interface via a single ground earth station (GES) at any given time. Hand-overs from one GES to another may result in the temporary interruption of service.

7.1.3.4 The originator of a CALL REQUEST packet will normally identify both the called and calling subnetwork user. The originator may also identify quality of service requirements by invoking the appropriate ISO 8208 facilities.

7.1.3.5 Implementations of a satellite subnetwork will normally contain elements that are not standardized by ICAO. One of these elements is a packet switch that interprets DTE addresses and delivers packets to the appropriate DTE. The AMSS SARPs permit (but do not require) the connection of multiple DTEs with an aircraft earth station (AES) or with a GES, or with both. AMSS SARPs also permit the use of any DTE address format, subject to the limitations of ISO 8208. Subnetwork users are responsible for co-ordinating the DTE address formats (and address compression schemes, if employed) between the air and the ground.

7.1.3.6 The satellite subnetwork provides connectivity notification event messages to the attached ATN routers. Since CN event messages are not transferred across the subnetwork, the standardization of formats and media for these messages are considered to be local matters.

7.1.4 ERROR HANDLING FOR COMMUNICATION FAILURES

If communication between an AES and a GES is abruptly terminated (e.g. due to a loss of physical connectivity), it is possible for the subnetwork layer to remain in its last state until connections are cleared by the user. The GES subnetwork layer is particularly susceptible, since it may not immediately be aware of the loss of communication. Users and/or implementors may use supplemental means to detect and correct such conditions.

7.2 Packet data performance

7.2.1 GENERAL

7.2.1.1 *The need for ICAO performance specifications*

7.2.1.1.1 AMSS minimum system performance standards apply over a geographic coverage area to be identified by each AMSS service provider. In general, the minimum system performance should be continuously available to each AES within the identified coverage area. However, AES antennas are not required to provide full coverage in all directions; multiple antennas and/or multiple satellites may be needed in order to achieve the minimum system performance.

7.2.1.1.2 AMSS minimum system performance standards do not represent the fundamental limits of system performance. Under favourable conditions, the achievable AMSS system performance may be significantly better than the minimum standards reflected in the AMSS SARPs. States are not precluded from seeking AMSS service arrangements that would provide system performance that exceeds the minimum requirements of the AMSS SARPs. However, such arrangements should take into consideration the minimum AES configurations and the minimum AES performance requirements of the AMSS SARPs.

7.2.1.2 *Physical layer*

The basic performance standard for the physical layer is the maximum bit error rate, which is specified as 10^{-3} for digital voice and 10^{-5} for packet data and associated signalling. These system specifications avert the need to specify detailed satellite link budgets, thus allowing the flexibility to implement a variety of satellite and GES architectures.

7.2.1.3 *Packet data subnetwork layer*

7.2.1.3.1 The specification of subnetwork service performance will allow flexibility in the design and operation of GESs while assuring a uniform minimum level of performance for the packet data user. In general, the subnetwork performance parameters are based on the definitions given in Section 10 of ISO 8348, "Information processing systems — Data communications — Network service definition" (1987), which are incorporated into the AMSS SARPs by reference. The mapping between packets and subnetwork service primitives is defined in ISO 8878, "Information processing systems — Data communications — Use of X.25 to provide the OSI connection mode network service".

7.2.1.3.2 The term "subnetwork service" in the context of packet data performance refers to the service provided by the subnetwork to the higher layer user. The term "service provider" in this same context refers to the protocols within the satellite subnetwork and to the net effect of their operation. These terms should not be confused with the services of the satellite communication provider or GES operator. Packet data service depends on all elements of the system: AES, satellite, GES, and the physical paths between them.

7.2.1.3.3 The values of the performance parameters in the AMSS SARPs are intended to permit economical and spectrum-efficient operation. They are calculated under nominal worst case conditions, including maximum physical bit error rate and peak busy hour traffic loading. Improved speed of service performance (relative to the specified values) may be achieved by increasing the number of physical channels used to serve a given traffic load, thus decreasing the traffic load per channel. Using this technique, cost of service may be expected to increase (and spectrum efficiency may be expected to decrease) as the speed of service is improved.

7.2.1.3.4 AMSS subnetwork performance does not include the effects of other links in the end-to-end data path. Subnetwork performance includes the effects of all operations beginning with the ISO 8208 DCE protocol at the sending end of the satellite subnetwork and terminating with the ISO 8208 DCE operations at the receiving end of the satellite subnetwork, including:

a) the satellite subnetwork interworking functions;

b) the satellite subnetwork dependent protocols;

c) the satellite data link layers; and

d) the satellite physical layers.

ISO 8208 operations associated with the DTE are not part of the satellite subnetwork, and are excluded from AMSS packet data performance specifications, as are data link layer and physical layer operations between the DCE and the DTE.

7.2.2 SPEED OF SERVICE

7.2.2.1 Speed of service is determined by a number of factors, including:

a) the system architecture;

b) the channel rate(s) in use;

c) the priority of the traffic for which speed of service is being measured;

d) the length of the messages for which speed of service is being measured, the traffic loading on the system; and

e) data processing delays.

Finally, the actual speed of service in the from-aircraft direction depends on the amount and type of traffic being transmitted from each aircraft, to the extent that packets may be delayed on the aircraft while other packets are being transmitted to the GES.

7.2.2.2 In accordance with current industry practice, speed of service is specified in terms of packets containing 128 octets of subnetwork user data.

7.2.2.3 There is no specification for the maximum amount of traffic to be handled on P or T channels. However, the speed of service performance standards are based on a maximum utilization of approximately 70 per cent (of theoretical capacity) for these channel types. Higher utilizations are permitted, provided that all of the applicable performance standards are met. For example, a GES that operates multiple T channels in an appropriate multiserver configuration may be able to achieve T channel utilization factors of 80 per cent or more within the constraints imposed by the speed of service requirements. P channels may be operated at utilization factors higher than 70 per cent if the total P channel utilization by traffic at and above the lowest priority associated with safety and regularity of flight does not exceed 70 per cent.

7.2.2.4 A GES that is intended to serve as a backup to a another GES should be appropriately sized to provide the required performance in the event of the failure of the primary GES.

7.2.2.5 The term "highest priority service" denotes priority 14 service, which is reserved for distress, urgency and certain infrequent network/system management messages. The term "lowest priority service" denotes the lowest priority used for safety and regularity of flight, under peak-hour traffic loading. Performance for priority levels not used for safety or regularity of flight is not specified.

7.2.2.6 *Transit delay and 95 per cent data transfer delay*

7.2.2.6.1 Transit delay is a standard speed of service performance measure for single DATA packets; transit delay is defined as an average value. Because the civil aviation community typically does not rely on average values for the most critical performance measures, the 95 per cent data transfer delay is also specified. Under actual operational conditions, the relationship between the average and 95 per cent delay values is not fixed, but may depend on the distribution of traffic. A typical statistical distribution of to-aircraft delays, under projected peak traffic loading and at the lowest P channel rate, is illustrated in Figure A-15 of this guidance material for the highest and lowest priority of data. A typical statistical distribution of from-aircraft delays under similar conditions is shown in Figure A-16 of this guidance material. From-aircraft delays are independent of priority unless two or more from-aircraft packets contend for resources within a particular AES. The extent to which such internal contention may occur within a particular AES will depend on the avionics architecture of the aircraft in which the AES is installed.

7.2.2.6.2 Transit delay and 95 per cent data transfer delay are specified on the basis of a standard reference DATA packet containing 128 octets of subnetwork user data. Actual delays for shorter packets may be reduced, but not necessarily in proportion to the packet length. The delay parameters associated with DATA packets shorter than 128 octets (of subnetwork user data) should not exceed the corresponding parameters for 128 octet DATA packets.

7.2.2.7 *Throughput*

Throughput is the standard speed of service performance parameter for the transfer of multiple DATA packets. In accordance with current industry practices, throughput is computed on the basis of standard reference DATA packets containing 128 octets of subnetwork user data. Throughput is computed for the transfer of multiple independent packets. Throughput performance for the transfer of M-bit sequences may be substantially higher. The subnetwork is expected to support the minimum throughput values shown in Table A-11.

7.2.2.8 *Connection establishment delay, connection release delay*

7.2.2.8.1 *Connection establishment delay.* The maximum connection establishment delay is based on a connection request of the lowest priority, containing a total of 15 octets of DTE address information and 42 octets of facility fields and optional data. The specified value for each channel rate applies to an equal mix of GES-originated requests and AES-originated requests. The maximum connection establishment delay is the standard speed of service specification for the connection establishment phase; it is not intended to limit in any way the future use of optional facilities, user data fields, or address fields.

7.2.2.8.2 *Connection release delay.* The maximum connection release delay is based on a disconnect request at the lowest priority, containing no user data, invoking no optional facilities and carrying no address information. The specified value for each channel rate applies to an equal mix of GES-originated requests and AES-originated requests, when the connection release is not delayed by the presence of packets in transit on the connection. The maximum connection release delay is the standard speed of service specification for the connection release phase; it is not intended to limit in any way the future use of optional facilities, user data fields, or address fields.

7.2.3 RELIABILITY OF SERVICE

7.2.3.1 Reliability of service is determined by the system architecture, by the physical layer bit error rate, and by the average rate of "collisions" on R channels. There is no specification on the rate of R channel collisions. However, the system performance specifications for both speed of service and reliability of service are based on an average R channel occupancy factor (i.e. the ratio of occupied R channel slots to the total number of R channel slots during a given interval) of approximately 0.15. Higher R channel occupancies are permitted, provided that all of the applicable performance standards are met.

7.2.3.2 The standard reliability of service parameter for the transfer of a single DATA packet is residual error probability, which is the probability that an attempt to transfer a single DATA packet is not entirely successful. It is based on a standard reference DATA packet containing 128 octets of subnetwork user data. The undetected error probability for AMSS packet data service is expected to be less than 3×10^{-7} for standard reference DATA packets containing 128 octets of subnetwork user data. The undetected error probability for shorter packets is reduced approximately in proportion to the packet length.

7.2.3.3 Other reliability of service parameters are resilience of the virtual circuit or logical channel with respect to reset and release, i.e. the probability that the subnetwork service provider invokes a reset or release over some period of time. Reset and release operations may result in the loss of user data, whether invoked by the subnetwork user or by the subnetwork service provider.

7.3 Satellite subnetwork dependent protocol services and operations

7.3.1 LOGICAL CHANNELS

The requirements for selecting logical channel numbers are intended to prevent call collisions.

7.3.2 CONNECTION ESTABLISHMENT

7.3.2.1 The following describes a normal connection establishment between two SNS users.

7.3.2.2 When a subnetwork connection is initiated by one of the SNS users, an ISO 8208 DCE entity in the satellite subnetwork receives an ISO 8208 CALL REQUEST packet from the ISO 8208 DTE. This packet is forwarded to the IWF. The IWF forwards this packet to the appropriate SSNDPX entity. This SSNDPX entity forwards this packet as a CONNECTION REQUEST SNPDU to the remote SSNDPX. When the remote SSNDPX receives this SNPDU, it forwards this to the IWF as an ISO 8208 INCOMING CALL packet. The IWF forwards this packet to the appropriate ISO 8208 DCE entity. The ISO 8208 DCE entity forwards this packet to the peer ISO 8208 DTE entity. The ISO 8208 DTE forwards this connection request to the receiving SNS user. After the receiving SNS user has accepted this connection request, the ISO 8208 DTE entity forwards an ISO 8208 CALL ACCEPTED packet to the peer ISO 8208 DCE entity. The ISO 8208 DCE entity forwards this packet to the IWF. The IWF forwards this packet to the appropriate SSNDPX entity. This SSNDPX entity forwards this packet as a CONNECTION CONFIRM SNPDU to the peer SSNDPX entity. When the remote SSNDPX entity receives this SNPDU, it forwards this as an ISO 8208 CALL CONNECTED packet to the IWF. The IWF forwards this packet to the appropriate ISO 8208 DCE entity. This ISO 8208 DCE entity forwards this packet to the peer ISO 8208 DTE entity. When the ISO 8208 DTE entity receives this packet, it informs the originating SNS user about the establishment of a connection to the remote SNS user.

7.3.2.3 A connection between two SNS users consists of a series of logical channels. Each logical channel is selected based on the established rule by the receiving entity. Therefore, these logical channels may not have the same number. Figure A-17 of this guidance material shows an example of connection establishment between three pairs of SNS users.

7.3.2.4 *Throughput negotiation*

Since the GES has the knowledge of available throughput based on the throughputs that have been assigned to the existing subnetwork connections (SNCs), it should assign the throughput classes for each direction of data transmission. The recommended actions by the GES are given in 7.3.6.1 and 7.3.7.1 of this guidance material.

7.3.3 CONNECTION RELEASE

7.3.3.1 *SSNDPX*

To avoid unnecessary releases at the SSNDPG caused by residual DATA/INTERRUPT SNPDUs from the SSNDPA, the SSNDPA waits until all DATA/INTERRUPT SNPDUs in transmission and pertaining to that connection have been transmitted before forwarding a CONNECTION RELEASED or a CONNECTION RELEASE COMPLETE SNPDU to the SSNDPG. The SSNDPA need not correlate the transmission status of each DATA/INTERRUPT SNPDU with transmission status indications from the data link layer. However, the SSNDPA waits until all outstanding DATA/INTERRUPT SNPDUs have been acknowledged by the link layer (success/fail LIDU) before sending a CONNECTION RELEASED or CONNECTION RELEASE COMPLETE

SNPDU. Since to-aircraft SNPDUs are always delivered in proper sequence by the link layer, the SSNDPG may send a CONNECTION RELEASED or CONNECTION RELEASE COMPLETE SNPDU without waiting for acknowledgement of previously sent DATA/INTERRUPT SNPDUs.

7.3.4 Data transfer

7.3.4.1 *IWF*

The IWF should forward the DATA packets between the appropriate SSNDPX and ISO 8208 DCE entities and supply these entities with sufficient information to identify the appropriate logical channel.

7.3.4.2 *SSNDPG*

Since the DATA SNPDUs from the AES are sent through either the R or T channel, they may be received out-of-sequence at the GES. Therefore, the SSNDPG should have sufficient storage to reorder the out-of-sequence DATA SNPDUs before forwarding the data in these SNDPUs to the IWF.

7.3.4.3 *Flow control procedure*

7.3.4.3.1 Memory management mechanisms are implementation dependent. In order to minimize the possibility of memory overflow and the consequent loss of data, the satellite subnetwork layer provides flow control, which may be invoked by the AES, the GES, or the subnetwork user. The SSNDPX uses start-stop flow control, while the DCE uses ISO 8208 window flow control. ISO 8208 RECEIVE READY and RECEIVE NOT READY packets are produced locally; they are never transferred across the subnetwork. If the SSNDPX remains in the "flow control not ready" state for 60 seconds, the subnetwork initiates a reset of the connection, regardless of whether flow control was suspended by the subnetwork or by the subnetwork user. The timer (tN7) is associated with the receiving SSNDPX, i.e. the SSNDPX that originated the FLOW CONTROL SUSPEND SNPDU.

7.3.4.3.2 System designs should minimize the possibility that flow control will be invoked on priority 14 connections, e.g. by dynamic memory allocation or by providing additional fixed memory allocation for priority 14 connections. Dynamic memory allocation procedures, if used, should take connection priority into consideration.

7.3.4.3.3 *SSNDPX*

7.3.4.3.3.1 When the SSNDPX surpasses a storage threshold or receives a FLOW CONTROL (suspend) SNPDU from the remote SSNDPX, it should notify the IWF of this condition.

7.3.4.3.3.2 If the SSNDPX falls below a storage threshold or receives a FLOW CONTROL (resume) SNPDU from the remote SSNDPX after it has informed the IWF of the flow control suspend condition, it should notify the IWF of this condition.

7.3.4.3.3.3 When the SSNDPX surpasses a storage threshold or receives flow control suspend information from the IWF, it should forward a FLOW CONTROL (suspend) SNPDU to the remote SSNDPX when the next DATA SNPDU is received on that VC, providing the situation has not cleared by then.

7.3.4.3.3.4 If the SSNDPX falls below a storage threshold or receives flow control resume information from the IWF after forwarding a FLOW CONTROL (suspend) SNPDU to the remote SSNDPX, it should forward a FLOW CONTROL (resume) SNPDU to the remote SSNDPX.

7.3.4.3.4 *ISO 8208 DCE*

7.3.4.3.4.1 When the ISO 8208 DCE surpasses a storage threshold or receives flow control suspend information from the IWF, it should suspend the updating of the lower window edge of the local DTE or forward a RECEIVE NOT READY packet to the local DTE.

7.3.4.3.4.2 If the ISO 8208 DCE falls below a storage threshold or receives a flow control resume information from the IWF after it has suspended the updating of the lower window edge of the local DTE or forwarded a RECEIVE NOT READY packet to the local DTE, it should resume updating the lower window edge of the local DTE or forward a RECEIVE READY packet to the local DTE.

7.3.4.3.4.3 When the ISO 8208 DCE surpasses a storage threshold or receives a RECEIVE NOT READY packet from the local DTE, it should notify the IWF of this condition.

7.3.4.3.4.4 If the ISO 8208 DCE falls below a storage threshold or receives a RECEIVE READY packet from the local DTE after it has informed the IWF of the flow control suspend condition, it should notify the IWF of this condition.

7.3.4.4 *Data loss*

7.3.4.4.1 In a connection release or connection reset, DATA SNPDUs and ISO 8208 DATA packets on that connection may be lost. To guarantee end-to-end delivery of end-user data, a confirmed service such as the one provided by a transport protocol may be used.

7.3.4.4.2 System designs should minimize the possibility that flow control will be invoked on priority 14 connections, e.g. by dynamic memory allocation or by providing additional fixed memory allocation for priority 14 connections. Dynamic memory allocation procedures, if used, should take connection priority into consideration.

7.3.4.5 *Expedited data transfer*

7.3.4.5.1 It is expected that the ATN will not require expedited data transfer service. However, expedited data transfer service is supported in accordance with ISO 8208.

7.3.4.5.2 For each logical channel, the expedited data transfer allows an interrupt SNPDU packet to be sent in a given direction while data transfer in that direction is suspended. This is accomplished by sending the interrupt SNPDU or interrupt packet ahead of data SNPDUs or data packets that have been suspended.

7.3.4.6 *Connection reset*

7.3.4.6.1 *SSNDPX.* To avoid resets at the SSNDPG caused by residual DATA/INTERRUPT SNPDUs from the SSNDPA, the SSNDPA waits until all DATA/INTERRUPT SNPDUs in transmission and pertaining to that connection have been transmitted before forwarding RESET or RESET CONFIRM SNPDUs to the SSNDPG. The SSNDPA need not correlate the transmission status of each DATA/INTERRUPT SNPDU with transmission status indications from the data link layer. However, the SSNDPA waits until all outstanding DATA/INTERRUPT SNPDUs have been acknowledged by the link layer (success/fail LIDU) before sending a RESET SNPDU. Since to-aircraft SNPDUs are always delivered in proper sequence by the link layer, the SSNDPG may send a RESET SNPDU without waiting for acknowledgement of previously sent DATA/INTERRUPT SNPDUs.

7.3.5 SNPDU FORMATS

7.3.5.1 *Fast select facility*

The fast select facility with parameter set to "use not permitted" may be included in the CONNECTION REQUEST SNPDU to explicitly indicate that no user data may be transferred in the CONNECTION CONFIRM and CONNECTION RELEASED SNPDUs. If this facility is not included in the CONNECTION REQUEST SNPDU, then up to 128 octets of user data may be transferred in the CONNECTION CONFIRM and CONNECTION RELEASED SNPDUs.

7.3.6 PACKET TO SNPDU MAPPING RULES

7.3.6.1 *GES actions*

7.3.6.1.1 The selected throughput class in the CALL ACCEPTED packet should be transferred to the TCN value in the CONNECTION CONFIRM SNPDU.

7.3.6.1.2 If the throughput class in the CALL REQUEST packet is less than or equal to the calculated available value, then the throughput class should be transferred to the TCN value in the CONNECTION REQUEST SNPDU; otherwise, the calculated available throughput, rounded down to the nearest standard value, should be transferred to the TCN value.

7.3.7 SNPDU TO PACKET MAPPING RULES

7.3.7.1 *GES actions*

7.3.7.1.1 If the throughput class negotiation (TCN) value in the CONNECTION REQUEST SNPDU is less than or equal to the calculated available throughput value, the throughput class in the INCOMING CALL packet should be set equal to the TCN value; otherwise, the throughput class in the INCOMING CALL packet should be set equal to the calculated available throughput, rounded down to the nearest standard value.

7.3.7.1.2 The selected throughput class in the CALL CONNECTED packet should be transferred from the TCN value in the CONNECTION CONFIRM SNPDU.

7.4 ISO 8208 DCE protocol operations

7.4.1 CONFORMANCE REQUIREMENTS

The capabilities which the ISO 8208 DCE is not required to support include the following:

a) modulo 128 packet sequencing;

b) default window size of more than 2; and

c) either the use of the D-bit or the optional mechanism for negotiating use or non-use of the D-bit since these capabilities are not required by the subnetwork users.

Note.— The use of D-bit or the optional mechanism for negotiating use or non-use of the D-bit is strongly discouraged.

7.5 Management interface

7.5.1 AES MANAGEMENT INTERFACE

When an AES logs off or otherwise terminates communication with a GES, the SSNL clears all connections and SVCs associated with that GES. This may be done by sending CLEAR INDICATION packets to each ISO 8208 DCE logical channel associated with these connections and releasing the resources for the logical channels in the associated SSNDPA entity.

7.5.1.1 *Connectivity notification*

Ways of sending the connectivity notification event messages through an ISO 8208 DCE entity include the following:

— permanent virtual circuit (PVC);

— CALL REQUEST packet with the fast select facility.

The method and formats for conveying connectivity event notifications should be co-ordinated locally between the subnetwork service provider and the subnetwork service user.

7.5.2 GES MANAGEMENT INTERFACE

When an AES logs-off from a GES, the SSNL should clear the connections between the SNS user(s) and the logged-off AES. This may be done by sending CLEAR INDICATION packets to each ISO 8208 DCE logical channel associated with these connections and releasing resources for the logical channels in the associated SSNDPG entity.

8. CIRCUIT-MODE SERVICES

8.1 Circuit-mode voice signalling protocols

8.1.1 *General.* The circuit-mode logic processes defined in Annex 10, Volume III, Part I, Chapter 4, 4.8 represent the minimum set of protocol interactions necessary to ensure interoperability of aircraft earth stations (AESs) and ground earth stations (GESs) operating in the safety service. The protocol interactions necessary to support air and ground-originated calls arriving at the AES or GES are defined via separate signalling procedures in each.

8.1.2 *Special logic for air-originations.* The AES and GES air-origination procedures differ from prevalent aeronautical mobile-satellite service (AMSS) signalling procedures for the non-safety service. The aeronautical mobile-satellite (route) service (AMS(R)S) procedures are specially designed to achieve enhanced and consistent call set-up times for air-originated voice calls at the safety priorities (i.e. distress/urgency, flight safety, and regularity/meteorological) with minimal performance impact from other AMSS traffic.

8.1.3 *Link layer services.* Circuit-mode services use the R, P, and C channel sub-band link layer protocols defined in Annex 10, Volume III, Part I, Chapter 4, 4.5 and 4.6 for all call signalling information exchanged between the AES and GES. This information is exchanged with the link layer via circuit-mode link interface data units (CM-LIDUs). Link layer services perform conversions between CM-LIDUs and the respective AMS(R)S circuit-mode signalling units (SUs). In all cases, only the direct link service (DLS) is used since circuit-mode services are responsible for recovering from missing SUs.

8.1.4 AIR-ORIGINATION PROCEDURES

8.1.4.1 *Aircraft earth station (AES) procedure*

8.1.4.1.1 The AES commences an air-origination by transmitting to the GES a series of four, three, or two contiguous "abbreviated access request" CM-LIDUs. The series length is determined by whether the call priority is distress/urgency, flight safety or regularity/meteorological, respectively. The purpose of the multiple transmissions is to mitigate the effects of an SU lost due to R channel collisions. The AES then awaits receipt from the GES of a C channel assignment CM-LIDU for a period of tA50 seconds. This sequence will be repeated four times before aborting the call attempt. Calls aborted by the AES in this manner must be reattempted by the user.

8.1.4.1.2 At the instant at which the call origination begins, if sufficient AES resources for the call are not available due to blockage attributable to a lower priority call at the AES, the AES will defer pre-emption of these resources and proceed as per 8.1.4.1.1 until a C channel assignment is received from the GES. This will allow the AES to make a proper pre-emption decision based on the exact EIRP assignment from the GES. Upon receipt of the C channel assignment, all required AES C channel resources (i.e. channel unit and AES EIRP) are pre-empted from a lower priority call (if necessary) and allocated to the call. This is followed immediately by further signalling and continuity checks on the C channel sub-band while the GES is engaged in completing the call to the ground destination.

Note.— As a secondary benefit, by requiring that the AES defer pre-emption until a C channel assignment is received, the future development of an alternative procedure incorporating reuse of an existing C channel is facilitated.

8.1.4.1.3 The "abbreviated access request" CM-LIDU contains all digits of the fixed-length 10-digit AMS(R)S ground address. Providing this information concurrent with the access request allows the GES to begin forward completion of the call across the ground network while it proceeds simultaneously with C channel establishment. These address digits are repeated on the C channel sub-band as "call information — service address" CM-LIDUs which serve as a basis for the C channel continuity check procedure. However, their presence in these CM-LIDUs serves no purpose for the AMS(R)S air-origination procedure other than to allow the AES to interwork with a GES which supports prevalent non-safety AMSS circuit-mode procedures rather than the SARPs-specific air-origination procedure.

8.1.4.2 *Ground earth station (GES) procedure*

8.1.4.2.1 Upon receipt of an "abbreviated access request" CM-LIDU from an AES, the GES immediately allocates C channel resources and responds with a "C channel assignment" CM-LIDU. Simultaneously, the GES analyzes the network-ID contained in the access request and begins forward call completion across the selected ground network. It is necessary that the GES perform forward call completion while the C channel is being established so that the over-all delay in completing the call to the ground destination is minimized from the viewpoint of the aircraft user.

8.1.4.2.2 The GES circuit-mode procedure monitors the status of the from-aircraft C channel carrier throughout the call. Loss of carrier for more than tG13 seconds will result in termination of the call by the GES. When this happens, the GES will send six "call progress — channel release" CM-LIDUs during this phase so as to ensure that the AES's call state is cleared. If the AES carrier were to reappear (possibly indicative of anomalous propagation conditions non-conducive to call continuance) the GES will attempt to again clear the AES call by sending six additional "call progress — channel release" CM-LIDUs on the C channel sub-band and one on the P channel.

8.1.4.2.3 When the GES passes the forward call origination to the selected ground network, it must also convey the call priority and the AES and terminal IDs of the originator. This will ensure that the ground network can be sensitive to the call's priority during routing; and that the ground user is always advised of the identity of the originator so as to facilitate return calls to aircraft that a controller may not otherwise be aware of. In those cases where a call is blocked due to an engaged (busy) condition at the ground destination, the GES may, as an option: (1) interpret a specific backward signal from the ground network which indicates that the call attempt has been recorded at the ground destination, and then (2) forward a corresponding CM-LIDU to the AES. This is accomplished by a specific combination of cause codes in the "call progress — channel release" CM-LIDU and the BITE 16 telephony event at the interworking interfaces with the external aircraft and terrestrial networks. This will serve to alert an aircrew that a ground user has been alerted to the existence of the unsuccessful call attempt and has been provided the information necessary to initiate a return call at a later time.

8.1.5 GROUND-ORIGINATION PROCEDURES

8.1.5.1 *Ground earth station (GES) procedure*

8.1.5.1.1 Upon receipt of a call origination from a ground network, the GES commences a ground-origination by allocating GES resources to the call and then sending to the AES via the P channel a "call announcement" CM-LID followed by a "C channel assignment" CM-LID. The GES will then await receipt of the from-aircraft C channel carrier prior to conducting a continuity check on the C channel sub-band. The AES will initiate the continuity check by sending a "call progress — test" CM-LIDU to which the GES will respond with a "call progress — test" CM-LIDU every tG35 seconds until the call is either completed to the aircraft destination or terminated unsuccessfully (e.g. destination busy, call clearing, etc.). The AES will acknowledge receipt of a "call progress — test" CM-LIDU, thereby completing the continuity check, by sending either a positive "telephony acknowledge" CM-LIDU or a "call progress — connect" CM-LIDU. (The latter will have been sent in lieu of the former if the aircraft user answered the call immediately after the continuity check procedure.) The GES will react to either CM-LIDU by forwarding an "address complete" BITE to the ground network and, in the case of the latter CM-LIDU, an "answer" BITE as well. At this point the talk phase of the call may proceed.

8.1.5.1.2 The GES will monitor the status of the C channel for the duration of the call. If a "call progress — connect" CM-LIDU is received during this phase and subsequent to the completion of the continuity check phase, the GES will forward an "answer" BITE to the ground network and maintain the C channel. The GES monitors the status of the from-aircraft C channel carrier throughout the call. Loss of carrier for more than tG19 seconds will result in termination of the call by the GES. When this happens, the GES will send six "call progress — channel release" CM-LIDUs during this phase so as to ensure that the AES's call state is cleared. If the AES carrier were to reappear (possibly indicative of anomalous propagation conditions non-conducive to a usable call) the GES will attempt to again clear the AES call by sending twelve additional "call progress — channel release" CM-LIDUs on the C channel sub-band and one on the P channel.

8.1.5.1.3 If the GES receives a "call progress — channel release" CM-LIDU (indicating that the aircraft user has terminated the call) the GES will forward a "clear back" BITE to the ground network and terminate the call. Similarly, if the GES receives a "clear forward" FITE from the ground network (indicating that the ground user has terminated the call) the GES will send six "call progress — channel release" CM-LIDUs over the C channel sub-band and then monitor the AES to ensure that it has terminated its from-aircraft C channel carrier.

8.1.5.1.4 Events such as unsuccessful continuity checks and call clearing will result in the eventual termination of C channel transmissions from the AES. While these various termination events are progressing, the GES will monitor the from-aircraft carrier to ensure that the AES is performing similar call termination activities. If the from-aircraft carrier has not terminated within tG17 seconds after the transmission of an initial series of "call progress — channel release" CM-LIDUs, the GES will send twelve additional of these CM-LIDUs via the C channel sub-band and a thirteenth via the P channel. If these transmissions are not successful in causing the AES to terminate its C channel transmission within tG18 seconds after the last transmission, the GES will terminate all call activities unilaterally.

8.1.5.2 *Aircraft earth station (AES) procedure*

8.1.5.2.1 An incoming call to an AES is announced by the receipt of "call announcement" and "C channel assignment" CM-LIDUs. Since these are sent on the direct link service, circuit-mode services implements an error recovery procedure whereby the AES can infer that one of these CM-LIDUs is missing (e.g. due to bit errors on the P channel) and request that it be repeated by the GES. The AES initiates the request by transmitting an appropriately encoded "telephony acknowledge" CM-LIDU via the R channel. When an AES has received a "call announcement" CM-LIDU and its associated "C channel assignment" CM-LIDU it will initially verify that the called terminal is available and that adequate C channel resources (i.e. channel unit and AES EIRP) are either available or pre-emptable. If the foregoing requirements are not all met the AES will send an appropriately encoded "call progress — call attempt result" CM-LIDU via the R channel and then terminate all activities for the call. Otherwise, it will activate a C channel unit on the assigned C channel frequency pair and begin the C channel continuity check procedure by sending a "call progress — test" CM-LIDU via the C channel sub-band.

8.1.5.2.2 The AES will send an additional "call progress — test" CM-LIDU every tA26 seconds for tA41 seconds until an identical CM-LIDU is received from the GES. This constitutes a successful continuity check and will immediately cause the AES to: (1) enable the voice circuit between the aircraft voice channel and the C channel unit, (2) forward a "call origination" FITE to the aircraft destination, and (3) send a "telephony acknowledge" CM-LIDU via the C channel sub-band to the GES. The AES will then await tA42 seconds for the aircraft destination to answer the call. If the call is not answered within this time period the AES will clear the call toward the aircraft destination, send six "call progress — channel release" CM-LIDUs to the GES, and then terminate the call. Otherwise, if the aircraft destination answers within this time limit the AES will send a "call progress — connect" CM-LIDU to the GES and maintain the C channel during the talk phase of the call.

8.1.5.2.3 When the "call progress — connect" CM-LIDU is sent, the AES will initiate an error recovery procedure to ensure its receipt at the GES. (The talk phase progresses in the interim.) Timer tA26 is used to implement a transmission repeat cycle for this CM-LIDU which must result in receipt at the AES of a "telephony acknowledge" CM-LIDU within tA30 seconds of the original transmission. Failure to receive the acknowledgement within tA30 seconds will cause the AES to terminate the call.

8.2 Interworking of circuit-mode services with other voice networks

8.2.1 *AMS(R)S circuit-mode procedures.* A standardized set of circuit-mode procedures within the AES and GES implement the AMS(R)S circuit-mode protocols and provide specific interfaces with non-AMS(R)S telephony interworking procedures. The AMS(R)S circuit-mode procedures correspond to specific AES and GES circuit-mode processes and represent the highest level of functionality contained in the AMSS SARPs. The interworking procedures, although physically contained within the AES and GES equipment, represent the initial "layer" of functionality immediately adjacent to and external from the AMS(R)S circuit-mode procedures. The interworking procedures represent the functional area where specific conversions between the AMS(R)S circuit-mode procedures and user or service provider-specific signalling implementations are effected. The interworking protocol between the AMS(R)S circuit-mode procedures and the interworking procedures is defined using a standard set of interworking telephony events.

8.2.2 *Interworking with external telephony systems.* Interworking is the controlled transfer of signalling information across the interface between different signalling systems where the significance of the information is identical or where the significance is translated in a defined manner.

8.2.2.1 *Interworking protocol basis.* The interworking protocol is defined through the use of a set of forward and backward interworking telephone events (FITEs and BITEs). The interworking telephone events that are used herein to define the interworking protocol are a subset derived from the standardized definitions contained in CCITT Recommendation Q.608. Defining the interworking protocols on the basis of FITEs and BITEs is in conformance with standard telephony system practice. It should be noted that the use of FITEs and BITEs is merely a convenient nomenclature and in no way places dependencies on specific equipment implementations.

8.2.2.1.1 *FITE.* A FITE is an event where telephony signalling information is transferred in the forward direction from an incoming signalling system to an outgoing signalling system. The "forward" direction of a FITE is referenced to the fact that a FITE propagates in a direction that is away from the originating end of a call. Certain FITEs may also carry mandatory and optional information elements pertinent to the event (e.g. address digits).

8.2.2.1.2 *BITE.* A BITE is an event where telephony signalling information is transferred in the reverse direction from an outgoing signalling system to an incoming signalling system. The "backward" direction of a BITE is referenced to the fact that a BITE propagates in a direction that is toward the originating end of a call. Certain BITEs may also carry mandatory and optional information elements pertinent to the event (e.g. call attempt result information).

8.2.3 AES TELEPHONY INTERWORKING

8.2.3.1 *Relationship of AES signalling systems.* Figure A-18 of this guidance material depicts the relationship between the AES circuit-mode procedures, their respective interworking procedures, and aircraft-specific telephony signalling implementations. In particular, the referenced figure defines both the usage of "incoming" and "outgoing" procedures from the viewpoint of the originating call party and the external interface of the AES circuit-mode procedures.

8.2.3.2 *AES interworking telephony event definition.* The AES circuit-mode procedures interwork with aircraft telephony signalling systems via the forward and backward interworking telephony events defined in the Standards. The AES circuit-mode procedures must map specific interworking telephony events to specific protocol interactions in the AES circuit-mode logic procedures where interactions with an aircraft signalling system are required. This mapping must also include parameter mapping where indicated in the Standards.

8.2.3.3 *Aircraft telephony interworking.* An on-aircraft telephony network is not to be required to implement any type or manner of physical network implementation. Any particular implementation is at the option of the aircraft operator as long as that implementation is made to interwork with the AES circuit-mode procedure's interworking protocol.

Note 1.— An aircraft operator might choose to not implement a discrete aircraft telephony signalling network external to the AES equipments. At their option, a "call control agent" function could be integrated within the AES equipments in such a manner as to eliminate the need for a discrete aircraft signalling network.

Note 2.— In those cases where an AES is configured to sustain more than one simultaneous ATS call, the aircraft's called terminal addresses should be configured into one or more appropriate "hunt groups". This will reduce the incidence of ground-originated calls to a specific called terminal being blocked by an engaged condition when an equally appropriate called terminal is available.

8.2.4 GES TELEPHONY INTERWORKING

8.2.4.1 *Relationship of GES signalling systems.* Figure A-19 of this guidance material depicts the relationship between the GES circuit-mode procedures, their respective interworking procedures, and ground-specific telephony signalling implementations. In particular, the referenced figure defines both the usage of "incoming" and "outgoing" procedures from the viewpoint of the originating call party and the interworking interface of the GES circuit-mode procedures.

8.2.4.2 *GES interworking telephony event definition.* The GES circuit-mode procedures interwork with terrestrial network telephony signalling systems via the forward and backward interworking telephony events defined in the Standards. The GES circuit-mode procedures must map specific interworking telephony events to specific protocol interactions in the GES circuit-mode logic procedures where interactions with a terrestrial network signalling system are required. This mapping must also include parameter mapping where indicated in the Standards.

8.3 Implementing satellite voice in the ATS environment

8.3.1 *Overview.* The AMS(R)S voice service has basic operational attributes which fundamentally differ with prevalent very high frequency (VHF) and high frequency (HF) voice operations. This will require close attention to how satellite voice is implemented in a data link-oriented ATS environment. These differences include a statistical delay in speech channel establishment, a perceptible delay in speech propagation, circuit-switched operation, full-duplex operation, and the inability for aircraft to monitor communications between the ground and other aircraft. Additionally, the AMS(R)S voice service places functional requirements on terrestrial facilities which are external to the GES (e.g. terrestrial networks and ACF automation equipment) in order to maximize its utility.

8.3.2 *Channel establishment delay.* Upon call origination, each user must provide to its respective AES or GES the telephone number of the desired destination and then wait for the system to establish a speech channel. This is in sharp contrast with conventional radio operations where typically each user maintains a continuous listening watch on a radio channel. In addition, the channel establishment delay is statistical in nature and is dependent upon the over-all traffic load on the AMSS system.

8.3.3 *Call annunciation.* It is anticipated that aircraft operators will integrate the satellite voice equipment with other aircraft systems in a manner very similar to current VHF and HF radio equipment. This may lead to minor inconsistencies in how voice calls are managed on different aircraft. For instance, interwiring satellite voice equipment with existing aircraft audio control panels may lead to inherently half-duplex operation on certain aircraft even though all of the intervening speech channels are full-duplex. Incoming air-originated calls will, in many cases, be annunciated to the aircrew via a SELCAL chime or other audible indication, and will require a crew action to answer the call. This means that a ground user must await a positive answer indication (e.g. crew voice response) before speech can begin. Otherwise, there would be no assurance to the ground user that the call is audible to the crew. This particular aspect is quite important given the expectation that:

a) satellite voice calls will be very infrequent in a data link oriented environment; and

b) the inability of an aircrew to monitor satellite voice communications by other aircraft precludes positive, routine assurance that the proper aircraft audio panel selections have been made.

8.3.4 *Aircraft call management.* Aircraft flight management computer systems can be useful in managing routine aspects of voice call management for the aircrew. For instance, ground number directories and selection menus can be provided by these systems so that the need for an aircrew to enter discrete telephone numbers on a control/display device can be minimized. These systems could also correlate with directory information the associated data link end-system address information or the aircraft's position in order to recommend an appropriate ground address for use in an ATC call. However, it should be noted that the crew must be able to select or otherwise imply the appropriate priority of a call attempt prior to origination.

8.3.5 *Air-originated call information.* When the GES forwards an air-originated call to the terrestrial network, the call indication will include, in addition to the desired ground address, the call's priority, and the AES-ID and calling terminal-ID associated with the call. (Annex 10, Volume III, Part I, Appendix 5 to Chapter 4, Figure A5-28 refers). The call priority can be used by the terrestrial network to facilitate a potential pre-emption action within that network and to notify the ground destination of the call's priority in cases where the ground user might be servicing other calls. The AES and terminal ID information is provided so as to facilitate correlated routing (8.3.6) of the call (by an ACF or other facility) to the proper destination within that facility as determined by the facility's information concerning the aircraft.

8.3.6 *Correlated routing.* Call routing functions within a facility should be able to determine the proper internal destination to which a call should be routed based on the facility's current data pertaining to the aircraft. This requires that the facility correlate the originating aircraft's AES-ID (see 8.3.5) with information that it may have concerning the aircraft and then route the call to the relevant ground user. Consideration should be given to the establishment of a universal default agent code in the AMS(R)S ground numbering plan (e.g. "000") which would be known to all facilities to be an implied request by the aircrew to provide the correlation function. The remaining 999 code values in the agent code field would remain available for discrete ground user addresses within a facility.

8.3.7 *Facility incoming call management.* The ground user should have several options available for those instances when an air-originated call arrives while they are conducting a pre-existing call with another aircraft. A ground user should be able to combine any reasonable number of satellite voice calls in a conference so that the communications service can be managed in a manner similar to a VHF radio channel if the ground user so chooses. This can be implemented with a conventional telephony conference bridge situated between the ground user and the terrestrial voice network. In addition, the ground user should receive an immediate presentation of the call information listed in 8.3.5 for all arriving calls so as to facilitate a proper call handling decision. Examples of two possible operational modes are as follows:

a) *Barge-in.* All arriving calls for an individual destination are automatically answered by an automation function on behalf of the ground user; and are placed in a multi-way conference consisting of the ground user and any existing calls. This is intrinsically the simplest mode of operation in that it allows all users to immediately contend for the ground user's attention by listening for any active conversation just as in VHF radio. Barging in to an active conversation, however, would require that the caller tie up a C channel resource while waiting for the previous conversation to end.

b) *Serial access with priority override.* An arriving call for an individual destination is automatically answered by an automation function on behalf of the ground user. Any additional calls arriving at a priority equal to or lower than an existing call receive a "busy" indication and are cleared automatically. Any additional calls arriving at a priority higher than an existing call are answered automatically and conferenced with any call(s) that the ground user is currently conducting. This allows only higher priority calls to "barge-in" on existing calls. It also allows a calling aircrew (at the higher priority) to gain the ground user's attention verbally without needlessly terminating an existing lower priority call.

8.3.8 *Aircraft microphone push-to-talk operation.* The AMSS voice channel provides a bi-directional audio path which is inherently full-duplex. However, it is strongly recommended that conventional (i.e. VHF-like) half-duplex push-to-talk (PTT) operation be maintained in all aircraft installations — but only to the extent that the flight crew must actuate a PTT key in order to be heard by the ground user. In other words, to-aircraft audio should always be audible in headphones without muting when the PTT key is actuated. (Designers should still pay due attention to cockpit speaker muting when a microphone is keyed.) This will allow the crew to manage the satellite voice conversation in consideration of other concurrent flight deck activities. In addition, enforced PTT operation will help ensure that the potential future use of audio conferencing at a ground user workstation is not impaired by uncontrolled cockpit ambient noise (i.e. from "hot" microphones) in those instances where a controller has several satellite voice calls operating simultaneously.

8.3.8.1 Flight crews should be able to override enforced half-duplex operation so they can take advantage of the full-duplex voice channel when the operational situation warrants (e.g. in-flight medical emergencies).

8.4 Terrestrial voice network considerations

8.4.1 *Overview.* The AMSS SARPs provide for the implementation of a shared, common-user terrestrial voice switching network that interconnects each GES with one or more ground facilities expressly for aeronautical safety communications. This network can be composed of one or more subnetworks operating in tandem to provide the appearance of a single cohesive network service between GESs and external ground facilities (e.g. ACF, aircraft dispatch, etc.) This network should be separate and distinct from other networks which may be attached to a GES for non-safety purposes (e.g. the public switched telephone network).

8.4.2 *Access control.* For air-originated calls, access to the terrestrial safety network is achieved by the AES encoding the access request signalling with a network-ID value of "10". This value will indicate to the GES that the call shall be routed to the terrestrial safety network and that all specific signalling information must be included with the call indication. AES implementations should be subject to certification provisions that ensure that it will not be possible for non-safety users on an aircraft to gain access to the terrestrial safety network.

8.4.3 *Routing analysis.* For air-originated calls, the GES will not analyze the ground address information contained within an access request other than to interpret the network-ID value for selection of the proper terrestrial network (i.e. "10"). Upon receipt of the call indication from the GES, the terrestrial safety network must interpret the country and facility code fields contained in the call information and route the call to the proper facility as required. For ground-originated calls, the originating facility must provide the terrestrial safety network with the ID of the desired GES along with the other call information (i.e. AES-ID, terminal-ID, and call priority) when the call indication is conveyed to the network.

8.4.4 *Call routing functions.* Call routing functions external to the GES can be categorized as being either high-level routing between GESs and ground facilities, and low-level routing carried out within a facility.

8.4.4.1 *High-level routing.* For air-originated calls, high-level routing consists of the terrestrial safety network interpreting the country and facility codes which are contained in the ground address and routing the call to the network's terminus with the proper facility. For ground-originated calls, high-level routing consists of the terrestrial safety network interpreting the GES-ID which was received in the call information from the originating facility and routing the call to the network's terminus with the proper GES.

8.4.4.2 *Low-level routing.* When an air-originated call reaches the desired facility over the terrestrial safety network, a low-level routing function within the facility must interpret the agent code contained within the call information and then route the call to the indicated ground user. It should be noted that, if the agent code value indicates that the call must be correlated with other aircraft information at the facility, the low-level routing function must also interpret the AES-ID contained within the call information and then route the call within the facility based on the correlation results.

8.4.5 *Terrestrial network implementation alternative.* Particular switching network architectures are not mandated for the terrestrial safety network. For instance, individual agreements between AMSS service providers and either administrations or aircraft operators may provide for the integration into the GES equipments of some or all of the high-level routing functions. This would then require that the GES perform the routing tasks described in 8.4.4.1 and route calls to individual facilities via dedicated GES-to-facility trunk groups.

8.4.6 *Pre-emption.* The terrestrial safety network, and/or its individual tandem subnetworks are required to pre-empt and reallocate any resource assigned to an existing call when that call is blocking the completion of a higher-priority call attempt. The incidence of pre-empted calls can be minimized by reserving one or more channels within all voice trunk group for high priority calls (e.g. distress/urgency).

8.5 Implementing the group call/broadcast functions

8.5.1 *Overview.* Under certain conditions a ground user may desire to establish a ground-originated conference call (a group call) with several aircraft at once. Similarly, there may be occasions where there is a need to establish a one-way broadcast to a group of aircraft (a group broadcast). Although the group call and group broadcast functions are not explicitly provided for in the AMS(R)S system protocols, equivalent functions can be readily catered for by implementing several basic call origination functions in the facility automation system.

8.5.2 *Group call.* The group call function can be effected by requiring that the ground user (or an associated automation service) place independent calls to each aircraft designated by the user to be in the group call or "conference". Separate, parallel calls through the terrestrial network and AMSS satellite service would then be established for each aircraft in the conference. The use of individual voice calls for each aircraft in the group can be easily implemented and it also facilitates the centralized management of aircraft entry-to and exit-from the conference by the user. Except for the facility automation functions and the low-level voice switching equipment serving the ground user, no other intervening tandem network (terrestrial or AMSS) need do any specialized call processing in order to establish a group call.

8.5.2.1 The terrestrial network equipment immediately adjacent to the ground user should provide an audio conference function on behalf of the user whereby all aircraft in the conference can hear speech audio generated by other aircraft as well as the ground user. This will provide a passive means to serialize access to the ground user that is identical to that of VHF radio except for the satellite delay effects. Additionally, the facility automation function should also manage the "list" of aircraft in the group so that the ground user can be constantly aware of the presence — or absence — of each aircraft in the group call.

8.5.2.2 During group call origination, the individual aircraft speech channels in a group call cannot be expected to begin operation simultaneously. This is because: (1) the call announcement signalling arriving over the P channel will not reach all aircraft in the group call simultaneously, (2) C channel establishment delay after receipt of this signalling will vary, and (3) all aircrew in the group may not be able to answer the incoming call simultaneously due to primary attention to flight deck duties. This latter human factors issue has the potential to cause considerable confusion as various aircrew answer the call and enter the group conference, especially if the aircrew are not aware that an incoming call is a group call. The risk of this confusion can be mitigated if the aircrew can be advised that an incoming call is actually a group call so that they can remain quiet on the circuit until the ground user begins speaking. One way to accomplish this is for the facility automation function to transmit a repetitive audio alert tone sequence or recorded verbal advisory until all aircraft have answered the call and are ready to participate in the conference.

8.5.3 *Group broadcast.* The procedures for group broadcast can be identical to those of group call except that the conference function provided by the facility should not convey or relay any air-to-ground audio that might inadvertently arrive from aircraft in the broadcast group. As in the case of group call, human factors considerations may require that there be some way to indicate the arrival of a one-way group broadcast to the aircrew.

8.6 Implementing the call registration function

8.6.1 *General.* Under normal circumstances, an ATS specialist who has available an AMS(R)S voice communications service should be able to receive and maintain concurrent air-originated calls from a reasonable number of aircraft. (Paragraph 8.3 provides further guidance on how this may be implemented.) However, there may be operational situations where the ATS specialist wishes either to bar incoming calls or to service arriving calls one at a time — in other words return a "busy" indication to calling aircraft. In these instances, good operational practice should include both making an automatic record of the call attempt for the ATS specialist (call "registration") and advising the aircrew that their failed call attempt has been registered. This notification to the aircrew would carry an implied intent on the part of the ATS specialist to originate a subsequent reciprocal call to the originating aircraft at the first opportunity.

Note.— Paragraph 8.3.5 describes the air-originated call information elements that can be used by the terrestrial facilities to accomplish call registration. The GES and terrestrial network facilities are required to convey this information to the ground user facility.

8.6.2 *Signalling of the call registration event.* The AMSS SARPs require that a call attempt to a busy destination be deemed unsuccessful and that a "call unsuccessful — called party busy" event (BITE 16) then be generated by the end-user's network facilities. (Intervening telephony signalling systems, including those of the AMS(R)S subnetwork, convey this event to the aircrew.) The call registration event is considered a variation of the BITE 16 event and it is carried over the AMS(R)S subnetwork by a unique code value in the cause value parameter of the AMS(R)S "call progress — channel release" LIDU (Annex 10, Volume III, Part I, Appendix 5 to Chapter 4, Figures A5-7 and A5-34 refer). Both terrestrial network facilities and network-specific telephony interworking logic within the GES must support the conveyance of this backward signal to the GES's air-origination logic procedure if the recommended call registration facility is implemented.

8.7 Notes on the AMS(R)S air-origination procedure

8.7.1 *General.* The procedures defined in the AMSS SARPs for use in air-originated AMS(R)S calls differ from other prevalent AMSS procedures which may be in use for non-safety calls (e.g. aeronautical public correspondence). The AMS(R)S procedures provide comparatively shorter and more consistent access delay performance for calls originated at the safety priorities.

8.7.2 ACCESS REQUEST PHASE

8.7.2.1 *Abbreviated access request SU.* An "abbreviated access request" SU is used in the AMS(R)S procedures as a means to deliver all call information (i.e. ground address and calling terminal-ID) to the GES concurrent with the R channel access request. This eliminates the need for the GES to await receipt of this information on the C channel sub-band as is the case for the prevalent non-AMS(R)S procedure.

8.7.2.2 *Series transmission of redundant access requests.* In order to mitigate the effects of R channel collisions on circuit-mode access delay performance, the AES will send a short series of identical abbreviated access request SUs upon both the initial access attempt and each of the four subsequent attempts (which are initiated by expiry of timer tA50) for a total of five attempts. The quantity of identical SUs in the series increases with increasing call priority. The probability of receiving at least one abbreviated access request SU at the GES upon each of the five attempts over an R channel loaded to 15 per cent is depicted in Table A-12 of this guidance material. (The table brackets the expected performance by depicting two cases where all conflicting R channel traffic from other AESs comprises either 1-SU bursts or 3-SU bursts.)

8.7.3 *Simultaneous set-up of circuit segments by the GES.* In addition to the enhanced delivery reliability for the abbreviated access request SU as described in 8.7.2.2, end-to-end access delay performance is further aided by the GES beginning forward completion of the call across the terrestrial network at the same instant at which the GES allocates C channel resources and begins C channel establishment in the backward direction. Immediate initiation of forward call completion is possible because the AMS(R)S abbreviated access request SU contains **all** necessary call information as described in 8.7.2.1. By establishing both the satellite and terrestrial segments of the end-to-end call concurrently, the limiting factor in end-to-end access delay (after receipt of the abbreviated access request SU) is the longer of either the terrestrial network call completion delay **or** the C channel establishment delay — but not the sum total of both delays as would be typical of the non-AMS(R)S procedure.

8.7.4 *AES interworking with non-compliant GES.* There may be certain AMS(R)S service areas where one or more GESs are not equipped to support the AMS(R)S air-origination procedure (e.g. prior to a mandatory ICAO implementation date). The AMS(R)S procedure as defined for the AES accommodates this by being inherently compatible with both equipped and non-equipped GESs (mode switching or crew intervention are not necessary). Specific attributes of the AMS(R)S air-origination procedure that allow an equipped AES to interwork with both types of GESs are as follows:

a) the format of the abbreviated access request SU is identical to that of the equivalent non-AMS(R)S access request SU except that the digit No. 2-9 and terminal ID fields are designated as reserved in the latter SU. This allows a non-equipped GES to interpret the call attempt as it would for a non-AMS(R)S call (i.e. the call information extracted from the SU is identical to that for a non-AMS(R)S call);

b) equipped and non-equipped GESs will discard any redundant copies of an access request SU. Therefore, receipt by the GES of multiple copies of the abbreviated access request SU will not result in call processing logic errors (multiple receipt may occur in the absence of R channel collisions or if timer tA50 has expired before the AES has received a C channel assignment SU); and

c) the C channel sub-band signalling and continuity test logic for equipped and non-equipped AESs and GESs is identical. Of particular note is the fact that an equipped AES will repeat the digit No. 2-9 and terminal ID fields (from the abbreviated access request SU) on the C channel sub-band in a manner identical to that of a non-equipped AES. This particular aspect of the AMS(R)S procedure is key to the ability for an equipped AES to interwork with any GES.

Note.— The end-to-end access delay performance through a non-equipped GES will not correspond to that realized when an equipped GES is in use.

8.8 Circuit-mode access delay performance

Note.— Except where noted, projections of end-to-end circuit-mode access delay performance are based on R and P channels operating at channel rates of 10 500 bits/s.

8.8.1 *Air-originated calls.* Paragraphs 8.7.2 and 8.7.3 describe the special attributes of the AMS(R)S air-origination procedure that result in enhanced access delay performance for the safety versus non-safety user. With respect to the concurrent set-up of both C channel and terrestrial network resources (8.7.3), the benefits of this improved procedure are most apparent when the access delay component that is incurred within the terrestrial network facilities is no greater than that which is incurred by C channel establishment. As a point of reference it should be noted that the GES will require a minimum of six seconds (latency) to establish a C channel — measured from the time at which the C channel assignment SU is enqueued for P channel service. This implies that to derive maximum benefit from the enhanced air-origination procedure, the terrestrial network facilities should impart no more than an equivalent delay component to the end-to-end access delay performance — including the time for the answer indication to flow in the backward direction.

8.8.1.1 *GES C channel demodulator acquisition delay.* Annex 10, Volume III, Part I, Chapter 4, 4.3.4.4 allows three seconds (99 per cent) for the GES C channel demodulator to recover the received carrier and achieve frame lock (this is included in the aforementioned six-second minimum for the GES to establish a C channel after it has received a request). The AMSS SARPs further recommends that implementors achieve shorter acquisition times. This delay has a direct effect on the minimum achievable end-to-end delay in those cases where the terrestrial network is able to provide an access delay component of less than six seconds (8.8.1).

8.8.1.2 *End-to-end access delay for air-originations.* If one can assume that the delay component which is attributable to the terrestrial network facilities can be constrained to be no greater than the component attributable to C channel establishment, then end-to-end access delay in the absence of any significant contending P channel traffic can be as short as eight seconds (95 per cent) for air-originations. If a GES is provisioned with C channel demodulators which exhibit acquisition performance akin to that of the AES's burst mode of operation, then a five second (95 per cent) end-to-end access delay figure is possible provided that the terrestrial network facilities can provide an equivalent improvement in performance.

8.8.2 *Ground-originated calls.* The AES and GES logic procedures for ground-originated AMS(R)S calls are essentially identical to those of the prevalent non-safety AMSS procedures. The expected access delay component that is attributable to the AMS(R)S subnetwork in the absence of any significant contending P channel traffic is projected to be six seconds (95 per cent). (Inclusive of three seconds for GES C channel demodulator acquisition overhead). A terrestrial network facility delay component of four to six seconds will result in an expected end-to-end access delay of 10 to 12 seconds (95 per cent). Improvements in either terrestrial network or GES demodulator overhead will yield an equivalent improvement in the end-to-end delay performance.

8.8.3 *Projections of AMS(R)S subnetwork call set-up delay.* The call processing delays in Annex 10, Volume III, Part I, Chapter 4, 4.8.4.1 specify only the components of AMS(R)S call set-up delay attributable to the performance of AES and GES equipment. These performance parameters, while not entirely deterministic in nature, are not likely to exhibit a significant statistical variance. This is because the parameters are specified as maximum internal processing delays exclusive of any transmission delays or queuing delays for link layer service such as that which might be experienced by a telephony signalling CM-LIDU awaiting P channel transmission. However, the over-all AMS(R)S subnetwork delay to establish an air or ground-originated call, which will be subject to the statistical performance of the link layer, is likely to be of interest to system planners. Based on simulation studies using a traffic model identical to that used to determine the packet-mode performance requirements in Annex 10, Volume III, Chapter 4, 4.7. AMS(R)S subnetwork call set-up delay performance for air and ground-originated calls is projected to be as depicted in Table A-13 of this guidance material.

Note.— Each performance parameter is applicable to all AMS(R)S priorities except for those parameters expressed as a range of values for highest to lowest priority.

8.9 Subjective voice quality evaluation

8.9.1 *General.* The end-to-end performance requirements that were used to establish a basis for the BT laboratories voice encoding algorithm have been characterized in terms of intelligibility and acceptability. Intelligibility has been measured using the diagnostic rhyme test (DRT) or modified rhyme test (MRT), and acceptability has been measured using the diagnostic acceptability measure (DAM) or mean opinion score (MOS).

8.9.2 *Intelligibility.* Intelligibility based on DRT or MRT was demonstrated to be 92 per cent or better under quiet conditions and 87 per cent or better when subjected to noise levels of up to 87 dB, referenced to 0.0002 microbar using a C-weighted curve.

8.9.3 *Acceptability.* Acceptability based on DAM (or MOS) was demonstrated to be 58 (3.75 out of 5.0) or better under quiet conditions and 53 (3.25 out of 5.0) or better when subjected to noise levels of up to 87 dB, referenced to 0.0002 microbar using C-weighted curve.

Note 1.— 87 dB is the ambient noise level of the military E4B aircraft. The 87 per cent DRT is based on using a noise cancelling microphone in an aircraft noise environment and an intermediate reference system (IRS, CCITT Red Book, Recommendation P.48, Volume V, 1985) handset in an office or ATC room environment.

Note 2.— These voice quality standards are minimum standards measured at a BER of $1x10^{-3}$.

9. AIRCRAFT EARTH STATION (AES) MANAGEMENT

9.1 General

Annex 10, Volume III, Part I, Chapter 4, 4.9 defines the minimum set of requirements that the AES management must meet in order to ensure interoperability. This chapter of the guidance material describes issues related to the AES management SARPs.

9.2 AES management interfaces

The AES management is described in the AMSS SARPs as an entity which interfaces to other AES entities, such as the link and subnetwork layers. The interfaces are defined in terms of the information exchanged between the AES management and these other entities and are shown in Figure A-20 of this guidance material. No formats of the exchanged information are specified in the AMSS SARPs. Such formats are considered to be implementation dependent.

9.3 AES management functions

9.3.1 AES TABLE MANAGEMENT

9.3.1.1 Two sets of information are required to be maintained by the AES. These sets of information are given in the AMSS SARPs in the form of tables, namely the system table and the log-on confirm table. The specifics of storing this information in the AES are not regulated by the AMSS SARPs, they are implementation dependent.

9.3.1.2 The information listed under "system table" is provided by the GES. This information contains the necessary search frequencies to enable the AES to select a satellite, a beam, and a GES in order to carry out the log-on procedure. Thus, it is mandatory that this information be current in the AES prior to logging on. The currency of the system table information is maintained at the AES by monitoring the system table broadcast sequences transmitted by the GES as stated in Annex 10, Volume III, Part I, Chapter 4, 4.9.3.2.3.1.

9.3.2 AES LOG STATUS MANAGEMENT

9.3.2.1 *Satellite, beam and GES selections*

9.3.2.1.1 Depending on the geographical location of the aircraft, the AES may have more than one option for the selection of a satellite, beam, and GES combination. The AMSS SARPs provide the flexibility of allowing the AES management to select the most desirable combination at a given time. The only requirement imposed on the selection is the AES capability of receiving an adequate signal on the selected GES P_{smc} channel.

9.3.2.1.2 The information used by the AES management in making its selection is contained in the AES system table. A GES is uniquely identified by the frequency of its P_{smc} channel transmitted within a specific beam in the service area of a given satellite. A satellite is uniquely identified by one or more sets of satellite/beam-identifying P_{smc} channel frequencies. Each set contains at least two frequencies and is associated with the ID of the beam within which the associated P channels are transmitted. If the satellite identification is made via the global beam (beam ID=0), the AES management may further attempt to select a spot beam, if any exist. For a satellite service area with spot beam only, the satellite identification will be made via a spot beam, thus the satellite and the spot beam selections are made concurrently.

9.3.2.2 *Log-on procedure*

9.3.2.2.1 *Log-on initiation.* As prescribed by the AES management AMSS SARPs, the log-on procedure could be initiated by the receipt of a log-on command. The log-on command could specify the GES and/or the satellite to be selected to log on. These AMSS SARPs specify neither the source nor the format of such command. The source could be external to the AES relaying the command to the AES management on a specific interface. The format is implementation dependent.

9.3.2.2.2 *Distress indication.* The AES management AMSS SARPs provide for a capability for the AES to indicate, at log-on, a distress condition to the GES management. In order to indicate such a condition, the AES management sets the "Q number of application" field to 15 in the log-on request SU. In such a case, the AES would expect the GES not to reject the log-on. However, the GES may elect not to process any AES message that is not at the distress precedence level.

9.3.2.2.3 *Log-on rejection.* Several reasons have been identified for the GES rejection of an AES log-on request. A list of these reasons is given in Annex 10, Volume III, Appendix 3 to Chapter 4. No specific AES responses corresponding to the specified rejection reasons have been given in the AMSS SARPs. Such responses are implementation dependent. However, the AMSS SARPs further classify the rejection reasons into three categories: permanent unavailability, temporary unavailability, and invalid parameters. The response of the AES management to a rejection reason could be defined in accordance with the category of the rejection reason in the following manner:

permanent unavailability: cease further log-on attempts to the same GES;
temporary unavailability: re-attempt log-on to the same GES, only as a least preference;
invalid parameters: re-attempt log-on to the same GES, only with different parameters.

9.3.2.3 *Universal time broadcast*

Some applications on the aircraft may need to be synchronized with the counterpart applications on the ground. The AMSS SARPs contain recommendations for support of a time synchronization facility at the AES and the GES. Thus, for interoperability consideration, a universal time signal unit (Annex 10, Volume III, Part I, Appendix 2 to Chapter 4, Figure A2-35) containing the current time to the nearest second, synchronized to the UTC standard has been defined in the AMSS SARPs. Upon receipt of a universal time SU from the GES, the AES may provide the received time information to the appropriate applications on the aircraft. The method selected by the AES to provide this time information to an application is implementation dependent.

9.3.2.4 *User commands*

9.3.2.4.1 The AMSS SARPs specify the AES responses to a minimum set of commands intended to influence some of the AES operations. Such commands may be initiated either prior to (Annex 10, Volume III, Part I, Chapter 4, 4.9.3.3.3.1) or after (Annex 10, Volume III, Part I, Chapter 4, 4.9.3.3.4.2) the AES log-on. Neither the sources nor the formats of such commands are specified in the AMSS SARPs. Such sources may be internal or external to the AES and operating in accordance with some stimulus criteria to satisfy a particular user requirement, such as continuity of service. For example, a stimulus criterion to invoke a beam-to-beam handover could be based on the knowledge of the beam pattern of a given satellite and the position and heading of the aircraft. The formats of the handover commands are implementation dependent.

9.3.2.4.2 *Handover commands*. The handover commands specified in the AMSS SARPs are intended to enable the AES user to alter the AES log-on conditions in various ways, as deemed suitable by the user.

9.3.2.4.2.1 A GES-to-GES handover command could be issued by the AES user in order to:

a) renew the log-on to the same GES but through a different spot beam;

b) to switch the log-on to a different GES in the same satellite service area, either through the same or a different spot beam.

Such command may have to specify the GES ID and spot beam ID when those IDs are different than the current values. Circuit-mode calls in a Level-4 AES (multiple transmit and receive channel units) are not effected by the execution of this command. Level-3 AES operation is as specified in Annex 10, Volume III, Part I, Chapter 4, 4.9.3.3.4.2 b).

9.3.2.4.2.2 A satellite-to-satellite handover command could be issued by the AES user in order to switch the AES log-on to a new GES within the service area of another satellite. Any circuit-mode call established through the current satellite will have to be forcibly terminated after a fixed period of time prior to switching to the new satellite. In the AMSS SARPs, this period of time is set to 3 minutes. If the AES was unable to tune to any of the listed satellite/beam-identifying P_{smc} channels of the new satellite, the AES may revert back to the previous satellite or any other satellite in view.

9.3.2.5 *P channel loss/degradation*

9.3.2.5.1 P channel loss/degradation declaration is conveyed to the AES management in the form of an indication from the AES physical layer (P channel receiver). The criterion on which such declaration is based is given in Annex 10, Volume III, Part I, Appendix A to Chapter 4. If the P channel loss or degradation is caused by the aircraft flying out of the selected beam coverage, the P channel loss/degradation declaration will cause the AES management to search for a new GES, within the same or a different satellite service area, and log-on to it. However, the loss/degradation of the P channel would cause an undesirable discontinuity of both data and voice services. Therefore, the use of such practice is not advisable as a means to invoke an AES handover. The handover commands described in Annex 10, Volume III, Part I, Chapter 4, 4.9.3.3.4.2 b) and c) provide a more controlled means to invoke AES handovers.

9.3.2.5.2 Because all R and T channel transmissions are synchronized to the framing format of the P channel, and in order to ensure positive control of the AES from the GES, such transmissions must cease with the loss of the P channel.

9.3.3 AES CHANNEL MANAGEMENT

9.3.3.1 *Voice-voice pre-emption*

9.3.3.1.1 Several circuit-mode calls could be contending for the limited resources in the AES. In such cases, the establishment and continuation of a circuit-mode call is regulated by the priority and pre-emption requirement of Annex 10, Volume III, Part I, Chapter 4, 4.8.3.2 according to the precedence of the Q number assigned to the C channels carrying the calls. The C channels Q number assignment for the various categories of voice transactions is given in Annex 10, Volume III, Part I, Chapter 4, Table 4-43.

9.3.3.1.2 Various requirements are included in the AMSS SARPs in order to enforce the priority and pre-emption statement of Annex 10, Volume III, Part I, Chapter 4, 4.8.3.2 in the AES. In this regard, the circuit-mode services will only request the assignment of a transmit/receive channel unit pair from the AES management if, and only if, there are either sufficient resources available or at least one of the circuit-mode calls in progress has at a Q number strictly lower than the Q number of the call being established. In the latter case, the AES management will make available the channel units being used by the call in progress to support the call being established.

9.3.3.2 *Level 3 AES voice/data arbitration*

In a Level 3 AES, a single transmit channel unit is shared among the R, T and C channels. The arbitration between the R channel and the T channel is resolved in the AMSS SARPs by considering that the T channel signal unit (SU) transmissions, regardless of the Q number of the SUs, have precedence over the SUs transmission on the R channel. However, a minimum number of "gaps" in the T channel slot reservations to a particular aircraft are required to ensure that the R channel transmission are not totally blocked (Annex 10, Volume III, Part I, Chapter 4, 4.6.5.3.3). Arbitration between the C channel and the R or T channels is accomplished according to the priorities of the transactions on these channels. The specific requirements for such arbitration are given in Annex 10, Volume III, Part I, Chapter 4, 4.9.3.4.1.4. It should be noted that the AMSS SARPs do not require that an established voice call be terminated if the transmission of a higher precedence data message is required; rather, such action is optional. An alternative scheme allowed by the AMSS SARPs would be to cease transmission on the C channel long enough to transmit any higher precedence signal units in the AES link layer and then reassign the transmit channel unit to the C channel.

10. GROUND EARTH STATION (GES) MANAGEMENT

10.1 General

10.1.1 Ground earth station (GES) management functions specified in Annex 10, Volume III, Part I, Chapter 4, 4.10 are mandatory for each GES implementation. The GES management includes functions to manage the AES log-on to a GES, to control the assignment of P, R and T channels for data and signalling transfer, to reassign new channels on detection of an excess loading on a channel, to assign C channel frequencies on-demand, to control the power of the assigned C channels, to update the system table and time information in the AES and to verify the operational status of its logged-on AESs.

10.2 GES management architecture

10.2.1 SATELLITE SERVICE AREA

A service area of a satellite is defined as the satellite coverage area within which a satellite provider provides services. Different satellites can have overlapping satellite service areas.

10.2.2 SATELLITE SYSTEM CONFIGURATIONS

The following are the three satellite system configurations:

a) *Satellite with global beam only*. In this configuration, there is only one beam per satellite. This beam is referred to as a global beam. In this configuration, two GESs may be required per satellite in a satellite service area to account for two satellite-identifying P_{smc} channels for satellite identification.

b) *Satellite with global beam and spot beams*. In this configuration, a satellite supports multiple beams with some beams enclosed within another beam. The beams enclosed within a beam are called spot beams and the enclosing beam is referred to as a global beam. In this configuration, two GESs may be required per satellite in a satellite service area to account for two satellite-identifying P_{smc} channels for satellite identification. The satellite-identifying P_{smc} channels for satellite identification in this configuration are transmitted in the global beam.

c) *Satellite with spot beams only*. In this configuration, the satellite supports spot beams only, with no global beam. In order that a satellite/beam-identifying P_{smc} channel is available throughout a satellite service area for satellite and beam identification, at least one P_{smc} channel frequencies must be transmitted in each spot beam in the satellite service area. A GES in a satellite service area can support more than one spot beam by transmitting and receiving a unique set of frequencies in each spot beam.

10.2.3 GES CAPABILITY

At a minimum, the GES should be capable of operating through a space segment with a Level 4 AES. This implies that the GES should support voice channels for ATC and AOC services and interface with public switched telephone network or leased circuits at the option of the GES operator. The GES should also have provision for the highest specified rate data channels and interface with private or public switched networks at the option of the GES operator. The number of AESs that a GES can support depends upon the channel loading and the channel frequencies allocated to a GES. The loading on the channel should be such that the packet-mode data transfer meets the performance requirements specified in Annex 10, Volume III, Part I, Chapter 4, 4.7.

10.2.4 GES-TO-GES COMMUNICATION

GES-to-GES communication link is used to transfer information regarding the status of logged-on AESs to other GESs within the same satellite service area. It is also to be used to transfer the C channel access requests and C channel call announcements/C channel assignments between the log-on GES and the GES handling the particular call.

10.3 GES management interfaces

10.3.1 GES management interfaces to other GES entities are defined in Annex 10, Volume III, Part I, Chapter 4, 4.10 in terms of the information exchanged over these interfaces. The format of the information exchanged is not specified; it is implementation dependent.

10.3.2 The GES management interfaces with the link layer to use its services to transfer the management LIDUs to its peer in the AES. The GES management interfaces with the subnetwork layer to inform the subnetwork layer about the AES connectivity. The GES management interfaces with the circuit-mode services to pass the C channel frequencies and channel units assigned to a circuit-mode call. The GES management interfaces with the physical layer to control the frequency and power of the transmitted and received channels and to pre-empt the channel units for higher precedence voice or data calls.

10.4 GES management functions

10.4.1 GES TABLE MANAGEMENT

10.4.1.1 The term "table" refers to the system information stored at a GES. The information stored at the log-on GES includes the status of logged-on AESs and the status of AESs logged on to other GESs within the same satellite service area. It also includes information about the satellite — its identifying frequencies, its location, the beams supported by the satellite, the GESs within the satellite service area and the frequencies and bit rates of the P_{smc}/R_{smc} channels supported by each GES within the satellite service area. The format and the storage capacity for the information is not specified in the AMSS SARPs; it is implementation dependent.

10.4.1.2 The AES system table specified in Annex 10, Volume III, Part I, Chapter 4, 4.10 can be used for any satellite configuration. The initial search data for a satellite service area served by a satellite with spot beams only will include two satellite/beam-identifying P_{smc} channel frequencies for each spot beam for satellite and beam identification. The initial search data for a satellite service area served by a satellite with other configurations may include two or more satellite/beam-identifying P_{smc} channel frequencies per satellite. The regional data of the AES system table for a satellite service area served by a satellite with spot beams only will include, for each beam, the GES ID and the P_{smc} and R_{smc} channel frequencies supported by the GES in that beam. A GES supporting more than one beam will appear under two different beam IDs with a unique set of frequencies in each beam. The regional data of the AES system table for a satellite service area served by a satellite with a global beam will include the spot beam identifying P channel for each spot beam supported by the satellite, the GES ID for each GES within the satellite service area and the P_{smc} and R_{smc} channel frequencies supported by each GES in the global beam as well as the GES IDs for all GESs supporting each spot beam.

10.4.1.3 *AES log-on status table*

The AES log-on status table maintained by a GES other than the log-on GES contains information about each AES logged-on to any GES within the same satellite service area. This information can be used by a GES for call routing purposes such as to reject a ground-initiated call request destined for an AES not logged-on to any GES in the satellite service area or to forward the call request to the GES to which the destined AES is logged-on.

10.4.2 GES LOG-ON STATUS MANAGEMENT

10.4.2.1 *Distress log-on*

10.4.2.1.1 Upon receipt of a log-on request LIDU with the "Q No. Of Application" field set to 15 (indicating AES in distress), the GES management transmits a log-on confirm LIDU followed by P/R channel control and T channel control LIDUs to the AES, in spite of the following:

a) the AES is unauthorized to log-on; and

b) the GES has no resources to assign to the new request.

10.4.2.1.2 After the AES has logged on and is out of distress (indicated by the receipt of lower precedence data by the GES), the handling of non-distress communications by the GES is at the discretion of the GES operator. A technique to block non-distress communication at the GES is implementation dependent.

10.4.2.2 *GES handover functions*

10.4.2.2.1 A log-on GES, upon receipt of an AES log-on information from another GES in the satellite service area served by the same satellite as the one serving the log-on GES, suspends any data transaction in progress with the AES if this AES was previously logged on to it. The voice calls in progress via the previous log-on GES does not have to be cleared since the AES can establish calls via a GES other than its log-on GES. The previous log-on GES does not indicate the AES in its AES log-on status table as being its logged on AES; however, it still retains the required information about the AES.

10.4.2.2.2 If the log-on information about an AES is received from a GES in a different satellite service area, then the received GES suspends the data transaction and clears voice calls in progress with the AES if this AES was previously logged-on to it and then deletes the AES from its AES log-on status table completely. The old log-on GES then transmits log-off information to other GESs in its satellite service area.

10.4.2.3 *Log-on verification*

10.4.2.3.1 The AMSS SARPs on GES management specify two methods of verifying the operational status of an AES. The direct verification method is utilized by the GES if the log-on verification (LOV) bit in the log-on request LIDU is set to zero by the AES; otherwise, indirect verification method is used.

10.4.2.3.2 The purpose of log-on verification is to optimize the use of resources among AESs. If an AES is not active for a period of time specified in the AMSS SARPs (i.e. it is not transmitting data or does not have a voice call set up to the log-on GES or to any other GES in the same satellite service area), the log-on GES logs-off the AES if the AES does not respond to log-on interrogation (for direct log-on verification) or remains inactive for 12 hours (for indirect verification). The resources released can thus be made available to other AESs that are trying to log on but cannot succeed due to insufficient resources at the GES.

10.4.2.3.3 The reason for an AES logged on to a GES to be inactive is that the AES has either landed without logging off or has switched satellites. Under such conditions, it is appropriate for the log-on GES to log off the AES.

10.4.2.4 *Log-on prompt*

The log-on prompt facility at a GES is used to prompt an AES to log on when the GES link layer receives a signal unit (SU) from an AES on an R_d channel and the AES is not in its AES log-on status table. This situation can occur if the GES has not updated its AES log-on status table after the initial log-on. The GES transmits the log-on prompt LIDU to the AES on all P channel frequencies.

10.4.2.5 *Assignment of data channels*

The GES management assign data channels (P, R, and T channels) at the highest bit rate, which is provided at both the GES and the AES and is supported by the combination of a satellite in use and the level of the AES. The decision as to which channels and with what EIRP to assign, can be made by the GES management from the following information:

a) the satellite in use (its return link sensitivity); and

b) the level of AES.

The GES management can assign up to eight R channels and up to four T channels at the time of log-on.

10.4.3 GES CHANNEL MANAGEMENT

10.4.3.1 *C channel frequency management*

On the basis of known/planned/predicted traffic capacity requirements, the GES can be pre-assigned a number of SCPC frequencies for use as a forward and return C channels. The total number of frequencies assigned to GESs within the same satellite service area is normally less than the total capacity available for the satellite in operation. On demand, each GES assigns the frequencies for a circuit-mode call from its own pool. However, lack of channel frequency for a call at the GES results in the initiation of a channel frequency reassignment request to a central authority which initially made the pre-assignment. The central authority can then make an assignment of frequency to the GES utilizing the frequencies held in a common pool.

10.4.3.2 *C channel power management*

10.4.3.2.1 The GES calculates the initial EIRP of the C channel according to the value derived from the worst case link budget.

10.4.3.2.2 The GESs can be assigned power budgets consistent with performance requirements of the channels operating to the satellite. Once this power budget is fully utilized, the GES management rejects further channels/call requests until sufficient power has been released to be assigned to the new requests or until the log-on request LIDU indicates AES in distress. The C channel power can be controlled for example in accordance with the following power control decision table:

for the 21 000 bits/s, rate 1/2 FEC channel, if the average number of errors per 2 560 channel bits (before decoding) is:

greater than 172:	increase EIRP by 2 dB
between 119 and 172:	increase EIRP by 1 dB
between 76 and 119:	leave EIRP unchanged
between 44 and 76:	decrease EIRP by 1 dB
less than 44:	decrease EIRP by 2 dB.

Note.— These values correspond to the input bit error rates to a rate 1/2 Viterbi decoder as specified for the C channel that provide an output bit error rate of 10^{-3} *(nominal) to* 10^{-4} *(1 dB above nominal), with a margin of 1.5 dB.*

10.4.4 GES PRE-EMPTION MANAGEMENT

10.4.4.1 *Voice versus voice pre-emption*

The purpose of this capability at the GES is to make resources available for a higher precedence voice call if there are no additional resources available at the GES and lower precedence voice calls are being serviced. The GES management, upon receipt of a request from circuit-mode services for a channel unit for a voice call, checks if the precedence of the new request for voice call set-up is higher than any call already in progress. If the precedence of new call request is higher than any one call-in-progress, the GES management then ruthlessly pre-empts the lowest precedence call in progress to make resources available for the higher precedence call. If there are more than one call at the lowest precedence in progress at a given time then it is at the discretion of the GES operator to pre-empt a call. One option could be to pre-empt the call which has been in progress for the longest time.

10.4.4.2 *Data versus voice pre-emption*

The purpose of this capability at the GES is to make resources available to set up an additional P channel for higher precedence data traffic when there are no additional resources available at the GES to set up an additional P channel, and lower precedence voice calls are being serviced and transmission of additional data traffic on the already operational P channels would violate the data transfer delay requirements specified in Annex 10, Volume III, Part I, Chapter 4, 4.7. However, a higher precedence voice call does not pre-empt an operational P channel to make resources available for setting up a higher precedence voice call because doing so will be detrimental to data transmissions from the AES.

10.4.5 GES SYSTEM BROADCAST

10.4.5.1 *System table broadcast*

10.4.5.1.1 This facility at the GES allows the GES to update the system table information stored in an AES. The system table updates are transmitted to AESs as complete or partial sequences.

10.4.5.1.2 The initial search data in the system table contains satellite/beam-identifying P_{smc} channel frequencies for all satellites. Any changes to the system table are made centrally by the satellite system provider and are disseminated to all GESs within all the satellite service areas provided by the satellite system provider, as required. The revision number for a system table is unique to each satellite service area.

10.4.5.1.3 The complete sequence is transmitted by the designated GES on the satellite/beam-identifying P_{smc} channel and it comprises all broadcast LIDUs headed by a broadcast index LIDU. The partial sequence comprises of one or more broadcast LIDUs headed by a broadcast index LIDU. The partial sequence contains the most recent updates only. The broadcast index LIDU identifies the presence of individual LIDU series within both the complete and partial sequences. Each GES broadcasts a partial sequence on all its operational P channels. Each satellite service area has its own system table broadcast information.

10.4.5.1.4 The system table complete and partial sequence broadcast rates may be reduced due to high P channel loading. This may delay the initiation of the log-on procedure at the AES. It is recommended that the GES management monitor such broadcast rates and provide further P channel capacity to maintain these rates at acceptable levels.

10.5 Considerations for GES services

10.5.1 The AMSS system, which forms part of the ICAO communications, navigation, and surveillance/air traffic management (CNS/ATM) systems concept, provides communication services on a global basis. The AMSS system architecture consists of a number of satellites and a limited number of GESs. All States/administrations can have full access to the AMSS, but most of them will not need to have their own GES; rather they will connect to the network through service providers.

10.5.2 Although a small number of GESs are sufficient for AMSS in a given geographical area, some States or administrations may feel it is necessary to install and operate their own GES for reasons such as:

a) redundancy — reducing the impact of GES failure;

b) less dependency on other States (who operate GESs) and service providers; and

c) exerting authority and control in their airspace.

10.5.3 However, the proliferation of GESs can lead to problems such as:

a) increased demand for spectrum because of the inefficiencies introduced by dividing the available spectrum into small pieces;

b) degraded packet data performance as AESs are subjected to more log-on/log-off cycles as they transit between various flight information regions (FIRs) which operate their own GESs;

c) increased workload for the flight crew (or cost and complexity of the AES) as they transit between various FIRs which operate their own GESs.

10.5.4 Additional factors which affect the number of GESs are the following:

a) available satellite power will limit the number of 600 bit/s P-channels, i.e. GESs, which can be supported per satellite; and

b) the cost of installing and operating a GES will not be economical for most administrations.

Given this, some States may be concerned about their dependency on other States or service providers, for GES services. This concern can be alleviated by several considerations:

a) For packet services, the ATN will allow States without GESs to choose between a number of different States or service providers to obtain GES services.

b) In States where the ATN is less developed, fixed satellite links between a GES and the air traffic control centre could provide an alternative to terrestrial links. This approach could be a source of both cost-competitiveness and redundancy. If designed properly, the extra delay introduced by a second satellite link will have a negligible effect on the packet data performance. A second satellite link may not be adequate for voice communications, at least not in a normal conversation mode. However, its effect on verbal exchanges typical of ATC applications has not been studied.

c) States should have adequate institutional arrangements with service providers based on ICAO guidelines for AMSS.

TABLES FOR ATTACHMENT A

Table A-1. Typical implementation versus levels of capability

Levels of capability	Packet data service (kbits/s)	Circuit mode service (kbits/s)	Number of channels	AES antenna gain	Comments
1	0.6 1.2	Not available	1 transmit 1 receive	0 dB	
2	0.6 4.8 10.5	Not available	1 transmit 1 receive	12 dB	Higher speed for packet data
3	0.6 4.8 10.5	Voice 21.0	1 transmit 2 receive	12 dB	Provides digitized voice, and packet data but not simultaneously
4	0.6 4.8 10.5	Voice 21.0	2 or more transmit 2 or more receive	12 dB	Simultaneous two-way packet and voice. Needs linear amplifier and power control for each carrier.

NOTES:

1. Circuit mode data services may be supported by some implementation, but these are not defined in the AMSS SARPs.
2. The 4.8 kbits/s channel applies only to the P channel.

Table A-2. Worst case data performance versus channel rate

Minimum channel rate in use by AES (bit/s)	Maximum connection establishment delay (95th percentile) (seconds)	Transit delay (average) (seconds)			Data transfer delay (95th percentile) (seconds)		
		To-aircraft		From-aircraft	To-aircraft		From- aircraft
		Highest priority	Lowest priority	Highest priority	Highest priority	Lowest priority	Highest priority
600	70	12	40	40	15	110	80
1 200	45	8	25	30	9	60	65
2 400	25	5	12	15	6	30	35
4 800	25	4	7	13	5	20	30
10 500	25	4	5	13	4	10	30

Residual error rate:
from-aircraft direction: 10^{-4} per SNSDU (maximum)
to-aircraft direction: 10^{-6} per SNSDU (maximum)

NOTES:

1. In any particular AES, lower priority from aircraft traffic may be subject to additional delay, depending on the amount and rate of from-aircraft traffic loading.
2. The values of the transfer delays are based on packet sizes of 128 octets.

Table A-3. Q-precedence structure for AMSS transmissions

AMSS Q-number	Function
15	Distress/urgency voice; signalling
14	Distress/urgency data messages
13	Reserved for signalling
12	Flight safety voice; signalling
11	Flight safety data messages; communications related to direction finding
10	Meteorological and flight regularity voice; signalling
9	Reserved for signalling
8	Meteorological data messages
7	Flight regularity data messages
6	Aeronautical Information Service Messages
5	Aeronautical administrative data messages, network/systems administrative data messages
4	Routine cockpit and cabin voice; signalling
3-0	Various AAC and APC categories; other

Table A-4. Frequency error budget for receiving the P channel

	Specification	Standard deviation
GES transmit reference error	±100 Hz	57.7 Hz
AFC pilot transmit error	±100 Hz	57.7 Hz
GES AFC error	±100 Hz	57.7 Hz
AES receive reference error	±155 Hz	89.5 Hz
Oscillator related errors at AES		
— standard deviation		134.2 Hz
— 99 per cent contour		±345.6 Hz

NOTES:

1. It is assumed that oscillator specifications define a uniform error distribution.
2. The contribution of a number of oscillators to the overall error is estimated using a root-sum-square calculation.

Table A-5. AES-to-GES frequency error budget with a P channel reference

	Specification (Hz)	Standard deviation (Hz)
AES receive reference error × 1.07[1]		107
AES transmit/receive reference error	(165 + 155) = 320	184.8
AES AFC error	100	57.5
AFC pilot transmit frequency error[2]	75	43.3
GES AFC error[2]	100	57.7
Frequency error at GES demodulator		
— standard deviation		232.6
— 99 per cent contour[3]		±600

1. This is the total of the first three contributors to frequency error for the P channel. The factor of 1.07 is the approximate ratio of the transmit and receive frequencies.
2. The combination of the GES AFC error and the AFC pilot transmit error produce the frequency error of the satellite translation oscillators on the return link.
3. This is the GES demodulator specification.

Table A-6. Typical C channel carrier-to-noise densities required

	To-aircraft link C channels (voice)		From-aircraft link C channels (voice)	
Elevation angle to the satellite (degrees)	5	20	5	20
Objective FEC decoder output BER	10^{-3}	10^{-3}	10^{-3}	10^{-3}
AES minimum antenna gain (dB)	12	12	12	12
Carrier/multipath ratio (dB)	10	12	10	12
Multipath fading bandwidth (Hz)	20 to 100	20 to 100	20 to 100	20 to 100
FEC coding rate	½	½	½	½
Modulation method	A-QPSK	A-QPSK	A-QPSK	A-QPSK
Theoretical required E_s/N_0 (dB)	1.2	0.6	1.2	0.6
Modem implementation loss (dB)	1.1	0.9	1.1	0.9
Imperfect interleaving loss (dB)	3.0	1.2	3.0	1.2
Adjacent channel interference loss (dB)	0.1	0.1	0.8	0.8
Modem E_o/N_0 (dB) required	5.4	2.8	6.1	3.5
REQUIRED C/N_0 (dBHz)				
21.0 kbits/s	48.6	46.0	49.3	46.7

Table A-7. Typical P channel carrier-to-noise densities required

	To-aircraft link P channels (low rate data)		To-aircraft link P channel (high rate data)	
Elevation angle to the satellite (degrees)	5	20	5	20
Objective FEC decoder output BER	10^{-5}	10^{-5}	10^{-5}	10^{-5}
AES minimum antenna gain (dB)	0	0	12	12
Carrier/multipath ratio (dB)	7	12	10	12
Multipath fading bandwidth (Hz)	20 to 100	20 to 100	20 to 100	20 to 100
FEC coding rate	½	½	½	½
Modulation method	A-BPSK	A-BPSK	A-QPSK	A-QPSK
Theoretical required E_s/N_0 (dB)	5.0	3.5	2.8	2.4
Modem implementation loss (dB)	1.2	1.1	1.5	1.1
Imperfect interleaving loss (dB)	1.0	0.5	1.0	0.5
Adjacent channel interference loss (dB)[1]	0.1	0.1	0.1	0.1
Modem E_s/N_0 (dB) required	7.3	5.2	5.4	4.1
REQUIRED C/N_0 (dBHz)				
0.6 kbits/s	35.0	32.9		
1.2 kbits/s	38.1	36.0		
2.4 kbits/s	41.1	39.0		
4.8 kbits/s			42.2	40.9
10.5 kbits/s			45.6	44.3

NOTES:

1. The adjacent channel interference loss is a function of channel spacing. The example losses are for channel rates of 2.4 and 10.5 kbits/s. for A-BPSK and A-QPSK, respectively. The losses should be no greater for the other channel rates because the channel spacing, relative to the channel rate, will be larger.
2. The low data rates (A-BPSK) can also be used with high gain antennas with potentially less C/N_0 required.

Table A-8. Typical R/T channel carrier to noise densities required

	From-aircraft link R/T channels (low rate data)		From-aircraft link R/T channel (high rate data)	
Elevation angle to the satellite (degrees)	5	20	5	20
Objective FEC decoder output BER	10^{-5}	10^{-5}	10^{-5}	10^{-5}
AES minimum antenna gain (dB)	0	0	12	12
Carrier/multipath ratio (dB)	7	12	10	12
Multipath fading bandwidth (Hz)	20 to 100	20 to 100	20 to 100	20 to 100
FEC coding rate	½	½	½	½
Modulation method	A-BPSK	A-BPSK	A-QPSK	A-QPSK
Theoretical required E_s/N_0 (dB)	5.0	3.5	2.8	2.4
Modem implementation loss (dB)	1.2	1.1	1.5	1.1
Imperfect interleaving loss (dB)[1]	1.2	0.6	1.0	0.5
Adjacent channel interference loss (dB)[2]	0.1	0.1	0.4	0.4
Modem E_s/N_0 (dB) required	7.5	5.3	5.7	4.4
REQUIRED C/N_0 (dBHz)				
0.6 kbits/s	35.0	32.9		
1.2 kbits/s	38.1	36.0		
2.4 kbits/s	41.3	39.1		
4.8 kbits/s			42.5	41.2
10.5 kbits/s			45.9	44.6

NOTES:

1. The interleaver loss is a function of channel rate, the example losses correspond to channel rates of 2.4 and 10.5 kbits/s for A-BPSK and A-QPSK, respectively.
2. The adjacent channel interference loss is a function of channel spacing, the example losses correspond to channel rates of 2.4 and 10.5 kbits/s for A-BPSK and A-QPSK, respectively. The losses should be no greater for the other channel rates because the channel spacing, relative to the channel rate, will be larger.
3. The low data rates (A-BPSK) can also be used with high gain antennas with potentially less C/N_0 required.

Table A-9. Channel spacings

Channel rate (kbits/s)	Channel spacing (kHz)	Modulation
21.0	17.5	A-QPSK
10.5	10.0/7.5[1]	A-QPSK
6.0	5.0	A-QPSK
5.25	5.0	A-QPSK
4.8	5.0	A-QPSK
2.4	5.0	A-BPSK
1.2	5.0/2.5[2]	A-BPSK
0.6	5.0/2.5[2]	A-BPSK

1. Channel spacing for 10.5 kbits/s channels may be 10.0 or 7.5 kHz, according to the relative availability of power and bandwidth in the operating satellite.
2. Channel spacing of 5.0 kHz applies to the P channel and 2.5 kHz applies to the R and T channel.

Table A-10. Typical values for computing earliest starting time

P Channel bit rate bits/s	P-Channel unit delay(s)	Queuing delay(s)	AES processing delay(s)
600	3.0	0.7	1.8
1200	2.0	0.5	1.2
≥1200	1.5	0.5	1.0

Table A-11. Minimum throughput values
(minimum achievable throughput on a subnetwork connection, bits/s, with 128-octec packets)

Minimum channel rate in use by AES (bits/s)	To-aircraft		From-aircraft	
	Highest priority service	Lowest priority service	Highest priority service	Lowest priority service
600	70	35	35	30
1 200	130	70	100	80
2 400	150	90	300	275
4 800	160	110	500	475
10 500	165	115	500	475

Table A-12. Probability of delivering at least one abbreviated access request SU (per cent)

Call priority (series length)	Conflicting traffic comprising 1-SU bursts	Conflicting traffic comprising 3-SU bursts
Distress/urgency (4)	99.99	97.9
Flight safety (3)	99.7	93.7
Regularity/meteorological (2)	97.5	89.2

Table A-13. Projected AMS(R)S subnetwork call set-up delay performance, (seconds) (R and P channels operating at 600 and 10 500 bits/s)

		Average	95 percentile
AIR-ORIGINATIONS	**AMS(R)S subnetwork signalling transit delay** (Difference between the time at which an air-originated call request (incoming FITE 18) is received at the AES interworking interface and the time at which the GES forwards the resultant call indication (outgoing FITE 18) to the terrestrial network.)	4 [@ 600 bits/s] 3 [@ 10 500 bits/s]	6 to 11 [@ 600 bits/s] 3 to 7 [@ 10 500 bits/s]
	Call set-up delay (Difference between the time at which an air-originated call request (incoming FITE 18) is received at the AES interworking interface and the time at which the C channel is ready for speech).	12 to 14 [@ 600 bits/s] 10 to 11 [@ 10 500 bits/s]	14 to 23 [@ 600 bits/s] 11 to 14 [@ 10 500 bits/s]
GROUND-ORIGINATIONS	**Call set-up delay** (Difference between the time at which a ground-originated call request (incoming FITE 18) is received at the GES interworking interface and the time at which the C channel is ready for speech and the AES forwards the resultant call indication (outgoing FITE 18) to the AES interworking interface.)	9 to 11 [@ 600 bits/s] 9 [@ 10 500 bits/s]	10 to 17 [@ 600 bits/s] 10 [@ 10 500 bits/s]

FIGURES FOR ATTACHMENT A

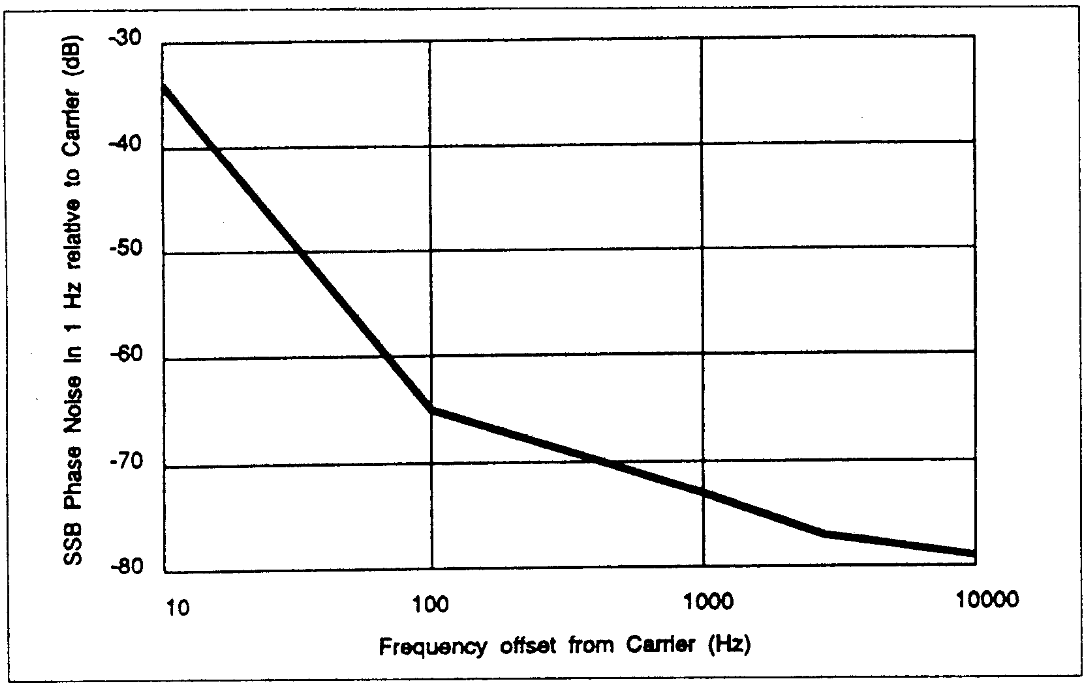


Figure A-1. Phase noise of L-band signals received by AES

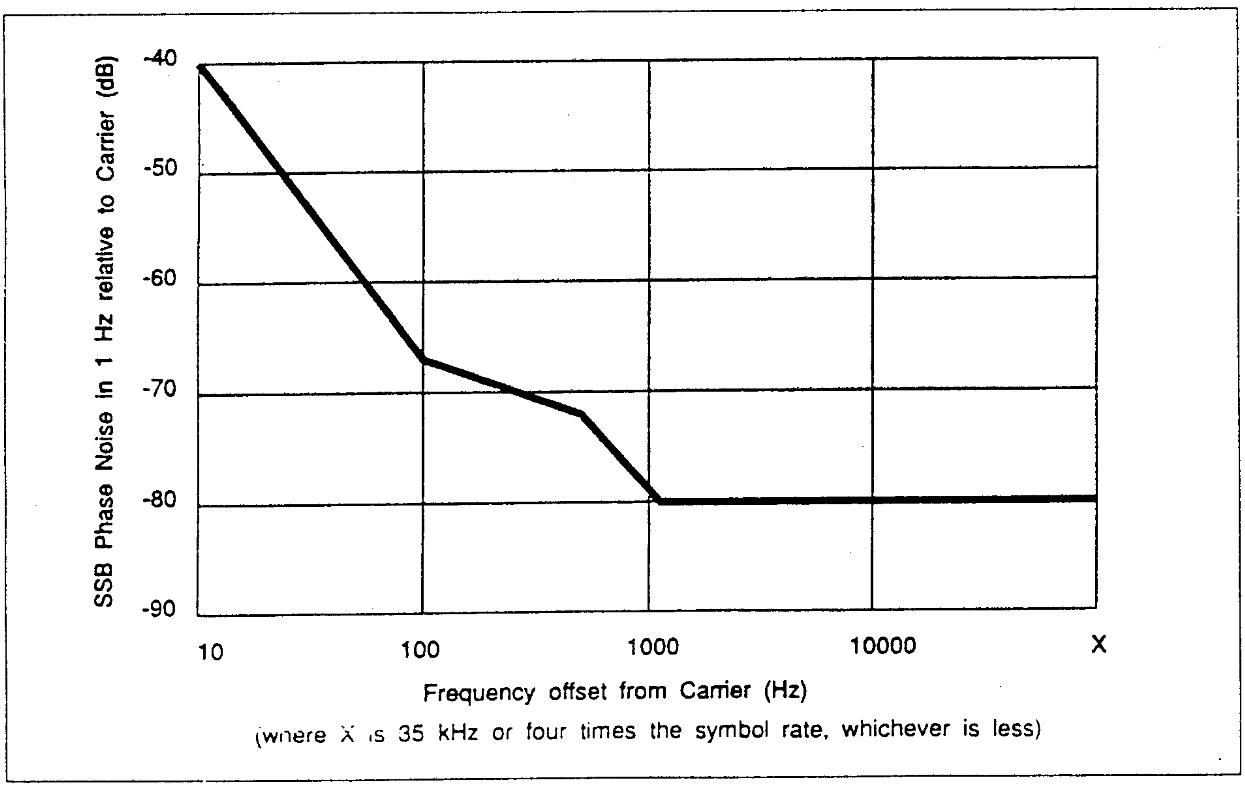


Figure A-2. AES transmit phase noise mask

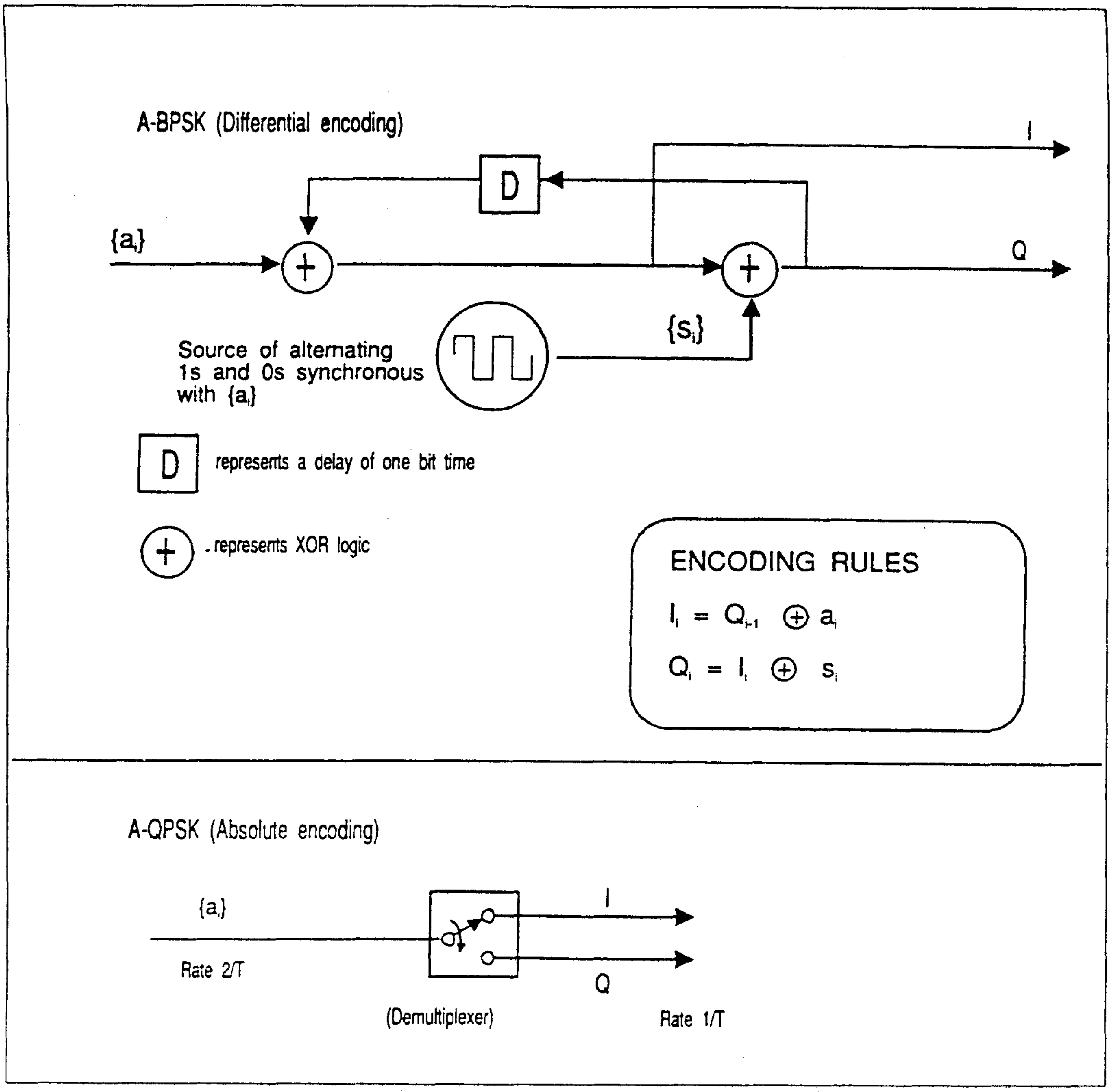
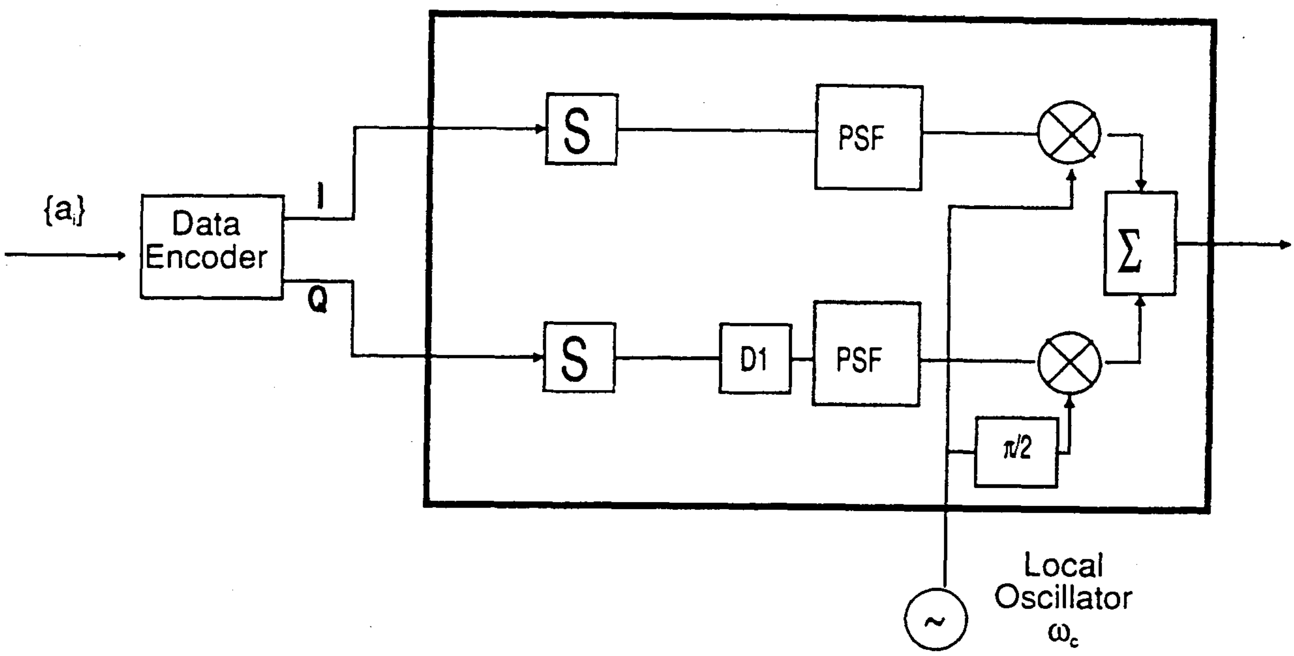


Figure A-3. Data encoders for modulator model



{a_i} is input data sequence. Channel rate is
1/T for A-BPSK
2/T for A-QPSK

{a_i} is mapped into two bit streams on the I and Q lines, each with bit rate 1/T

S is an ideal sampling process:
input = "1", output = $\delta(t)$
input = "0", output = $-\delta(t)$

D1 is a delay of: 0 for A-BPSK
T/2 for A-QPSK

PSF are Pulse Shaping Filters

⊗ represents an ideal linear modulator

Σ represents an ideal combiner

Figure A-4. Ideal modulator (A-BPSK and A-QPSK)

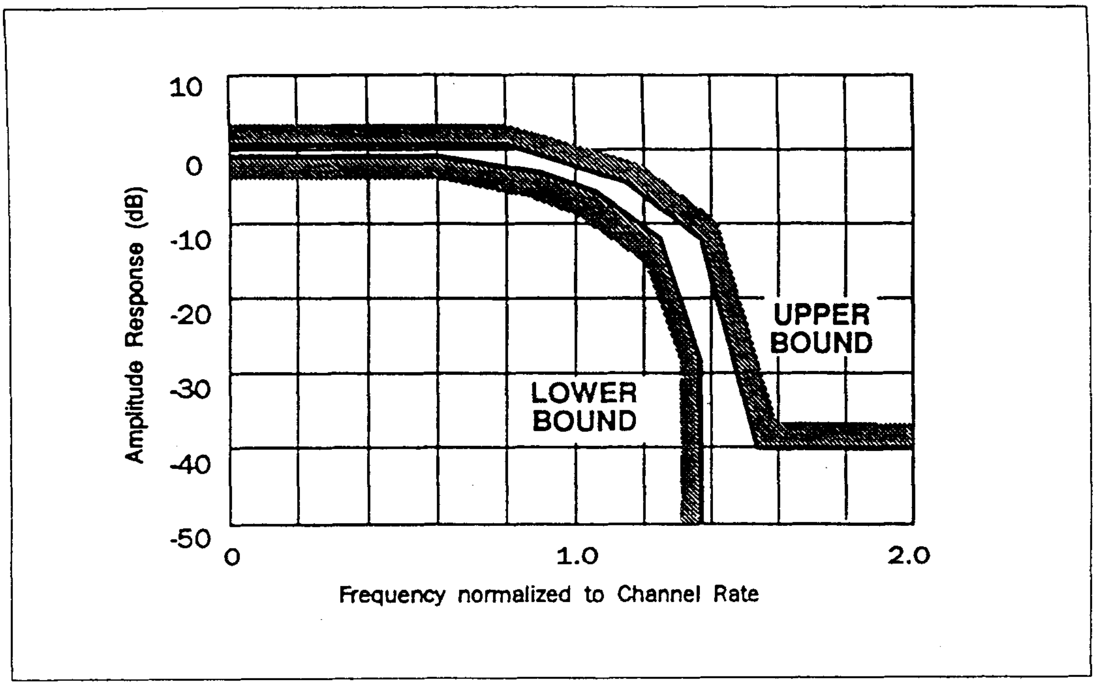


Figure A-5. AES A-BPSK transmit filter response mask

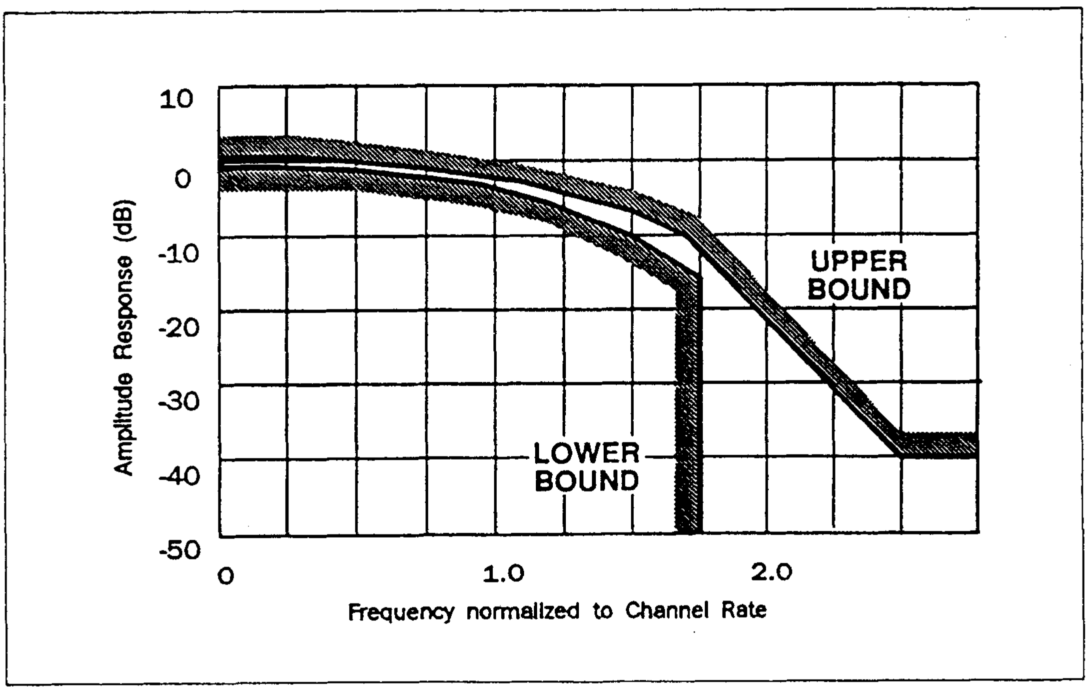


Figure A-6. AES A-QPSK transmit filter response mask

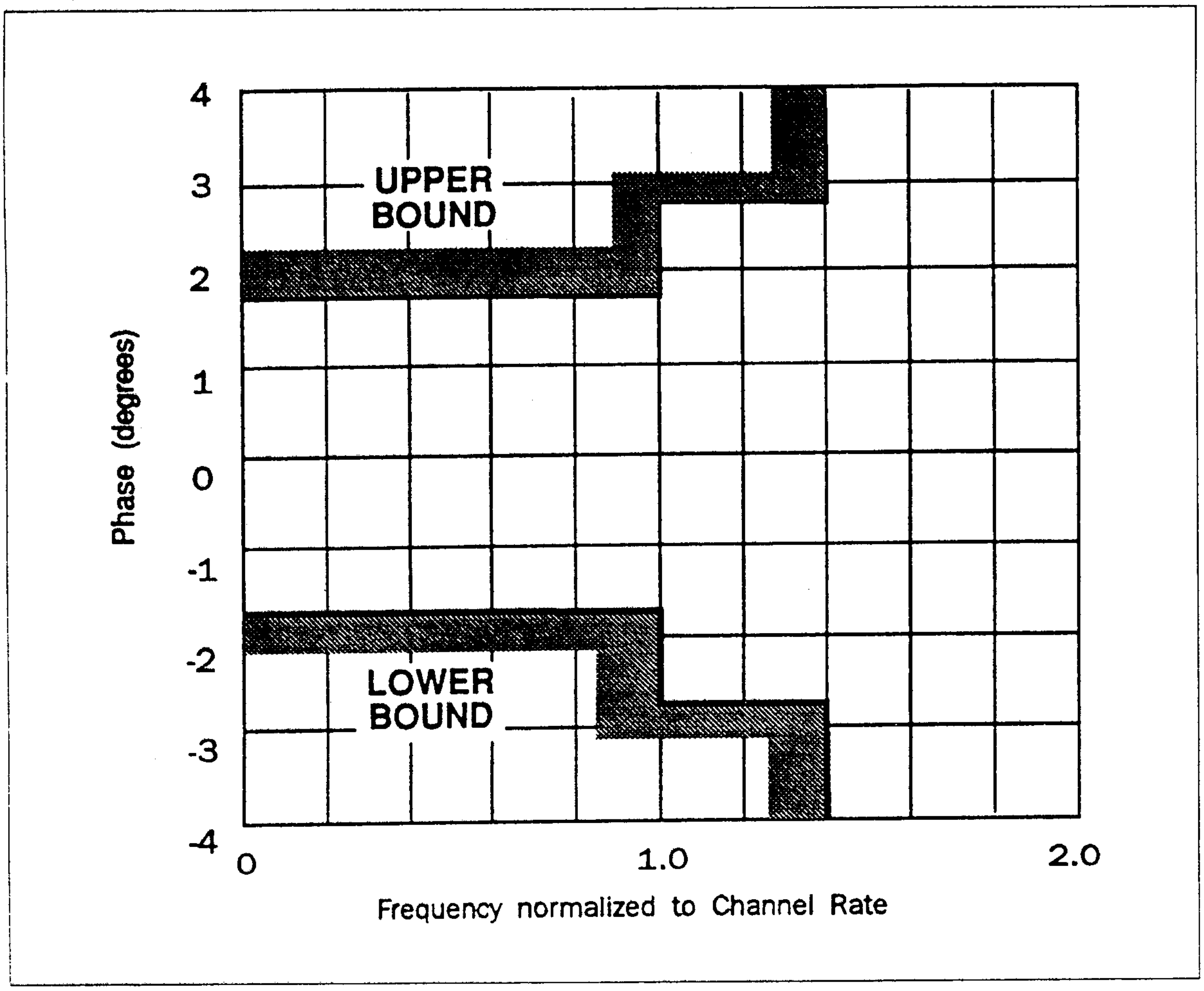
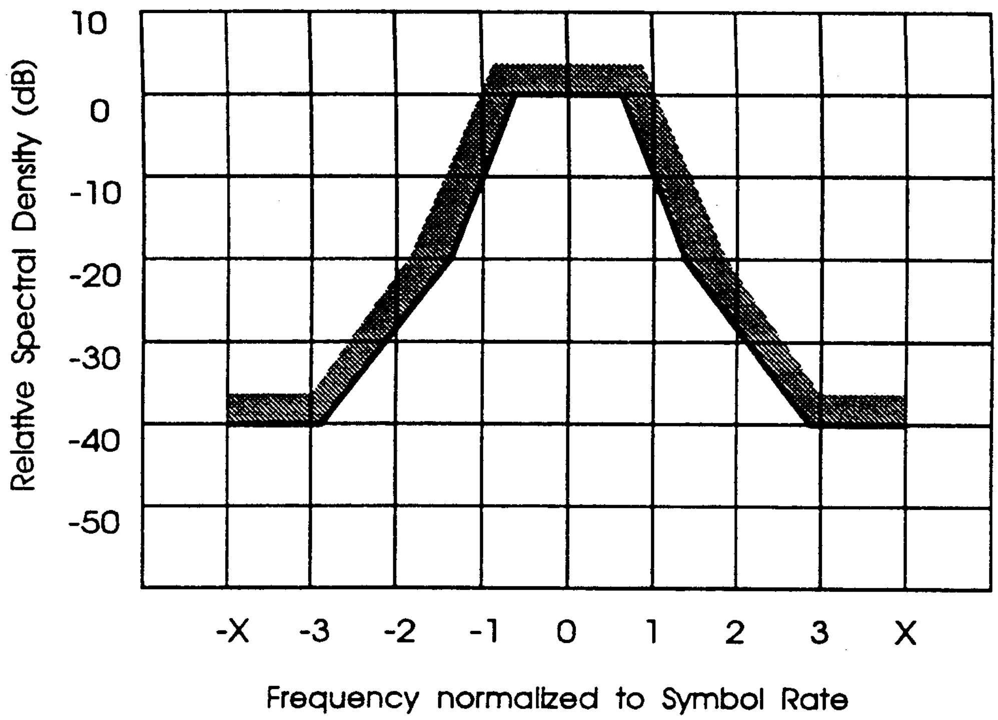


Figure A-7. Phase deviation tolerance for A-BPSK and A-QPSK transmit filter response mask



NOTES:

1. The symbol rate is equal to the channel rate for A-BPSK and is half the channel rate with A-QPSK.
2. The frequency X is 35 kHz.

Figure A-8. Required spectral limits for AES transmissions

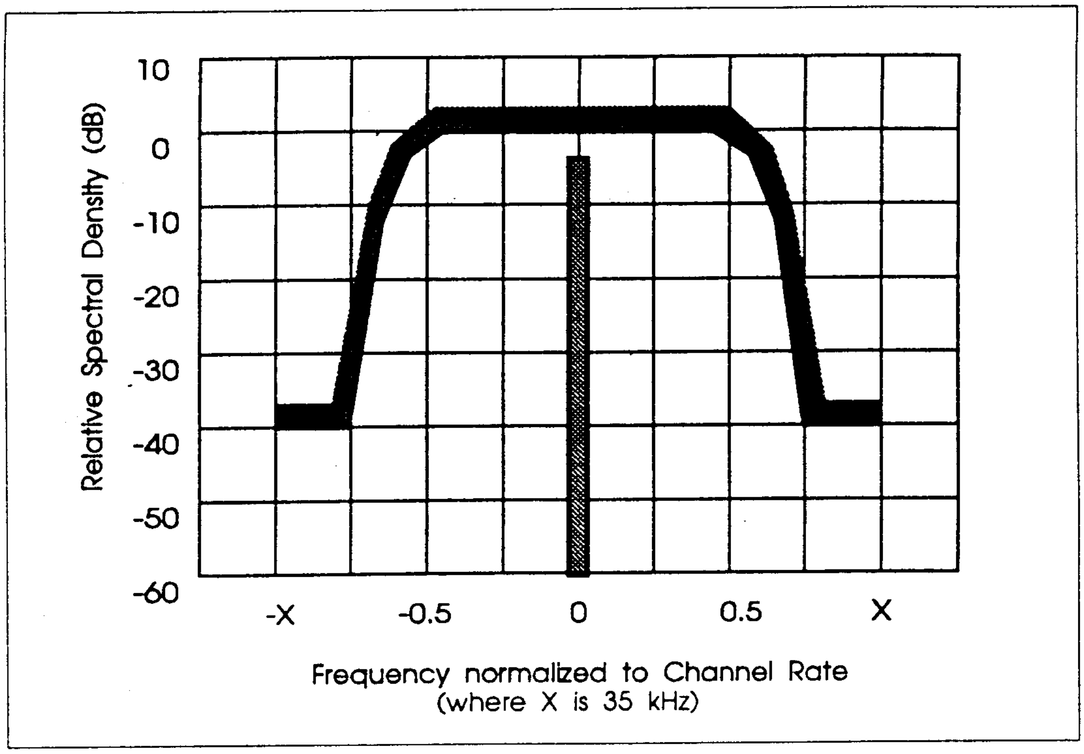


Figure A-9. Spectral mask of A-BPSK received by AES

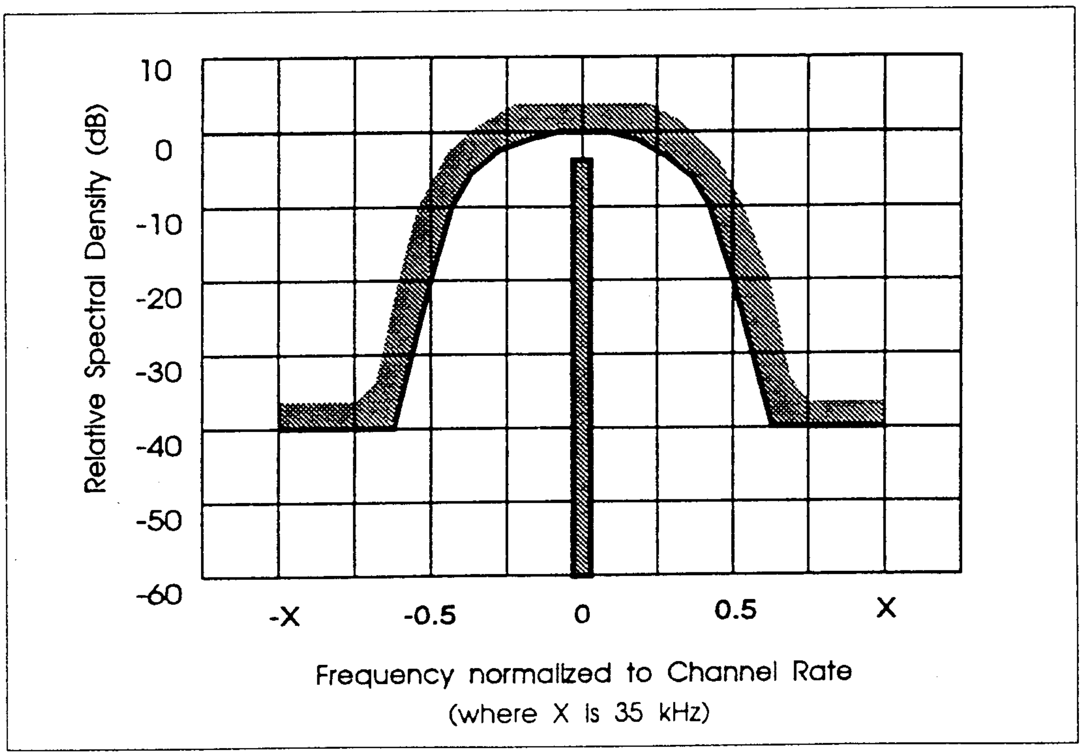


Figure A-10. Spectral mask of A-QPSK received by AES

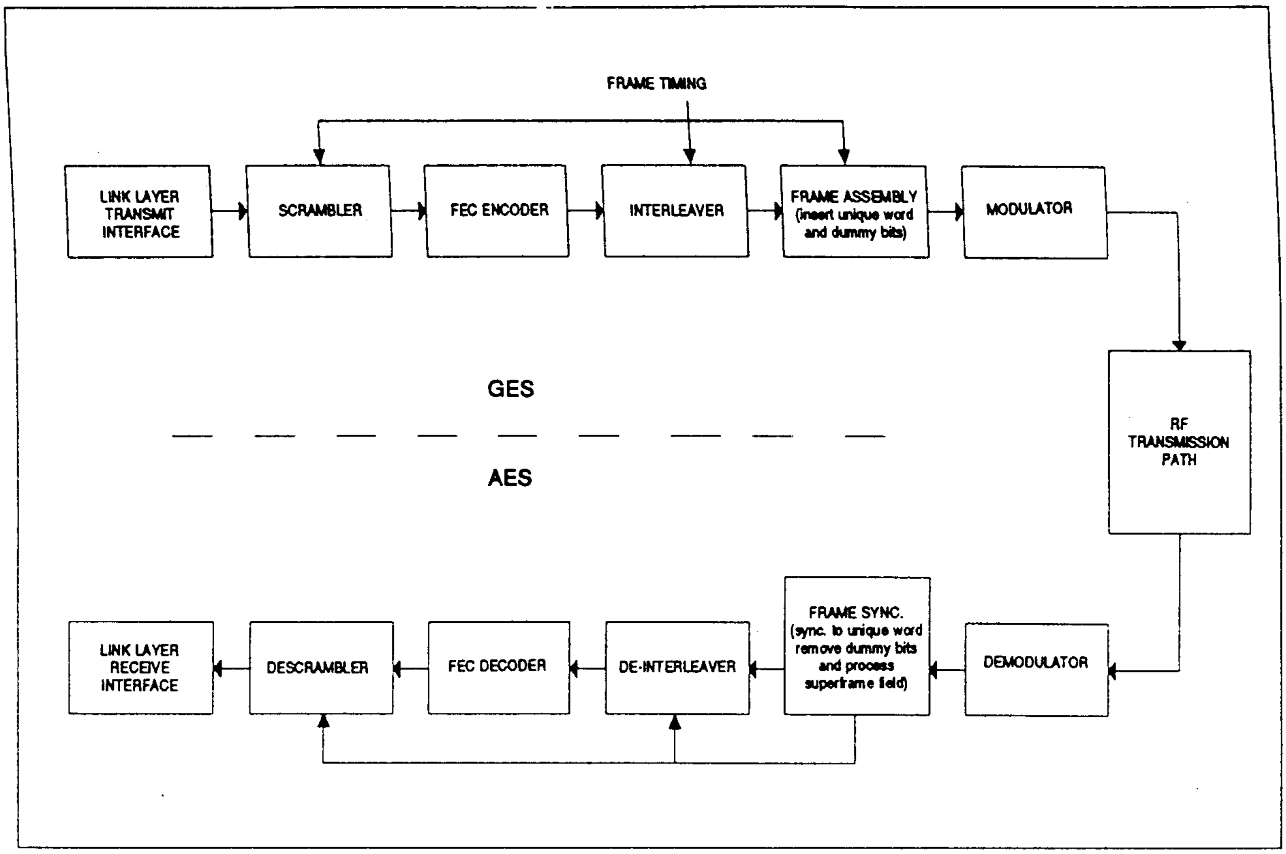


Figure A-11. P channel functional blocks

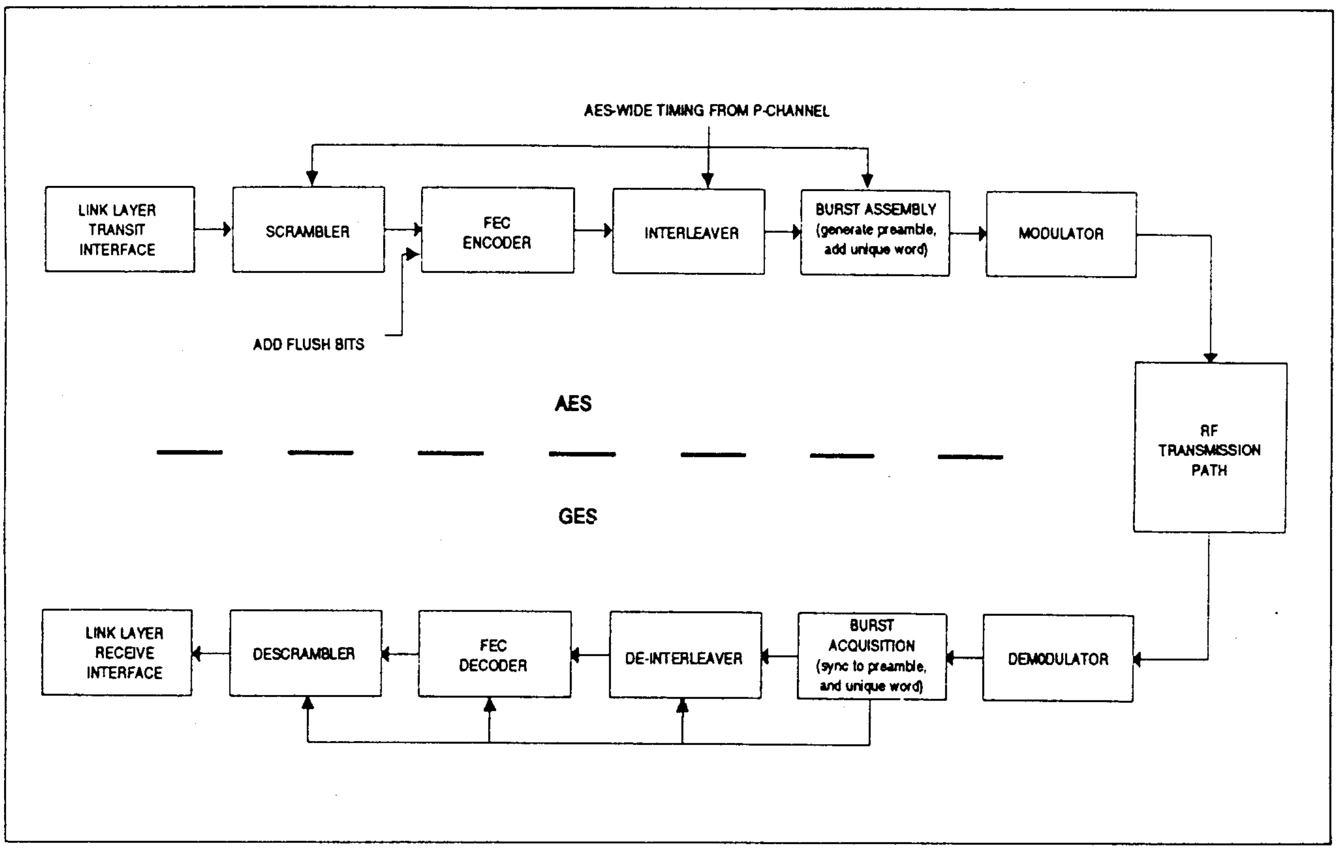


Figure A-12. R and T channel functional blocks

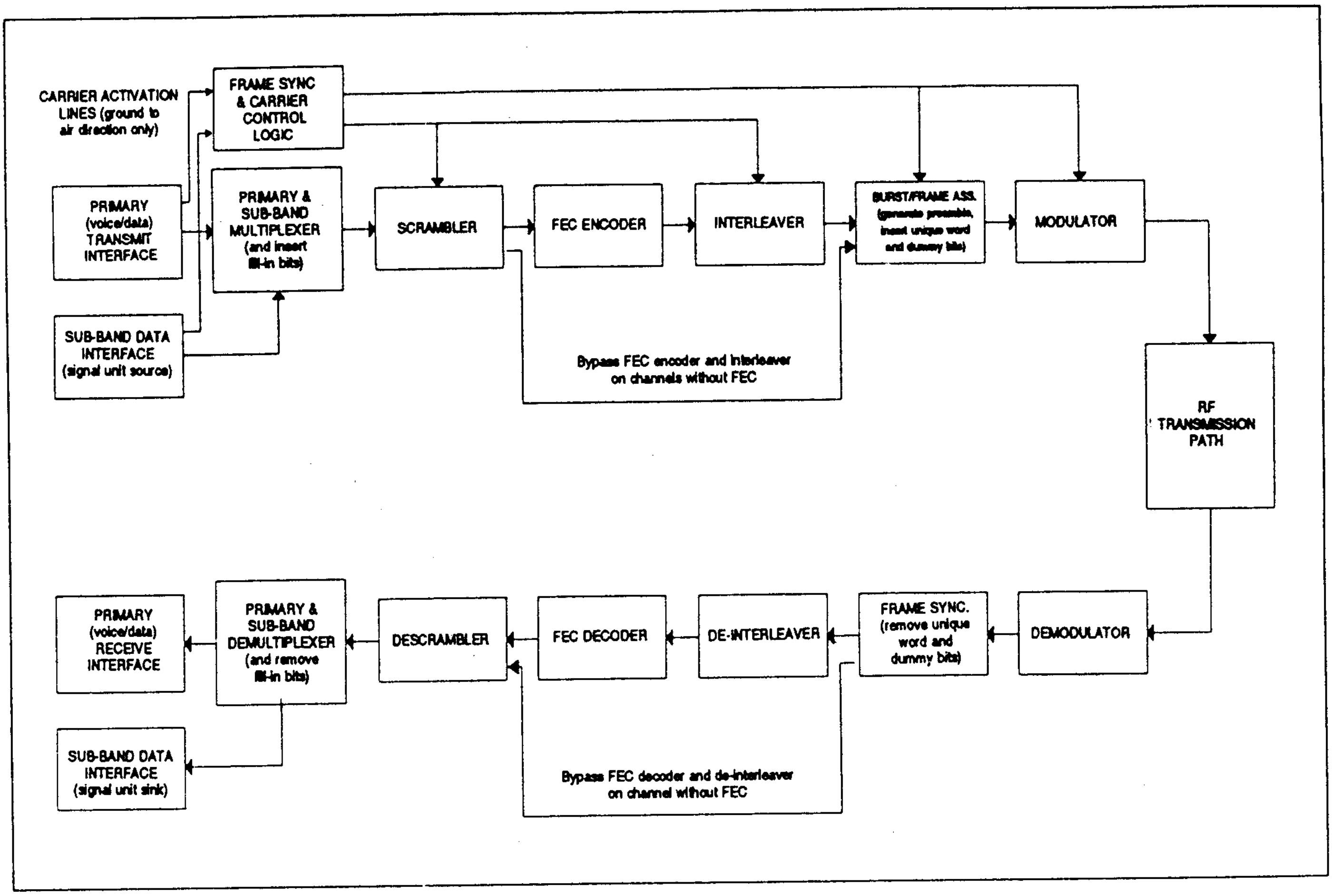


Figure A-13. C channel functional blocks

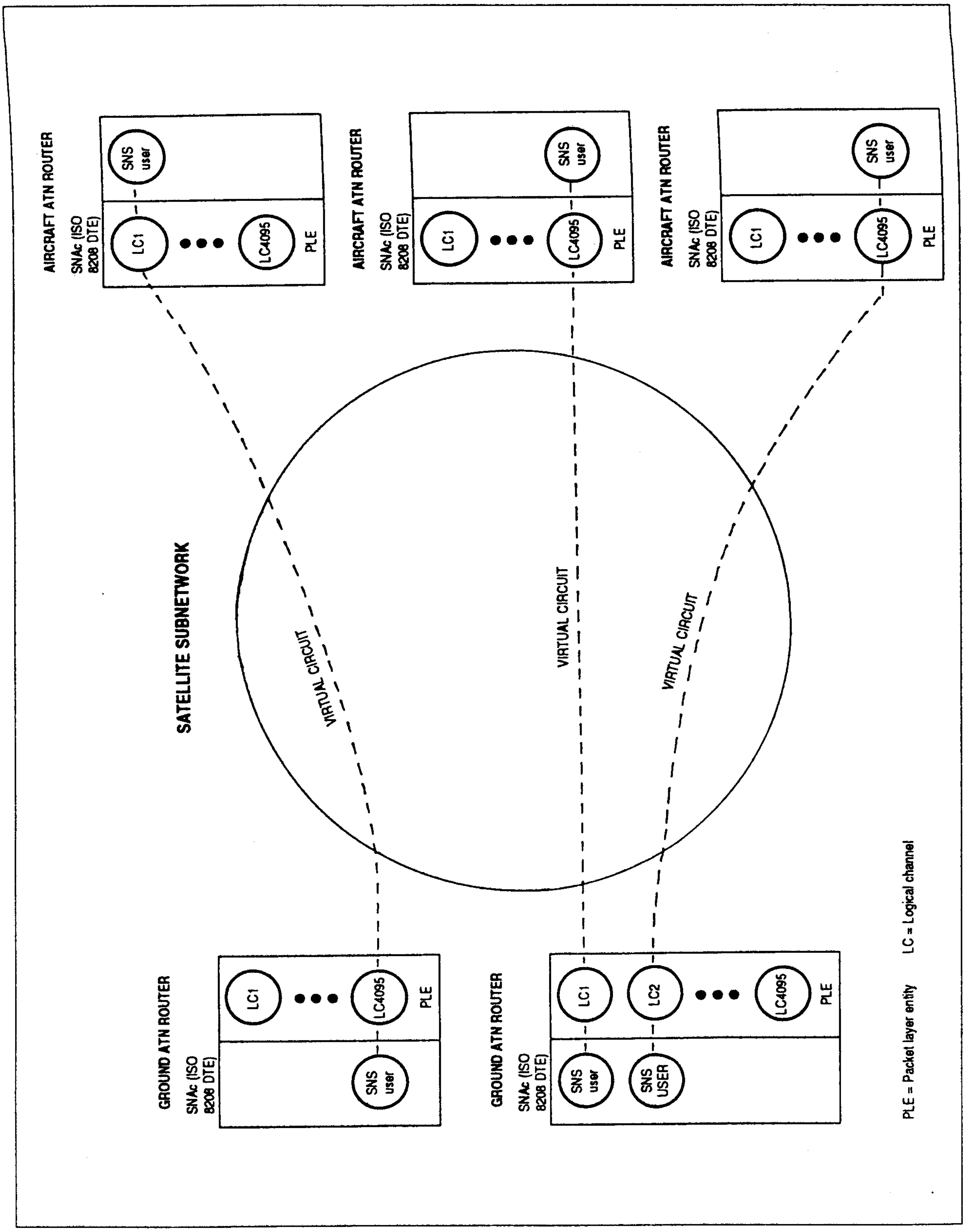


Figure A-14. Satellite subnetwork connection-oriented packet data service

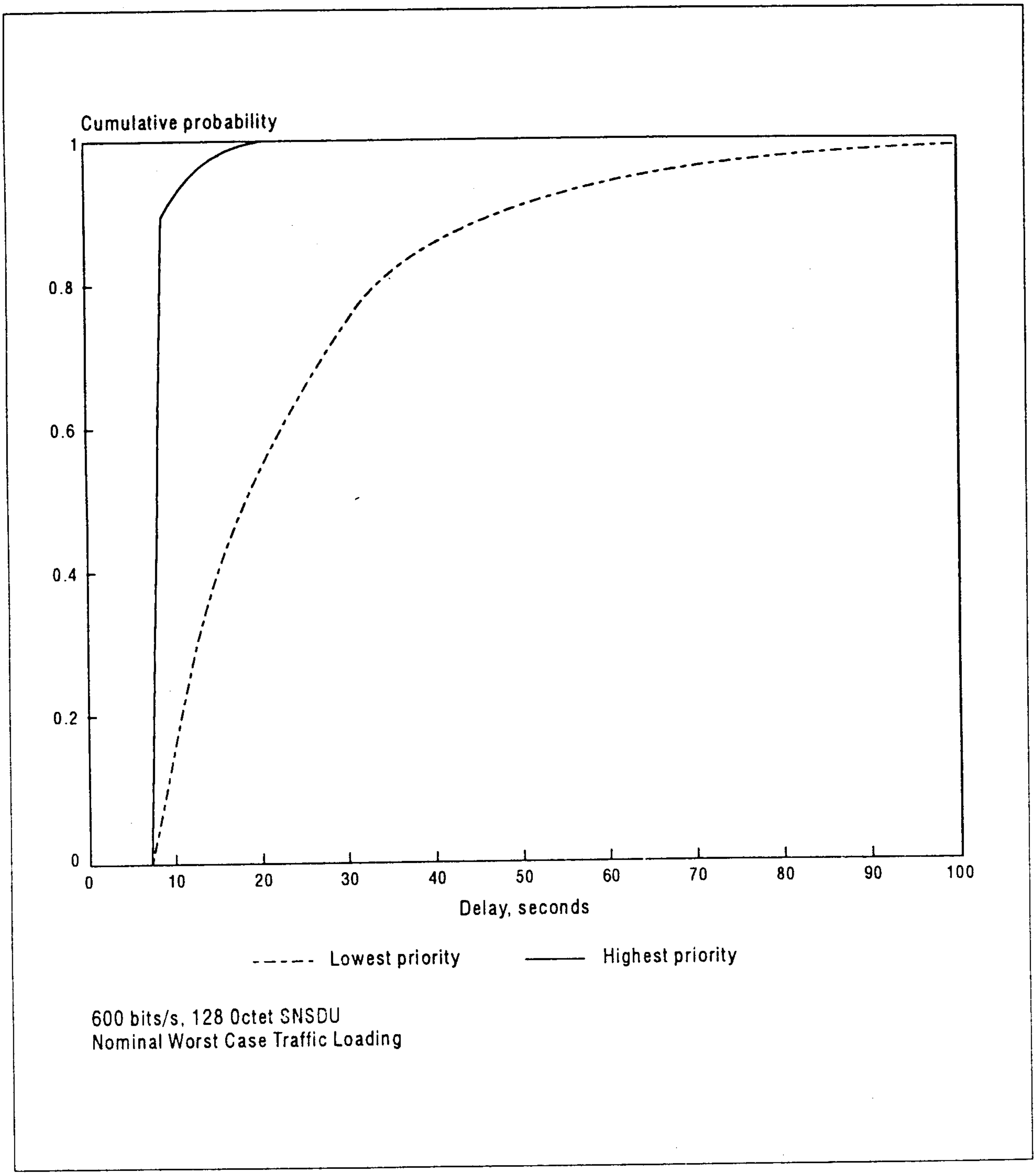


Figure A-15. Typical to-aircraft delay distributions

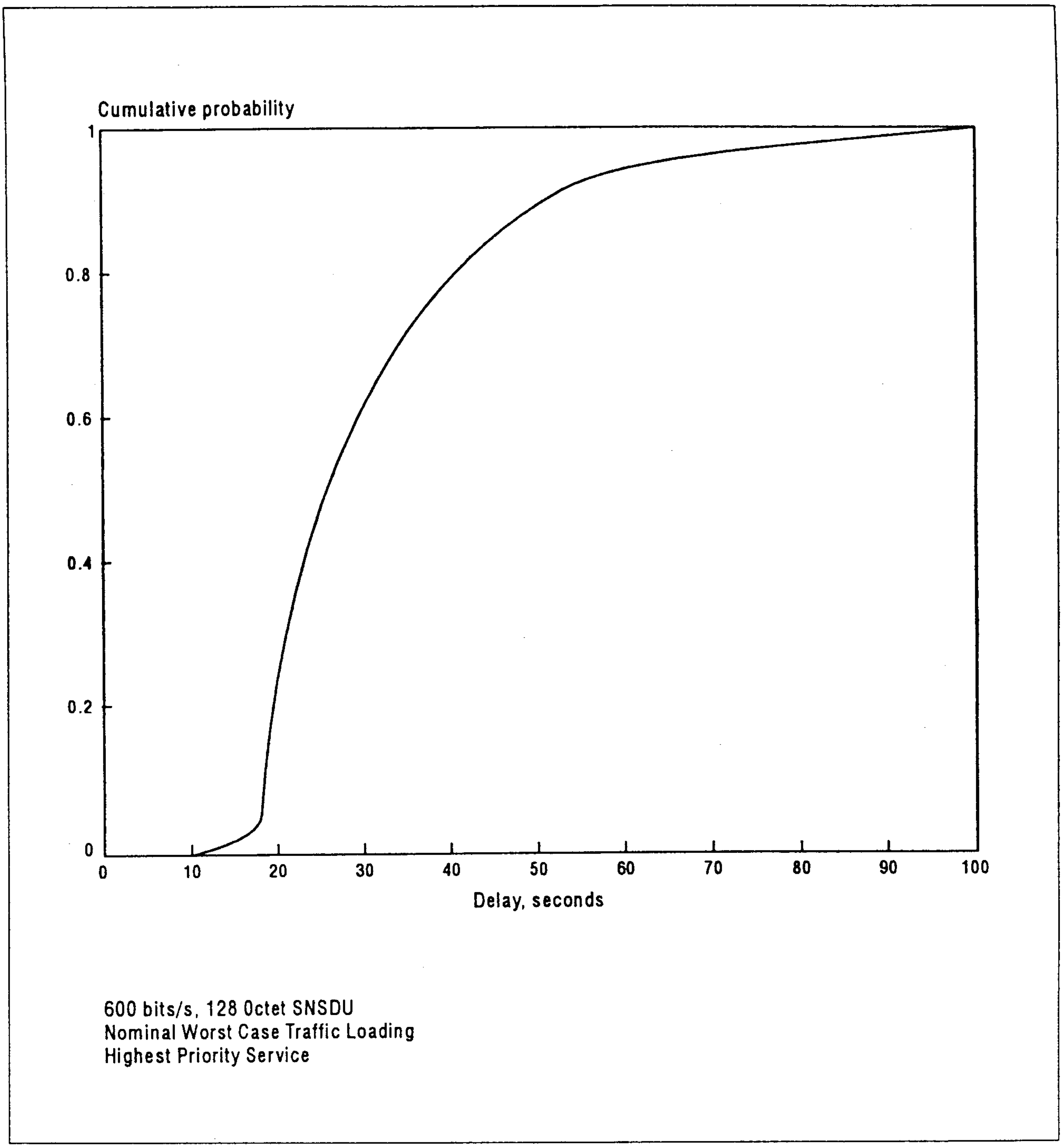


Figure A-16. Typical from-aircraft delay distribution

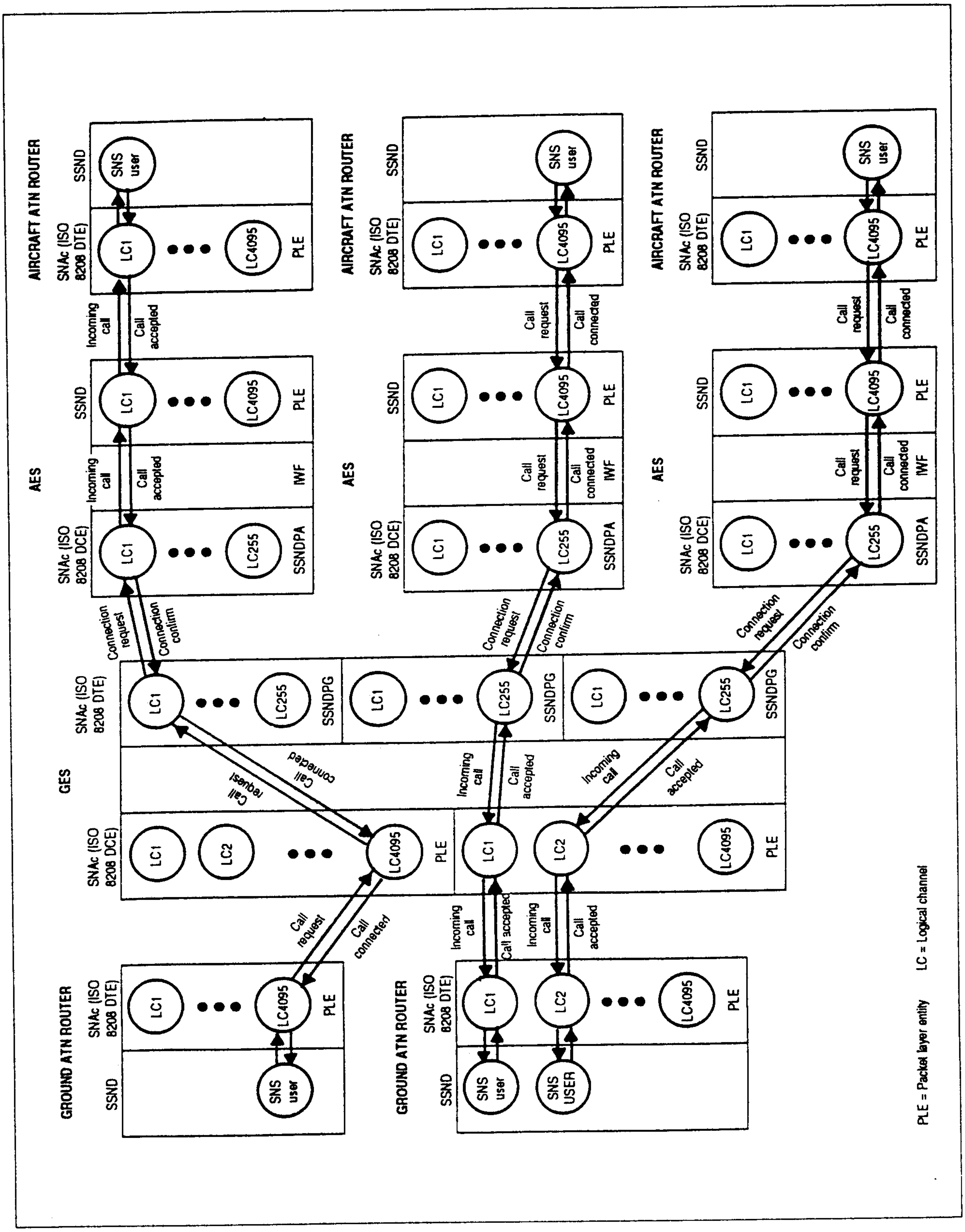


Figure A-17. Satellite subnetwork protocol entities and virtual circuit establishment

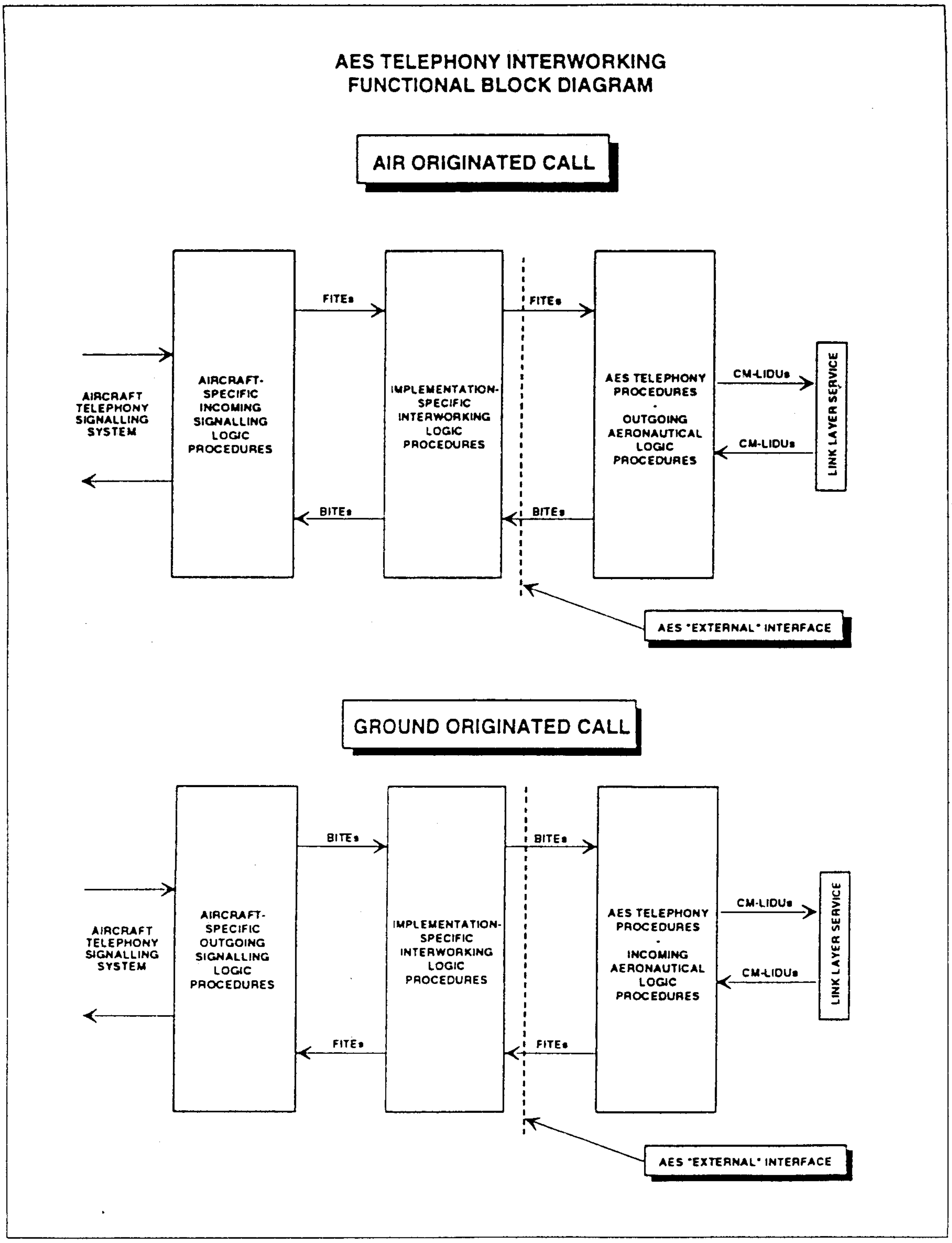


Figure A-18. AES telephony interworking block diagram

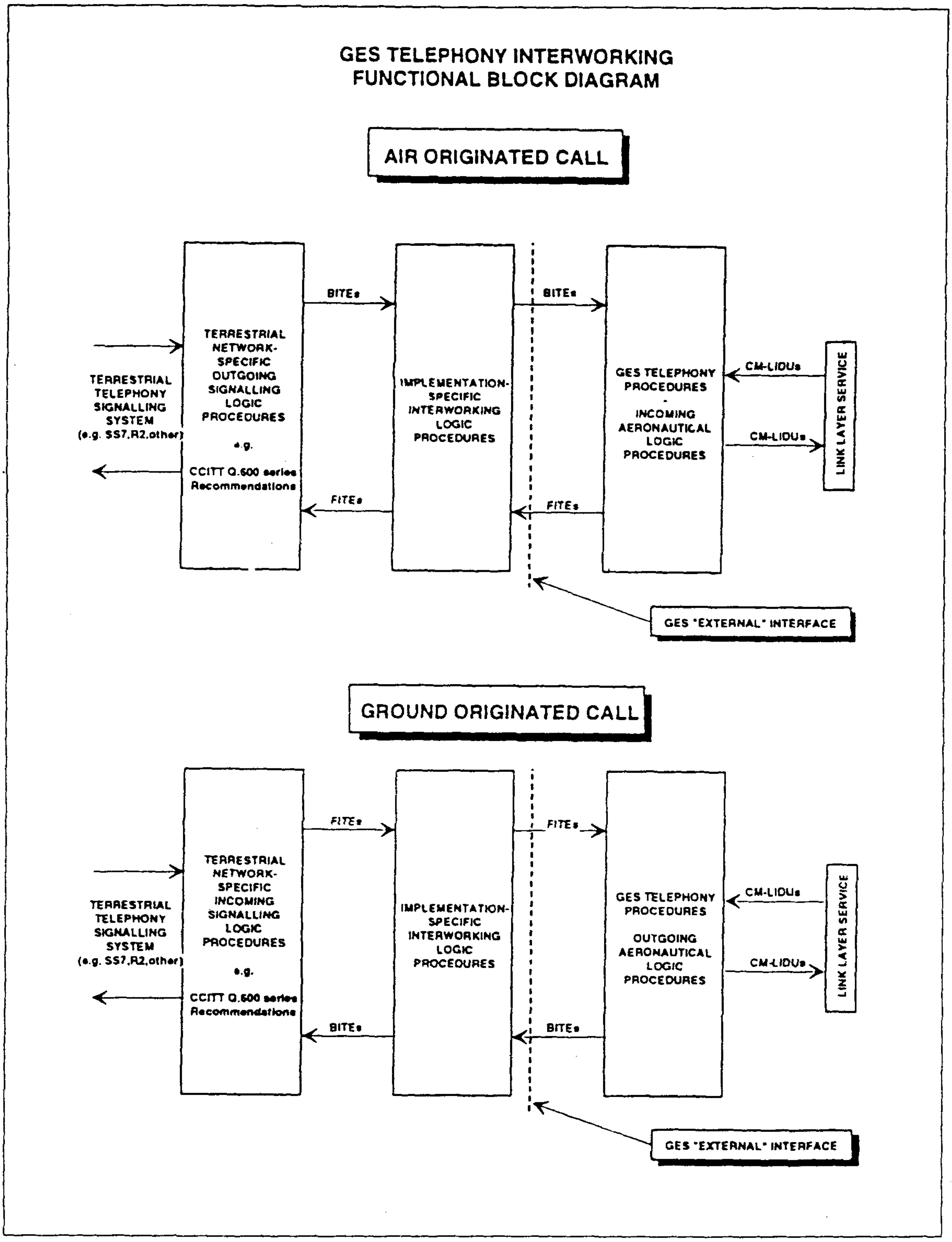


Figure A-19. GES telephony interworking block diagram

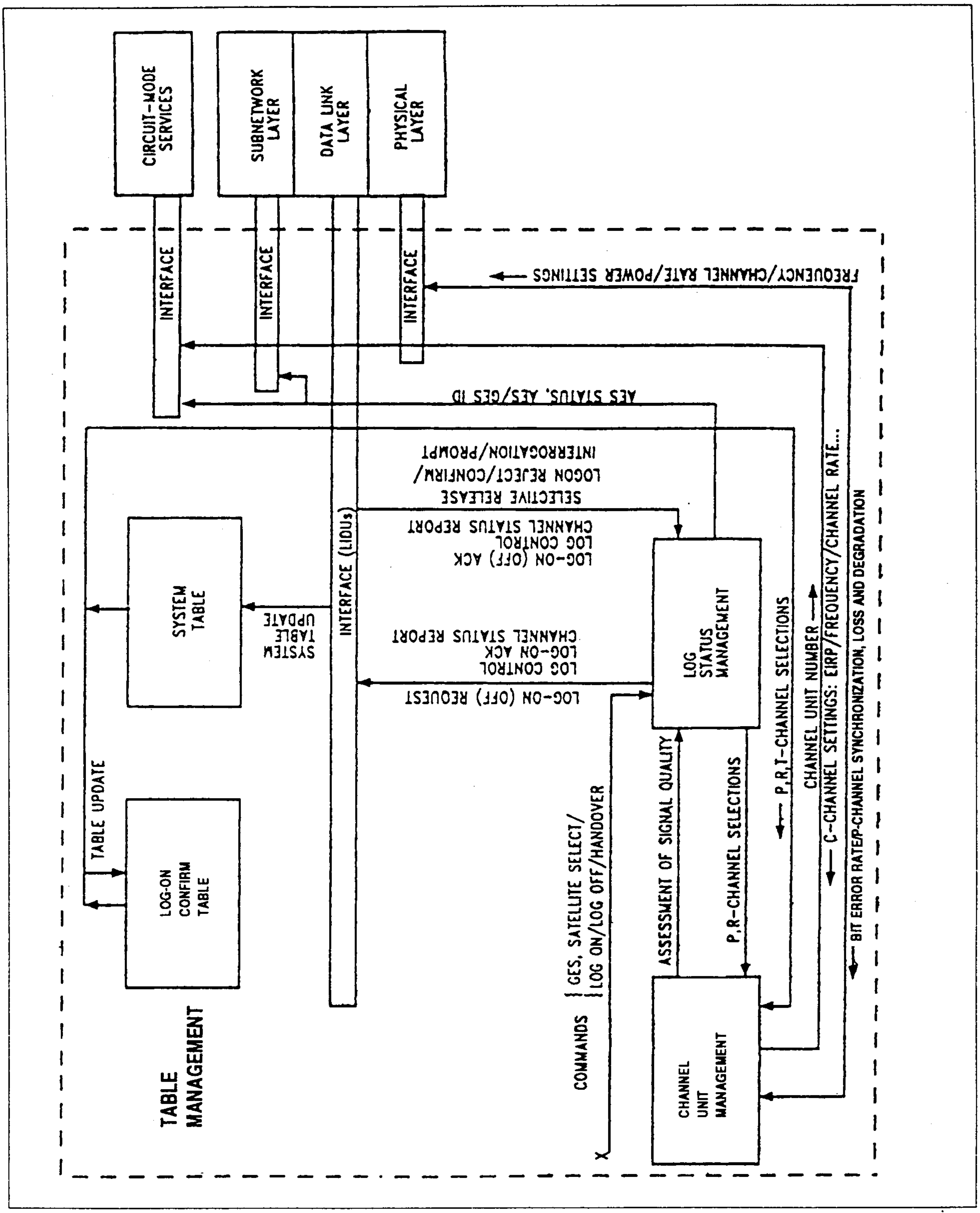


Figure A-20. AES management and interfaces

Appendix to Attachment A
PERFORMANCE ANALYSIS

A1. RF link analysis

The typical performance measure for an RF link is the average bit error rate (BER). The satellite subnetwork end-to-end performance is related to the RF link performance by a required average BER. The relationship between a channel BER and the achieved carrier-to-noise density performance depends upon the modulation technique and the channel conditions. For the case of ideal linear modulation techniques and an additive white Gaussian noise channel, this relationship can be derived analytically. For the case of a random fading channel this relationship can be derived through simulation, or using a worst case assumption that all multipath energy is equivalent to noise.

The digital RF communications link can be assured of satisfactory average BER performance if the achieved carrier-to-noise power density ratio is greater than or equal to the carrier-to-noise power density ratio required for communication at the desired average BER:

$$\left(\frac{C}{N_O}\right)_{ACHIEVED} \geq \left(\frac{C}{N_O}\right)_{REQ} \qquad [A.1]$$

where:

$\left(\frac{C}{N_O}\right)_{REQ}$ is the minimum required carrier-to-noise density ratio for communication at the desired average BER.

$\left(\frac{C}{N_O}\right)_{ACHIEVED}$ is the carrier-to-noise density ratio achieved by the end-to-end link.

The required carrier-to-noise density ratio is determined by the particular signalling wave-form used and by the noise and propagation characteristics of the channel. Statistical methods can be used to determine the minimum required carrier-to-noise ratio needed to assure operation at an average BER. Statistical methods can also be used to include the effects of propagation environment and other random losses in the form of a required margin.

Hence, for operation at a desired average BER the following relationship must hold:

$$M_P \times \left(\frac{C}{N_O}\right)_{REQ} \leq \left(\frac{C}{N_O}\right)_{ACHIEVED} \qquad [A.2]$$

where: M_P is the link margin required for the propagation environment and various random RF parameter variations.

The carrier-to-noise performance measures must be allocated to various portions of the RF link, which are discussed below.

A1.1 To-aircraft link analysis

The achieved carrier-to-noise density ratio on the forward link is determined by a number of noise sources in the RF link. With simple, frequency translating transponders, the achieved signal (carrier)-to-noise power ratio can be computed from the expression:

$$\left(\frac{C}{N_{0\,ACHIEVED}}\right)^{-1} = \left(\frac{C}{N_{UF}}\right)^{-1} + \left(\frac{C}{N_D}\right)^{-1} + \left(\frac{C}{I_M}\right)^{-1} + \left(\frac{C}{I_{IS}}\right)^{-1} + \left(\frac{C}{I_{OD}}\right)^{-1} + \left(\frac{C}{I_{OUF}}\right)^{-1} \qquad [A.3]$$

where:

N_{UF} = the thermal noise power density of the uplink feeder link.

N_D = the thermal noise power density of the L-band downlink.

I_M = the intermodulation power density on the L-band downlink due to the satellite transponder.

I_{IS} = the intrasystem interference power density.

I_{OD} = the downlink L-band intersystem interference power density at the receiver.

I_{OUF} = the intersystem interference power density on the feeder link uplink.

An important assumption is inherent in equation [A.3]. It is assumed that in an individual channel bandwidth all the noise sources can be considered to be "white Gaussian" in nature.

A1.2 From-aircraft link analysis

In the same manner as the forward link, the achieved carrier-to-noise density ratio is determined by a number of noise sources in the return link. The achieved carrier-to-noise power density ratio can be obtained from the expression:

$$\left(\frac{C}{N_{0\,ACHIEVED}}\right)^{-1} = \left(\frac{C}{N_{DF}}\right)^{-1} + \left(\frac{C}{N_U}\right)^{-1} + \left(\frac{C}{I_{M\,AES}}\right)^{-1} + \left(\frac{C}{I_{ISS}}\right)^{-1} + \left(\frac{C}{I_{OU}}\right)^{-1} + \left(\frac{C}{I_{ODF}}\right)^{-1} \qquad [A.4]$$

where:

N_{DF} = the thermal noise power density of the downlink feeder link.
N_U = the thermal noise power density of the L-band uplink.
$I_{M\ AES}$ = the minimum operable intermodulation power density expected on the L-band uplink from the multi-carrier operation of the AES high power amplifiers.
I_{ISR} = the intrasystem interference power density.
I_{OU} = the intersystem interference power density at L-band expected on the uplink.
I_{ODF} = the intersystem interference power density on the feeder link downlink.

A1.3 Propagation anomalies and required margins

An idealized RF link can be adversely affected by a number of factors which can be divided into two basic classes: deterministic and nondeterministic. Deterministic factors influencing RF link margin requirements depend on the propagation path established by the relative locations of the aircraft, satellite and earth in a particular situation. Other deterministic factors are fixed by the system design, such as, information bit rates, modulation type, interleaver depths, coding schemes, etc.

The nondeterministic factors that influence the RF link requirements are system design and operational elements specified by the service provider, degradation due to interference and other propagation-related random losses.

Many factors that influence the RF link requirements may be viewed as losses that reduce the available carrier power and degrade link performance. Detailed discussions of several of these factors are included in the following sections.

A1.3.1 Multipath fading

The term "multipath" refers to a condition in which energy reaches the receiver of a telecommunications system by more than one path. Multipath propagation may result from reflection from land and water surfaces and man-made structures. Multipath operation is generally undesirable, because signals arriving over the different paths arrive with variable relative phase, with the result that they alternatively add constructively or destructively in space. Hence, the total received signal will be characterized by fading, involving repeated minima which may fall below the signal level required for acceptable communications performance. Fading is also significantly higher over water as opposed to land. Furthermore, the signals arriving over the different paths also have different time delays, and in digital systems intersymbol interference can result.

A number of investigators have researched the effects of multipath fading on aeronautical satellite communications. The statistical nature of multipath fading for aeronautical channels is therefore well understood. The amplitude of fading is known to have a Rician distribution. Furthermore, the carrier-to-multipath ratio is known to be a function of the elevation angle to the satellite, and can be expected to be less than 10 dB for elevation angles below 10 degrees.

The carrier-to-noise ratio for a channel is affected by multipath and the particular form of modulation and coding. It is appropriate to include the effects of multipath in setting the carrier-to-noise requirement rather than including it in a separate margin; a conservative approach is to treat the multipath energy as equivalent to additive Gaussian noise, and then, in a coded system, to add additional margin for imperfect interleaving.

A1.3.2 Scintillation

Ionospheric scintillation is a phenomenon involving the effects of the sun and the earth's magnetic field that produces random variations in electromagnetic waves traversing the ionosphere. The phenomenon is manifested in satellite-earth station RF links as "scintillation fading"; positive and negative (loss) changes in the amplitude of the received signal that can be significant at the L-band frequencies used for the satellite-to-AES link. Values as high as 27 dB have been observed for short periods of time during severe scintillation events; however, the expected value is substantially lower. Phase shifting is also associated with scintillation fading, the effects of which can further degrade RF link performance.

As satellite RF link power margins are normally small for economic reasons, a loss value due to scintillation fading as low as 0.3 dB could be significant. Scintillation loss is highly correlated with the position and local time of the aircraft, thus is of major concern to certain routes and times of flight. Scintillation events also exhibit a seasonal influence, peaking during the vernal and autumnal equinoxes. Significant scintillation loss can be expected for aircraft located near the geomagnetic equator (between 15 degrees latitude North and South) at aircraft local time between 2130 and 0230 hours, and for aircraft located in polar regions (latitudes greater than ±65 degrees although coverage by geosynchronous satellites is effectively limited of latitudes to 80 degrees or less) at any time of day. Available data indicate that scintillation fading is about twice as intense in the equatorial region as compared with the polar regions. For a stationary earth station, about 1 per cent of equatorial region fades exceed 20 dB, and stay above 15 dB for several seconds. Eastward motions of the ionosphere at rates of 50 to 200 metres/second are typically seen, implying correlation distances of 10 to 100 metres. It would be possible for an eastbound aircraft's velocity to become "synchronized", resulting in substantially longer fading periods.

Fading in the polar regions is less intense, (about 10 dB for a stationary earth station) as compared with the equatorial region. Also, the velocity of the polar ionosphere is typically higher and more variable, in the range of 100 to 1 000 metres/second.

Data regarding the scintillation effects on earth stations in motion — in particular, on the signal-in-space used by AMSS — is currently limited. Further, the probability of an aircraft experiencing significant effects of scintillation is highly sensitive to its route and timing of its flight. Consequently, the effects of scintillation fading have not been accounted for herein.

A1.3.3 POLARIZATION LOSS

The transmission loss between two antennas due to imperfect circular polarization can be calculated by:

$$L_{POL} = 10\ LOG\left(\frac{(R_1^2+1)(R_2^2+1)}{(R_1R_2+1)^2\cos^2(\theta)+(R_1+R_2)^2\sin^2(\theta)}\right) \quad [A.5]$$

where it is assumed that the antennas have the same sense (e.g. righthand circular) and where:

R_i = the voltage axial ratio (AR) of the ith antenna.

θ = the angle between the major axes of the two elliptically polarized waves that would be radiated, one from each antenna.

The polarization loss is determined completely by the axial ratios and relative orientation of their major axes. The worst case situation is when the major axes are orthogonal, i.e. $\theta = 90°$. Various forms of equation [A.5] are possible, depending upon the assumptions about the reference antenna. For link budget calculations, one typically might consider the worst case satellite antenna orientation, and a statistical estimate of the effects of AES antenna orientation.

A1.3.4 PATH LOSS

The path loss due to space is a function only of the frequency and range. The path loss is easily calculated by:

$$L = \left(\frac{4\pi r}{\lambda}\right)^2 \quad [A.6]$$

where:

r = the range from the AES to the satellite in metres.

λ = the wavelength in metres.

In general, the range to the satellite, r, is a function of the geographical position of the AES. Conveniently, the range to the satellite is simply a function of the observed elevation to the satellite and is given by:

$$r = \sqrt{R^2 + (R+h)^2 - 2R(R+h)\cos\beta} \quad [A.7]$$

where:

R = the Earth's mean radius ≅ 6 378 km

h = the geosynchronous altitude = 35 786 km (from earth surface at the subsatellite point).

$\beta = \cos^{-1}\left[\frac{R\cos(\theta)}{R+h}\right] - \theta$

where:

θ = the elevation angle of the satellite relative to level flight.

With the satellite directly overhead, the path loss at 1 545 MHz is 187.3 dB. At 5° elevation, the path loss is 188.5 dB. Therefore, the path loss for aircraft operating with a 5° elevation angle to the satellite is 1.2 dB greater than an aircraft with the satellite directly overhead. In practice, the path loss is calculated for a specific elevation angle to the satellite.

A1.3.5 PRECIPITATION LOSS

Raindrops cause attenuation to radio waves by both absorption and scatter. The magnitude of attenuation is a function of frequency, average droplet size, aircraft latitude, elevation angle and rainfall rate. The relationships among these factors are well established through years of research and experimental measurement, making it possible to predict performance with confidence.

In general, attenuation due to rainfall is not significant at the L-band frequencies used for the AMSS service links. However, the feeder links for the AMSS services will be at much higher frequencies where the rain attenuation could be very significant. Feeder link design must take into account the expected rainfall for the location of the ground earth station, particularly as regards link availability.

The effect of rain attenuation on the feeder link in the forward direction can be compensated for by GES power control. The GES power is increased such that the signal maintains the required level when received at the satellite. One consequence of this increase in power can be to increase the intermodulation products originating at the GES. The link must be designed so that this additional interference will not degrade the over-all achieved carrier-to-noise performance below the required level.

In the return direction, rain attenuation will lower the carrier power to thermal noise ratio for the feeder link. Again, this additional interference must not degrade the over-all achieved carrier-to-noise performance below the required level.

There is no specific allotment in the required margin to account for the effects of rain fading. It is the responsibility of the satellite system designer to ensure that the satellite and GES design is such that the over-all link carrier-to-noise ratio can be maintained under the expected rain conditions in the stated coverage areas.

9/11/95

— END —

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AERONAUTICAL TELECOMMUNICATIONS

ANNEX 10

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME IV
(SURVEILLANCE RADAR AND COLLISION AVOIDANCE SYSTEMS)

FIRST EDITION — JULY 1995

The first edition of Annex 10, Volume IV was adopted by the Council on 20 March 1995 and becomes applicable on 9 November 1995.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

FOREWORD

Historical background

Standards and Recommended Practices for Aeronautical Telecommunications were first adopted by the Council on 30 May 1949 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 10 to the Convention. They became effective on 1 March 1950. The Standards and Recommended Practices were based on recommendations of the Communications Division at its Third Session in January 1949.

Up to and including the Seventh Edition, Annex 10 was published in one volume containing four Parts together with associated attachments: Part I — Equipment and Systems, Part II — Radio Frequencies, Part III — Procedures, and Part IV — Codes and Abbreviations.

By Amendment 42, Part IV was deleted from the Annex; the codes and abbreviations contained in that Part were transferred to a new document, Doc 8400.

As a result of the adoption of Amendment 44 on 31 May 1965, the Seventh Edition of Annex 10 was replaced by two volumes: Volume I (First Edition) containing Part I — Equipment and Systems, and Part II — Radio Frequencies, and Volume II (First Edition) containing Communication Procedures.

As a result of the adoption of Amendment 70 on 20 March 1995, Annex 10 was restructured to include five volumes: Volume I — Radio Navigation Aids; Volume II — Communication Procedures; Volume III — Communication Systems; Volume IV — Surveillance Radar and Collision Avoidance Systems; and Volume V — Aeronautical Radio Frequency Spectrum Utilization. By Amendment 70, Volumes III and IV were published in 1995 and Volume V was planned for publication with Amendment 71.

Table A shows the origin of amendments to Annex 10, Volume IV subsequent to Amendment 70, together with a summary of the principal subjects involved and the dates on which the Annex and the amendments were adopted by Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards, Recommended Practices and Procedures specified in Annex 10 should be notified and take effect in accordance with the provisions of Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been deliberately written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices*:

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption;

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text;

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices;

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use on non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 10, Volume IV

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
70	Air Navigation Commission; Fifth Meeting of the Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel	Creation of Volume IV and introduction of Standards and Recommended Practices and related guidance material for airborne collision avoidance system (ACAS)	20 March 1995 24 July 1995 9 November 1995

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

Note.— This chapter will be expanded with the relocation from Volume I to Volume IV of material relating to surveillance radar systems.

Airborne collision avoidance system (ACAS). An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Note 1.— In this context the term "independently" means that ACAS operates independently of other systems used by air traffic services except for communication with Mode S ground stations as defined in Chapter 4, 4.3.6.2.

Note 2.— SSR transponders referred to above are those operating in Mode C or Mode S.

CHAPTER 2. GENERAL

Note.— Material for this chapter will be introduced with the relocation from Volume I to Volume IV of material relating to surveillance radar systems.

CHAPTER 3. SURVEILLANCE RADAR SYSTEMS

Note.— Material for this chapter will be introduced with the relocation from Volume I to Volume IV of material relating to surveillance radar systems.

CHAPTER 4. AIRBORNE COLLISION AVOIDANCE SYSTEM

Note.— Guidance material relating to airborne collision avoidance system is contained in Attachment A.

4.1 DEFINITIONS RELATING TO AIRBORNE COLLISION AVOIDANCE SYSTEM

ACAS I. An ACAS which provides information as an aid to "see and avoid" action but does not include the capability for generating resolution advisories (RAs).

Note.— ACAS I is not intended for international implementation and standardization by ICAO. Therefore, only ACAS I characteristics required to ensure compatible operation with other ACAS configurations and interference limiting are defined in 4.2.

ACAS II. An ACAS which provides vertical resolution advisories (RAs) in addition to traffic advisories (TAs).

ACAS III. An ACAS which provides vertical and horizontal resolution advisories (RAs) in addition to traffic advisories (TAs).

ACAS broadcast. A long Mode S air-air surveillance interrogation (UF = 16) with the broadcast address.

Altitude crossing RA. A resolution advisory is altitude crossing if own ACAS aircraft is currently at least 30 m (100 ft) below or above the threat aircraft for upward or downward sense advisories, respectively.

Closest approach. The occurrence of minimum range between own ACAS aircraft and the intruder. Thus range at closest approach is the smallest range between the two aircraft and time of closest approach is the time at which this occurs.

Co-ordination. The process by which two ACAS-equipped aircraft select compatible resolution advisories (RAs) by the exchange of resolution advisory complements (RACs).

Co-ordination interrogation. A Mode S interrogation (uplink transmission) radiated by ACAS II or III and containing a resolution message.

Co-ordination reply. A Mode S reply (downlink transmission) acknowledging the receipt of a co-ordination interrogation by the Mode S transponder that is part of an ACAS II or III installation.

Corrective RA. A resolution advisory that advises the pilot to deviate from the current flight path.

Cycle. The term "cycle" used in this chapter refers to one complete pass through the sequence of functions executed by ACAS II or ACAS III, nominally once a second.

Established threat. An intruder that has been declared a threat and still merits a resolution advisory.

Established track. A track generated by ACAS air-air surveillance that is treated as the track of an actual aircraft.

Increased rate RA. A resolution advisory with a strength that recommends increasing the altitude rate to a value exceeding that recommended by a previous climb or descend RA.

Intruder. An SSR transponder-equipped aircraft within the surveillance range of ACAS for which ACAS has an established track.

Own aircraft. The aircraft fitted with the ACAS that is the subject of the discourse, which ACAS is to protect against possible collisions, and which may enter a manoeuvre in response to an ACAS indication.

Positive RA. A resolution advisory that advises the pilot either to climb or to descend (applies to ACAS II). A positive RA can be either corrective or preventive.

Potential threat. An intruder deserving special attention either because of its close proximity to own aircraft or because successive range and altitude measurements indicate that it could be on a collision or near-collision course with own aircraft. The warning time provided against a potential threat is sufficiently small that a traffic advisory (TA) is justified but not so small that a resolution advisory (RA) would be justified.

Preventive RA. A resolution advisory that advises the pilot to avoid certain deviations from the current flight path but does not require any change in the current flight path.

Resolution advisory (RA). An indication given to the flight crew recommending:

a) a manoeuvre intended to provide separation from all threats; or

b) a manoeuvre restriction intended to maintain existing separation.

Resolution advisory complement (RAC). Information provided by one ACAS to another via a Mode S interrogation in order to ensure complementary manoeuvres by restricting the choice of manoeuvres available to the ACAS receiving the RAC.

Resolution advisory complements record (RAC record). A composite of all currently active vertical RACs (VRCs) and horizontal RACs (HRCs) that have been received by ACAS. This information is provided by one ACAS to another ACAS or to a Mode S ground station via a Mode S reply.

Resolution advisory strength. The magnitude of the manoeuvre indicated by the RA. An RA may take on several successive strengths before being cancelled. Once a new RA strength is issued, the previous one automatically becomes void.

Resolution message. The message containing the resolution advisory complement (RAC).

Reversed sense RA. A resolution advisory that has had its sense reversed.

Sense. The sense of an ACAS II RA is "upward" if it requires climb or limitation of descent rate and "downward" if it requires descent or limitation of climb rate.

Sensitivity level (S). An integer defining a set of parameters used by the traffic advisory (TA) and collision avoidance algorithms to control the warning time provided by the potential threat and threat detection logic, as well as the values of parameters relevant to the RA selection logic.

Threat. An intruder deserving special attention either because of its close proximity to own aircraft or because successive range and altitude measurements indicate that it could be on a collision or near-collision course with own aircraft. The warning time provided against a threat is sufficiently small that an RA is justified.

Track. A sequence of at least three measurements representing positions that could reasonably have been occupied by an aircraft.

Traffic advisory (TA). An indication given to the flight crew that a certain intruder is a potential threat.

Vertical speed limit (VSL) RA. A resolution advisory advising the pilot to avoid a given range of altitude rates. A VSL RA can be either corrective or preventive.

Warning time. The time interval between potential threat or threat detection and closest approach when neither aircraft accelerates.

4.2 ACAS I GENERAL PROVISIONS AND CHARACTERISTICS

4.2.1 *Functional requirements.* ACAS I shall perform the following functions:

a) surveillance of nearby SSR transponder-equipped aircraft; and

b) provide indications to the flight crew identifying the approximate position of nearby aircraft as an aid to visual acquisition.

Note.— ACAS I is intended to operate using Mode A/C interrogations only. Furthermore, it does not co-ordinate with other ACAS. Therefore, a Mode S transponder is not required as a part of an ACAS I installation.

4.2.2 *Signal format.* The RF characteristics of all ACAS I signals shall conform to the provisions of Annex 10, Volume I, Part I, Chapter 3, 3.8.1.1 through 3.8.1.6 and 3.8.2.1 through 3.8.2.4.

4.2.3 Interference control

4.2.3.1 *Maximum radiated RF power.* The effective radiated power of an ACAS I transmission at zero degrees elevation relative to the longitudinal axis of the aircraft shall not exceed 24 dBW.

4.2.3.2 *Unwanted radiated power.* When ACAS I is not transmitting an interrogation, the effective radiated power in any direction shall not exceed −70 dBm.

Note.— This requirement is to ensure that, when not transmitting an interrogation, ACAS I does not radiate RF energy that could interfere with, or reduce the sensitivity of, the SSR transponder or radio equipment in other nearby aircraft or ground facilities.

4.2.3.3 *Interference limiting.* Each ACAS I interrogator shall control its interrogation rate or power or both in all SSR modes to minimize interference effects (4.2.3.3.3 and 4.2.3.3.4).

Note.— These limits are a means of ensuring that all interference effects resulting from these interrogations, together with the interrogations from all other ACAS I, ACAS II and ACAS III interrogators in the vicinity are kept to a low level.

4.2.3.3.1 *Determination of own transponder reply rate.* ACAS I shall monitor the rate that own transponder replies to interrogations to ensure that the provisions in 4.2.3.3.3 are met.

4.2.3.3.2 *Determination of the number of ACAS II and ACAS III interrogators.* ACAS I shall count the number of ACAS II and ACAS III interrogators in the vicinity to ensure that the provisions in 4.2.3.3.3 or 4.2.3.3.4 are met. This count shall be obtained by monitoring ACAS broadcasts (UF = 16), (4.3.7.1.2.4) and shall be updated as the number of distinct ACAS Mode S addresses received within the previous 20 s period at a nominal frequency of at least 1 Hz.

4.2.3.3.3 *Mode A/C ACAS I interference limits.* The interrogator power shall not exceed the following limits:

n_a	*Upper limit for* $\{\sum_{k=1}^{k_t} P_a(k)\}$	
	If $f_r \leq 240$	*If* $f_r > 240$
0	167	48
1	157	45
2	147	42
3	137	39
4	127	36

n_a	*Upper limit for* $\{\sum_{k=1}^{k_t} P_a(k)\}$	
	If $f_r \leq 240$	*If* $f_r > 240$
5	117	34
6	107	31
7	97	28
8	87	25
9	77	22
10	67	19
11	57	16
12	47	14
13	37	11
14	27	8
≥15	17	5

where:

n_a = number of operating ACAS II and ACAS III equipped aircraft near own (based on ACAS broadcasts received with a transponder receiver threshold of −74 dBm);

{ } = average value of the expression within the brackets over last 16 interrogation cycles;

$P_a(k)$ = peak power radiated from the antenna in all directions of the pulse having the largest amplitude in the group of pulses comprising a single interrogation during the *k*th Mode A/C interrogation in a 1 s interrogation cycle, W;

k = index number for Mode A/C interrogations, $k = 1, 2, ..., k_t$;

k_t = number of Mode A/C interrogations transmitted in a 1 s interrogation cycle;

f_r = Mode A/C reply rate of own transponder.

4.2.3.3.4 *Mode S ACAS I interference limits.* An ACAS I that uses Mode S interrogations shall not cause greater interference effects than an ACAS I using Mode A/C interrogations only.

4.3 GENERAL PROVISIONS RELATING TO ACAS II AND ACAS III

Note 1.— The acronym ACAS is used in this section to indicate either ACAS II or ACAS III.

Note 2.— There are currently no ICAO provisions concerning mandatory carriage of ACAS equipment.

Note 3.— The term "equipped threat" is used in this section to indicate a threat fitted with ACAS II or ACAS III.

4.3.1 Functional requirements

4.3.1.1 *ACAS functions.* ACAS shall perform the following functions:

a) surveillance;

b) generation of TAs;

c) threat detection;

d) generation of RAs;

e) co-ordination; and

f) communication with ground stations.

The equipment shall execute functions b) through e) on each cycle of operation.

Note.— Certain features of these functions must be standardized to ensure that ACAS units co-operate satisfactorily with other ACAS units, with Mode S ground stations and with the ATC system. Each of the features that are standardized is discussed below. Certain other features are given herein as recommendations.

4.3.1.1.1 The duration of a cycle shall not exceed 1.2 s.

4.3.2 Surveillance performance requirements

4.3.2.1 *General surveillance requirements.* ACAS shall interrogate SSR Mode A/C and Mode S transponders in other aircraft and detect the transponder replies. ACAS shall measure the range and relative bearing of responding aircraft. Using these measurements and information conveyed by transponder replies, ACAS shall estimate the relative positions of each responding aircraft. ACAS shall include provisions for achieving such position determination in the presence of ground reflections, interference and variations in signal strength.

4.3.2.1.1 *Track establishment probability.* ACAS shall generate an established track, with at least a 0.90 probability that the track is established 30 s before closest approach, on aircraft equipped with transponders when all of the following conditions are satisfied:

a) the elevation angles of these aircraft are within ±10 degrees relative to the ACAS aircraft pitch plane;

b) the magnitudes of these aircraft's rates of change of altitude are less than or equal to 51 m/s (10 000 ft/min);

c) the transponders and antennas of these aircraft meet the Standards of Annex 10, Volume I, Part I, Chapter 3, 3.8.1 and 3.8.2; and

d) the closing speeds and directions of these aircraft, the local density of SSR transponder-equipped aircraft and the number of other ACAS interrogators in the vicinity (as determined by monitoring ACAS broadcasts, 4.3.7.1.2.4) satisfy the conditions specified in Table 4-1.

4.3.2.1.1.1 ACAS shall continue to provide surveillance with no abrupt degradation in track establishment probability as any one of the condition bounds defined in 4.3.2.1.1 is exceeded.

4.3.2.1.1.2 ACAS shall not track Mode S aircraft that report that they are on the ground.

Note.— A Mode S aircraft may report that it is on the ground by coding in the vertical status (VS) field in a DF = 0 transmission (Annex 10, Volume I, Chapter 3, 3.8.2.8.2.1). Alternatively, if the aircraft is under Mode S ground surveillance, ground status may be determined by monitoring the flight status (FS) field in downlink formats DF = 4, 5, 20 or 21 (Annex 10, Volume I, Chapter 3, 3.8.2.6.5.1).

4.3.2.1.1.3 **Recommendation.—** *ACAS should achieve the required tracking performance when the average SSR Mode A/C asynchronous reply rate from transponders in the vicinity of the ACAS aircraft is 240 replies per second and when the peak interrogation rate received by the individual transponders under surveillance is 500 per second.*

Note.— The peak interrogation rate mentioned above includes interrogations from all sources.

Table 4-1

Conditions									*Performance*
Quadrant						*Maximum traffic density*		*Maximum number of other ACAS within 56 km (30 NM)*	*Probability of success*
Forward		*Side*		*Back*					
Maximum closing speed									
m/s	*kt*	*m/s*	*kt*	*m/s*	*kt*	*aircraft/ km^2*	*aircraft/ NM^2*		
260	500	150	300	93	180	0.087	0.30	30	0.90
620	1 200	390	750	220	430	0.017	0.06	30	0.90

4.3.2.1.2 *False track probability.* The probability that an established Mode A/C track does not correspond in range and altitude, if reported, to an actual aircraft shall be less than 10^{-2}. For an established Mode S track this probability shall be less than 10^{-6}. These limits shall not be exceeded in any traffic environment.

4.3.2.2 INTERFERENCE CONTROL

4.3.2.2.1 *Maximum radiated RF power.* The effective radiated power of an ACAS transmission at zero degrees elevation relative to the longitudinal axis of the aircraft shall not exceed 27 dBW.

4.3.2.2.1.1 *Unwanted radiated power.* When ACAS is not transmitting an interrogation, the effective radiated power in any direction shall not exceed −70 dBm.

4.3.2.2.2 *Interference limiting.* Each ACAS interrogator shall control its interrogation rate or power or both so as to conform with specific inequalities (4.3.2.2.2.2).

4.3.2.2.2.1 *Determination of the number of other ACAS.* ACAS shall count the number of other ACAS II and III interrogators in the vicinity to ensure that the interference limits are met. This count shall be obtained by monitoring ACAS broadcasts (UF = 16), (4.3.7.1.2.4). Each ACAS shall monitor such broadcast interrogations to determine the number of other ACAS within detection range.

4.3.2.2.2.2 *ACAS interference limiting inequalities.* ACAS shall adjust its interrogation rate and interrogation power such that the following three inequalities remain true, except as provided in 4.3.2.2.2.2.1.

$$\left\{\sum_{i=1}^{i_t} \frac{p(i)}{250}\right\} < minimum \left[\frac{280}{1 + n_a}, 18\right] \qquad (1)$$

$$\left\{\sum_{i=1}^{i_t} m(i)\right\} < 0.01 \qquad (2)$$

$$\left\{\frac{1}{B} \sum_{k=1}^{k_t} \frac{P_a(k)}{250}\right\} < minimum \left[\frac{80}{1 + n_a}, 5\right] \qquad (3)$$

The variables in these inequalities shall be defined as follows:

i_t = number of interrogations (Mode A/C and Mode S) transmitted in a 1 s interrogation cycle;

i = index number for Mode A/C and Mode S interrogations, $i = 1, 2, ..., i_t$;

$p(i)$ = peak power radiated from the antenna in all directions of the pulse having the largest amplitude in the group of pulses comprising a single interrogation during the *i*th interrogation in a 1 s interrogation cycle, W;

$m(i)$ = duration of the mutual suppression interval for own transponder associated with the *i*th interrogation in a 1 s interrogation cycle, s;

B = beam sharpening factor (ratio of 3 dB beamwidth to beamwidth resulting from interrogation sidelobe suppression). For ACAS interrogators that employ transmitter sidelobe suppression (SLS), the appropriate beamwidth shall be the extent in azimuth angle of the Mode A/C replies from one transponder as limited by SLS, averaged over the transponder population;

{ } see 4.2.3.3.3
$P_a(k)$ "
k "
k_t "
n_a "

Note.— RA and ACAS broadcasts (4.3.6.2.1 and 4.3.7.1.2.4) are interrogations.

4.3.2.2.2.2.1 *Transmissions during RAs.* All air-to-air co-ordination interrogations and RA and ACAS broadcasts shall be transmitted at full power and these interrogations shall be excluded from the summations of Mode S interrogations in the left-hand terms of inequalities (1) and (2) in 4.3.2.2.2.2 for the duration of the RA.

4.3.2.2.2.2.2 *Transmissions from ACAS units on the ground.* Whenever the ACAS aircraft indicates that it is on the ground, ACAS interrogations shall be limited by setting the number of other ACAS II and III aircraft (n_a) count in the interference limiting inequalities to a value of 60.

4.3.3 Traffic advisories (TAs)

4.3.3.1 *TA function.* ACAS shall provide TAs to alert the flight crew to potential threats. Such TAs shall be accompanied by an indication of the approximate relative position of potential threats.

4.3.3.2 PROXIMATE TRAFFIC DISPLAY

Recommendation.— *While any RA and/or TA are displayed, proximate traffic within 11 km (6 NM) range and, if altitude reporting, ±370 m (1 200 ft) altitude should be displayed. This proximate traffic should be distinguished (e.g. by colour or symbol type) from threats and potential threats, which should be more prominently displayed.*

4.3.3.2.1 *ANGULAR ACCURACY*

Recommendation.— *The error in the measurement of relative bearing used in the display of traffic should not exceed 10 degrees rms.*

4.3.3.3 *TAs as RA precursors.* The criteria for TAs shall be such that they are satisfied before those for an RA.

4.3.3.3.1 *TA warning time.* For intruders reporting altitude, the nominal TA warning time shall not be greater than (T+20 s) where T is the nominal warning time for the generation of the resolution advisory.

Note.— Ideally, RAs would always be preceded by a TA but this is not always possible, e.g. the RA criteria might be already satisfied when a track is first established, or a sudden and sharp manœuvre by the intruder could cause the TA lead time to be less than a cycle.

4.3.4 Threat detection

4.3.4.1 *Declaration of threat.* ACAS shall evaluate appropriate characteristics of each intruder to determine whether or not it is a threat.

4.3.4.1.1 *Intruder characteristics.* As a minimum, the characteristics of an intruder that are used to identify a threat shall include:

a) tracked altitude;

b) tracked rate of change of altitude;

c) tracked slant range;

d) tracked rate of change of slant range; and

e) sensitivity level of intruder's ACAS, S_i.

For an intruder not equipped with ACAS II or ACAS III, S_i shall be set to 1.

4.3.4.1.1.1 *Range resolution.* Range shall be measured with a resolution of 14.5 m (1/128 NM) or better.

4.3.4.1.2 *Own aircraft characteristics.* As a minimum, the characteristics of own aircraft that are used to identify a threat shall include:

a) altitude;

b) rate of change of altitude; and

c) sensitivity level of own ACAS (4.3.4.3).

4.3.4.2 *Sensitivity levels.* ACAS shall be capable of operating at any of a number of sensitivity levels. These shall include:

a) S = 1, a "standby" mode in which the interrogation of other aircraft and all advisories are inhibited;

b) S = 2, a "TA only" mode in which RAs are inhibited; and

c) S = 3-7, further levels that enable the issue of TAs and RAs that provide the warning times indicated in Table 4-2.

4.3.4.3 *Selection of own sensitivity level (S_o).* The selection of own ACAS sensitivity level shall be determined by sensitivity level control (SLC) commands which shall be accepted from a number of sources as follows:

a) SLC command generated automatically by ACAS based on altitude band or other external factors;

b) SLC command from pilot input; and

c) SLC command from Mode S ground stations.

Table 4-2

Sensitivity level	*2*	*3*	*4*	*5*	*6*	*7*
Nominal warning time	no RAs	15s	20s	25s	30s	35s

4.3.4.3.1 *Permitted SLC command codes.* As a minimum, the acceptable SLC command codes shall include:

	Coding
for SLC based on altitude band	2-7
for SLC from pilot input	0,1,2
for SLC from Mode S ground stations	0,2-6

4.3.4.3.2 *Altitude-band SLC command.* Where ACAS selects an SLC command based on altitude, hysteresis shall be applied to the nominal altitude thresholds at which SLC command value changes are required as follows: for a climbing ACAS aircraft the SLC command shall be increased at the appropriate altitude threshold plus the hysteresis value; for a descending ACAS aircraft the SLC command shall be decreased at the appropriate altitude threshold minus the hysteresis value.

Note.— The automatic selection of SLC commands based on altitude alone has been found to be generally useful and acceptable but other automatic algorithms, for example based on altitude rate, are not precluded.

4.3.4.3.3 *Pilot SLC command.* For the SLC command set by the pilot the value 0 shall indicate the selection of the "automatic" mode for which the sensitivity level selection shall be based on the other commands.

4.3.4.3.4 *Mode S ground station SLC command.* For SLC commands transmitted via Mode S ground stations (4.3.8.4.2.1.1), the value 0 shall indicate that the station concerned is not issuing an SLC command and that sensitivity level selection shall be based on the other commands, including non-zero commands from other Mode S ground stations. ACAS shall not process an uplinked SLC value of 1.

4.3.4.3.4.1 *ATS selection of SLC command code.* ATS authorities shall ensure that procedures are in place to inform pilots of any ATS selected SLC command code other than zero (4.3.4.3.1).

4.3.4.3.5 *Selection rule.* Own ACAS sensitivity level shall be set to the smallest non-zero SLC command received from any of the sources listed in 4.3.4.3.

4.3.4.4 *Selection of parameter values for RA generation.* When the sensitivity level of own ACAS is 3 or greater, the parameter values used for RA generation that depend on sensitivity level shall be based on the greater of the sensitivity level of own ACAS, S_o, and the sensitivity level of the intruder's ACAS, S_i.

4.3.4.5 *Selection of parameter values for TA generation.* The parameter values used for TA generation that depend on sensitivity level shall be selected on the same basis as those for RAs (4.3.4.4) except when an SLC command with a value of 2 ("TA only" mode) has been received from either the pilot or a Mode S ground station. In this case, the parameter values for TA generation shall retain the values they would have had in the absence of the SLC command from the pilot or Mode S ground station.

4.3.5 Resolution advisories (RAs)

4.3.5.1 *RA generation.* For all threats, ACAS shall generate an RA except where:

a) the RA needs to be delayed in order to ensure co-ordination with an equipped threat (4.3.5.8.1), in which case the RAC is none the less selected and transmitted to the threat (4.3.6.1.3); or

b) it is not possible to select an RA that can be predicted to provide adequate separation either because of uncertainty in the diagnosis of the intruder's flight path or because there is a high risk that a manoeuvre by the threat will negate the RA, in which case an RAC is not transmitted.

4.3.5.1.1 *RA cancellation.* Once an RA has been generated against a threat or threats it shall be maintained or modified until tests that are less stringent than those for threat detection indicate on two consecutive cycles that the RA may be cancelled, at which time it shall be cancelled.

4.3.5.2 *Selection of RA magnitude.* ACAS shall generate the RA that is predicted to provide adequate separation from all threats and that has the least effect on the current flight path of the ACAS aircraft consistent with the other provisions in this chapter.

4.3.5.3 *RA effectiveness.* ACAS shall not generate or continue to display an RA that, considering the range of probable threat trajectories, is more likely to reduce separation than increase it at the predicted time of closest approach, subject to the provisions in 4.3.5.5.1.1 and 4.3.5.6.

4.3.5.4 *Aircraft capability.* The RA generated by ACAS shall be consistent with the performance capability of the aircraft.

4.3.5.4.1 *Proximity to the ground.* Descend RAs shall not be generated or maintained when own aircraft is below Z_{nd} AGL.

4.3.5.4.1.1 The value of Z_{nd} shall not be less than 335 m (1 100 ft). Hysteresis of ±30.5 m (100 ft) shall be applied to Z_{nd} according to the rule described in 4.3.4.3.2.

4.3.5.4.2 ACAS shall not operate in sensitivity levels 3-7 when own aircraft is below 300 m (1 000 ft) AGL.

4.3.5.5 *Reversals of sense.* ACAS shall not reverse the sense of an RA from one cycle to the next, except as permitted in 4.3.5.5.1 to ensure co-ordination or when the predicted separation at closest approach for the existing sense is inadequate.

4.3.5.5.1 *Sense reversals against equipped threats.* If an RAC received from an equipped threat is incompatible with the current RA sense, ACAS shall modify the RA sense to conform with the received RAC if own aircraft's Mode S address is higher in value than that of the threat.

Note.— 4.3.6.1.3 requires that the own ACAS RAC for the threat is also reversed.

4.3.5.5.1.1 ACAS shall not modify an RA sense in a way that makes it incompatible with an RAC received from an equipped threat if own aircraft's Mode S address is higher in value than that of the threat.

4.3.5.6 *RA strength retention.* Subject to the requirement that a descend RA is not generated at low altitude (4.3.5.4.1), an RA shall not be modified if the time to closest approach is too short to achieve a significant response or if the threat is diverging in range.

4.3.5.6.1 An RA shall not be modified if the tests provided for in 4.3.5.1.1 have indicated once, but not twice successively, that the RA may be cancelled.

4.3.5.7 *Weakening an RA.* An RA shall not be weakened if it is likely that it would subsequently need to be strengthened.

4.3.5.8 *ACAS-equipped threats.* The RA shall be compatible with all the RACs transmitted to threats. If an RAC is received from a threat before own ACAS generates an RAC for that threat, the RA generated shall be compatible with the RAC received unless such an RA is more likely to reduce separation than increase it and own Mode S address is lower in value than that of the threat.

4.3.5.8.1 *Resolution advisory deferral.* ACAS shall defer generation of an RA in respect of a particular equipped threat for up to three cycles if:

a) the threat has an operating resolution capability; and

b) an RAC has not been received from the threat; and

c) the threat has a Mode S address that is lower than that of own ACAS.

4.3.5.8.1.1 If an RAC is received from the threat during the deferral period, ACAS shall immediately generate an RA compatible with the RAC that has been received, if necessary cancelling its earlier RAC (4.3.6.1.3.4) to comply with 4.3.5.8.

4.3.5.9 *Encoding of ARA subfield.* Each cycle, the RA sense, strength and attributes shall be encoded in the active RA (ARA) subfield (4.3.8.4.2.2.1.1). If the ARA subfield has not been refreshed for an interval of 6 s, it shall be set to ZERO, along with the MTE subfield in the same message (4.3.8.4.2.2.1.3).

4.3.5.10 *System response time.* The system delay from receipt of the relevant SSR reply to presentation of an RA sense and strength to the pilot shall be as short as possible and shall not exceed 1.5 s.

4.3.6 Co-ordination and communication

4.3.6.1 PROVISIONS FOR CO-ORDINATION WITH ACAS-EQUIPPED THREATS

4.3.6.1.1 *Multi-aircraft co-ordination.* In a multi-aircraft situation, ACAS shall co-ordinate with each equipped threat individually.

4.3.6.1.2 *Co-ordination lock state.* ACAS shall prevent simultaneous access to data by different processes within ACAS by means of a co-ordination lock state. ACAS shall enter the co-ordination lock state before accessing any data for which the potential for simultaneous data access exists. When in the co-ordination lock state ACAS shall prevent access to such data except by the process that initiated the co-ordination lock state.

4.3.6.1.3 *Co-ordination interrogation.* Each cycle ACAS shall transmit a co-ordination interrogation to each equipped threat, unless generation of an RA is delayed because it is not possible to select an RA that can be predicted to provide adequate separation (4.3.5.1). The resolution message transmitted to a threat shall include an RAC selected for that threat. If an RAC has been received from the threat before ACAS selects an RAC for that threat, the selected RAC shall be compatible with the received RAC. If an RAC received from an equipped threat is incompatible with the RAC own ACAS has selected for that threat, ACAS shall modify the selected RAC to be compatible with the received RAC if own aircraft's Mode S address is higher in value than that of the threat.

Note 1.— This RAC is selected and sent notwithstanding the deferral of an RA in accordance with 4.3.5.8.1.

Note 2.— The RAC included in the resolution message is in the form of a vertical RAC (VRC) for ACAS II (4.3.8.4.2.3.2.2) and a vertical RAC (VRC) and/or horizontal RAC (HRC) for ACAS III.

4.3.6.1.3.1 ACAS shall transmit a co-ordination interrogation to an equipped intruder newly declared not a threat during the first cycle following cancellation of the RA. In this case, the resolution message transmitted to that aircraft shall include a cancellation code for the previously sent RAC.

4.3.6.1.3.2 ACAS co-ordination interrogations shall be transmitted until a co-ordination reply is received from the threat, up to a maximum of not less than six and not more than twelve attempts. The successive interrogations shall be nominally equally spaced over a period of 100 ±5 ms. If the maximum number of attempts is made and no reply is received, ACAS shall continue its regular processing sequence.

4.3.6.1.3.3 ACAS shall provide parity protection (4.3.8.4.2.3.2.6 and 4.3.8.4.2.3.2.7) for all fields in the co-ordination interrogation that convey RAC information.

Note.— This includes the vertical RAC (VRC), the cancel vertical RAC (CVC), the horizontal RAC (HRC) and the cancel horizontal RAC (CHC).

4.3.6.1.3.4 Whenever own ACAS reverses its sense against an equipped threat, the resolution message that is sent on the current and subsequent cycles to that threat shall contain both the newly selected RAC and the cancellation code for the RAC sent before the reversal.

4.3.6.1.3.5 When a vertical RA is selected, the vertical RAC (VRC) (4.3.8.4.2.3.2.2) that own ACAS includes in a resolution message to the threat shall be as follows:

a) "do not pass above" when own ACAS has an upward sense RA for the threat;

b) "do not pass below" when own ACAS has a downward sense RA for the threat.

4.3.6.1.4 *Resolution message processing.* Resolution message processing shall be performed while in the co-ordination lock state. If ACAS receives a resolution message while it is not in the co-ordination lock state, ACAS shall enter the co-ordination lock state and process the message immediately. If ACAS receives a resolution message while it is in the co-ordination lock state, ACAS shall place the message in a queue and process the message as soon as the current processing is completed.

Note.— According to 4.3.6.1.2, resolution message processing must not access any data whose usage is not protected by the co-ordination lock state.

4.3.6.1.4.1 An RAC or an RAC cancellation received from another ACAS shall be rejected if the encoded sense bits indicate the existence of a parity error or if undefined value(s) are detected in the resolution message. An RAC or an RAC cancellation received without parity errors and without undefined resolution message values shall be considered valid.

4.3.6.1.4.2 *RAC storage.* A valid RAC received from another ACAS shall be stored or shall be used to update the previously stored RAC corresponding to that ACAS. A valid RAC cancellation shall cause the previously stored RAC to be deleted. A stored RAC that has not been updated for an interval of 6 s shall be deleted.

4.3.6.1.4.3 *RAC record update.* A valid RAC or RAC cancellation received from another ACAS shall be used to update the RAC record. If a bit in the RAC record has not been refreshed for an interval of 6 s by any threat, that bit shall be set to ZERO.

4.3.6.2 PROVISIONS FOR ACAS COMMUNICATION WITH GROUND STATIONS

4.3.6.2.1 *Air-initiated downlink of ACAS RAs.* When an ACAS RA exists, ACAS shall:

a) transfer to its Mode S transponder an RA report for transmission to the ground in a Comm-B reply (4.3.11.4.1); and

b) transmit periodic RA broadcasts (4.3.7.3.2).

4.3.6.2.2 *Sensitivity level control (SLC) command.* ACAS shall store SLC commands from Mode S ground stations. An SLC command received from a Mode S ground station shall remain effective until replaced by an SLC command from the same ground station as indicated by the site number contained in the IIS subfield of the interrogation. If an existing stored command from a Mode S ground station is not refreshed within 4 minutes, or if the SLC command received has the value 15 (4.3.8.4.2.1.1), the stored SLC command for that Mode S ground station shall be set to ZERO.

4.3.6.3 PROVISIONS FOR DATA TRANSFER BETWEEN ACAS AND ITS MODE S TRANSPONDER

4.3.6.3.1 *Data transfer from ACAS to its Mode S transponder:*

a) ACAS shall transfer RA information to its Mode S transponder for transmission in an RA report (4.3.8.4.2.2.1) and in a co-ordination reply (4.3.8.4.2.4.2);

b) ACAS shall transfer current sensitivity level to its Mode S transponder for transmission in a sensitivity level report (4.3.8.4.2.5); and

c) ACAS shall transfer capability information to its Mode S transponder for transmission in a data link capability report (4.3.8.4.2.2.2).

4.3.6.3.2 *Data transfer from Mode S transponder to its ACAS:*

a) ACAS shall receive from its Mode S transponder sensitivity level control commands (4.3.8.4.2.1.1) transmitted by Mode S ground stations;

b) ACAS shall receive from its Mode S transponder ACAS broadcast messages (4.3.8.4.2.3.3) transmitted by other ACAS; and

c) ACAS shall receive from its Mode S transponder resolution messages (4.3.8.4.2.3.2) transmitted by other ACAS for air-air co-ordination purposes.

4.3.7 ACAS protocols

4.3.7.1 SURVEILLANCE PROTOCOLS

4.3.7.1.1 *Surveillance of Mode A/C transponders.* ACAS shall use the Mode C-only all-call interrogation (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.1.5.1.2) for surveillance of aircraft equipped with Mode A/C transponders.

4.3.7.1.2 *SURVEILLANCE OF MODE S TRANSPONDERS*

4.3.7.1.2.1 *Detection.* ACAS shall detect the presence and determine the address of Mode S-equipped aircraft by monitoring at 1 090 MHz for Mode S all-call replies (DF = 11). The altitude of the Mode S-equipped aircraft shall then be determined either by passively monitoring replies that contain altitude (DF = 0, 4, 16 or 20) received from that aircraft or, if necessary, by interrogating the aircraft with UF = 0.

4.3.7.1.2.2 *Surveillance interrogations.* On first receipt of a 24-bit aircraft address from an aircraft within an altitude band 920 m (3 000 ft) above and below own aircraft, or closing in altitude at a rate that would cause it to become co-altitude within 60 s, ACAS shall transmit a short air-air interrogation (UF = 0) for range acquisition. Surveillance interrogations shall be transmitted each cycle when this altitude condition is satisfied and the range of the detected aircraft divided by the sum of the maximum speed of own aircraft and the maximum speed of the detected aircraft is less than 42 s. Otherwise, interrogations to the Mode S aircraft shall be suspended until the predicted time is reached when both these conditions will be met, unless the interference limiting inequalities of 4.3.2.2.2.2 are satisfied and do not result in any constraint on the number or power of Mode C or Mode S interrogations and ACAS aircraft is not operating below a pressure altitude of 3 050 m (10 000 ft).

4.3.7.1.2.2.1 *Range acquisition interrogations.* ACAS shall use the short air-air surveillance format (UF = 0) for range acquisition. ACAS shall set AQ = 1 (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.1.1) and RL = 0 (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.1.2) in an acquisition interrogation.

Note 1.— Setting AQ = 1 results in a reply with bit 14 of the RI field equal to ONE and serves as an aid in distinguishing the reply to own interrogation from replies elicited from other ACAS units (4.3.7.1.2.2.2).

Note 2.— In the acquisition interrogation RL is set to ZERO to command a short acquisition reply (DF = 0).

4.3.7.1.2.2.2 *Tracking interrogations.* ACAS shall use the short air-air surveillance format (UF = 0) with RL = 0 and AQ = 0 for tracking interrogations.

4.3.7.1.2.3 *Surveillance replies.* These protocols are described in 4.3.11.3.1.

4.3.7.1.2.4 *ACAS broadcast.* An ACAS broadcast shall be made nominally every 8 to 10 s at full power from the top antenna. Installations using directional antennas shall operate such that complete circular coverage is provided nominally every 8 to 10 s.

Note.— A broadcast causes other Mode S transponders to accept the interrogation without replying and to present the interrogation content containing the MU field at the transponder output data interface. The UDS1 = 3, UDS2 = 2 combination identifies the data as an ACAS broadcast containing the discrete address of the interrogating ACAS *aircraft. This provides each ACAS with a means of determining the number of other ACAS within its detection range for limiting interference. The format of the MU field is described in 4.3.8.4.2.3.*

4.3.7.2 AIR-AIR CO-ORDINATION PROTOCOLS

4.3.7.2.1 *Co-ordination interrogations.* ACAS shall transmit UF = 16 interrogations (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.3.2, Figure 3-3.6) with AQ = 0 and RL = 1 when another aircraft reporting RI = 3 or 4 is declared a threat (4.3.4). The MU field shall contain the resolution message in the subfields specified in 4.3.8.4.2.3.2.

Note 1.— A UF = 16 interrogation with AQ = 0 and RL = 1 is intended to cause a DF = 16 reply from the other aircraft.

Note 2.— An aircraft reporting RI = 3 or RI = 4 is an aircraft equipped with an operating ACAS which has vertical only or vertical and horizontal resolution capability, respectively.

4.3.7.2.2 *Co-ordination reply.* These protocols are described in 4.3.11.3.2.

4.3.7.3 PROTOCOLS FOR ACAS COMMUNICATION WITH GROUND STATIONS

4.3.7.3.1 *RA reports to Mode S ground stations.* These protocols are described in 4.3.11.4.1.

4.3.7.3.2 *RA broadcasts.* RA broadcasts shall be transmitted at full power from the bottom antenna at jittered, nominally 8 s intervals for the period that the RA is indicated. The RA broadcast shall include the MU field as specified in 4.3.8.4.2.3.4. The RA broadcast shall describe the most recent RA that existed during the preceding 8 s period. Installations using directional antennas shall operate such that complete circular coverage is provided nominally every 8 s and the same RA sense and strength is broadcast in each direction.

4.3.7.3.3 *Data link capability report.* These protocols are described in 4.3.11.4.2.

4.3.7.3.4 *ACAS sensitivity level control.* ACAS shall act upon an SLC command if and only if TMS (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.1.4.1) has the value 0 and DI is either 1 or 7 in the same interrogation.

4.3.8 Signal formats

4.3.8.1 The RF characteristics of all ACAS signals shall conform to the Standards of Annex 10, Volume I, Part I, Chapter 3, 3.8.1.1 through 3.8.1.6, 3.8.2.1 through 3.8.2.3, 3.8.2.5 and 3.8.2.8.

4.3.8.2 RELATIONSHIP BETWEEN ACAS AND MODE S SIGNAL FORMATS

Note.— ACAS uses Mode S transmissions for surveillance and communications. ACAS air-air communication functions permit RA decisions to be co-ordinated with ACAS-equipped threats. ACAS air-ground communication functions permit the reporting of RAs to ground stations and the uplinking of commands to ACAS-equipped aircraft to control parameters of the collision avoidance algorithms.

4.3.8.3 *Signal format conventions.* The data encoding of all ACAS signals shall conform to the Standards of Annex 10, Volume I, Part I, Chapter 3, 3.8.2.3.

Note.— In air-air transmissions used by ACAS, interrogations transmitted at 1 030 MHz are designated as uplink transmissions and contain uplink format (UF) codes. Replies received at 1 090 MHz are designated as downlink transmissions and contain downlink format (DF) codes.

4.3.8.4 FIELD DESCRIPTION

Note 1.— The air-air surveillance and communications formats which are used by ACAS but not fully described in Annex 10, Volume I, Part I, Chapter 3, 3.8.2 are given in Figure 4-1.

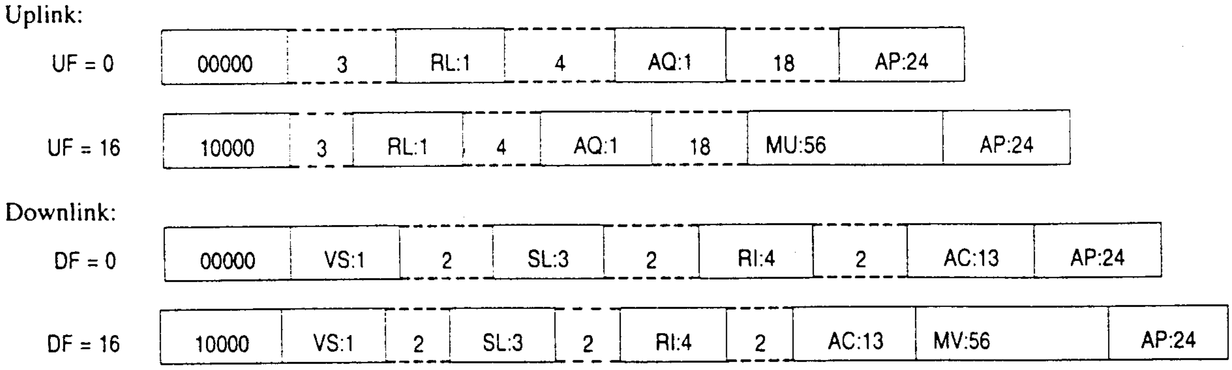


Figure 4-1. Surveillance and communication formats used by ACAS

Note 2.— This section defines the Mode S fields (and their subfields) that are processed by ACAS to accomplish ACAS functions. Some of the ACAS fields (those also used for other SSR Mode S functions) are described with unassigned ACAS codes in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6. Such codes are assigned in 4.3.8.4.1. Fields and subfields used only by ACAS equipment are assigned in 4.3.8.4.2.

4.3.8.4.1 *FIELDS AND SUBFIELDS INTRODUCED IN ANNEX 10, VOLUME I, PART I, CHAPTER 3, 3.8.2*

Note.— Codes for mission fields and subfields that are designated "reserved for ACAS" in Annex 10, Volume I, Part I, Chapter 3, 3.8.2, are specified in this section.

4.3.8.4.1.1 *DR (downlink request).* The significance of the coding of the downlink request field shall be as follows:

Coding	
0-1	See Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.5.2
2	ACAS message available
3	Comm-B message available and ACAS message available
4-5	See Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.5.2
6	Comm-B broadcast message 1 available and ACAS message available
7	Comm-B broadcast message-2 available and ACAS message available
8-31	See Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.5.2

4.3.8.4.1.2 *RI (air-air reply information).* The significance of the coding in the RI field shall be as follows:

Coding	
0	No on-board ACAS
1	ACAS on standby
2	ACAS with resolution capability inhibited
3	ACAS with vertical-only resolution capability
4	ACAS with vertical and horizontal resolution capability
5-7	Not assigned
8-15	See Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.2.2

Bit 14 of the reply format containing this field shall replicate the AQ bit of the interrogation. The RI field shall report "no on-board ACAS" (RI = 1) if the ACAS unit has failed. The RI field shall report "ACAS with resolution capability inhibited" (RI = 2) if sensitivity level is 2 or TA only mode has been selected.

Note.— Codes 0-7 in the RI field indicate that the reply is a tracking reply and also give the ACAS capability of the interrogated aircraft. Codes 8-15 indicate that the reply is an acquisition reply and also give the maximum true airspeed capability of the interrogated aircraft.

4.3.8.4.1.3 *RR (reply request).* The significance of the coding in the reply request field shall be as follows:

Coding	
0-18	See Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.1.2
19	Transmit a resolution advisory report
20-31	See Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.1.2

4.3.8.4.2 *ACAS FIELDS AND SUBFIELDS*

Note.— The following paragraphs describe the location and coding of those fields and subfields that are not defined in Annex 10, Volume I, Part I, Chapter 3, 3.8.2 but are used by aircraft equipped with ACAS.

4.3.8.4.2.1 *Subfield in MA.* When ADS1 = 0 and ADS2 = 5, the following subfield shall be contained in MA:

4.3.8.4.2.1.1 *SLC (ACAS sensitivity level control (SLC) command).* This 4-bit (41-44) subfield shall denote a sensitivity level command for own ACAS.

Coding	
0	No command issued
1	Not assigned
2	Set ACAS sensitivity level to 2
3	Set ACAS sensitivity level to 3
4	Set ACAS sensitivity level to 4
5	Set ACAS sensitivity level to 5
6	Set ACAS sensitivity level to 6
7-14	Not assigned
15	Cancel previous SLC command from this ground station

Note.— Structure of MA for a sensitivity level control command:

33	37	41	45
ADS1 = 0	ADS2 = 5	SLC	--- 44 ---
36	40	44	88

4.3.8.4.2.2 *Subfields in MB*

4.3.8.4.2.2.1 *Subfields in MB for an RA report.* When BDS1 = 3 and BDS2 = 0, the subfields indicated below shall be contained in MB. For 18±1 s following the end of an RA, all MB subfields in the RA report with the exception of bit 59 (RA terminated indicator) shall retain the information reported at the time the RA was last active.

4.3.8.4.2.2.1.1 *ARA (active RAs).* This 14-bit (41-54) subfield shall indicate the currently active RA, if any, generated by the ACAS associated with the transponder transmitting the subfield. The bits in ARA shall have meanings determined by the value of the MTE subfield (4.3.8.4.2.2.1.3) and, for vertical RAs, the value of bit 41 of ARA. The meaning of bit 41 of ARA shall be as follows:

Coding	
0	Different vertical senses have been generated in a multi-threat situation (when MTE = 1); or no RA has been generated (when MTE = 0)
1	The same vertical sense has been generated in a single or multi-threat situation

When ARA bit 41 = 1 and MTE = 0 or 1, bits 42-47 shall have the following meanings:

Bit	*Coding*	
42	0	RA is preventive
	1	RA is corrective
43	0	Upward sense RA has been generated
	1	Downward sense RA has been generated
44	0	RA is not increased rate
	1	RA is increased rate
45	0	RA is not a sense reversal
	1	RA is a sense reversal
46	0	RA is not altitude crossing
	1	RA is altitude crossing
47	0	RA is vertical speed limit
	1	RA is positive
48-54		Reserved for ACAS III

When ARA bit 41 = 0 and MTE = 1, bits 42-47 shall have the following meanings:

Bit	*Coding*	
42	0	RA does not require a correction in the upward sense
	1	RA requires a correction in the upward sense
43	0	RA does not require a positive climb
	1	RA requires a positive climb
44	0	RA does not require a correction in the downward sense
	1	RA requires a correction in the downward sense
45	0	RA does not require a positive descend
	1	RA requires a positive descend
46	0	RA does not require a crossing
	1	RA requires a crossing
47	0	RA is not a sense reversal
	1	RA is a sense reversal
48-54		Reserved for ACAS III

Note.— When ARA bit 41 = 0 and MTE = 0, no vertical RA has been generated.

4.3.8.4.2.2.1.2 *RAC (RACs record).* This 4-bit (55-58) subfield shall indicate all the currently active RACs, if any, received from other ACAS aircraft. The bits in RAC shall have the following meanings:

Bit	*Resolution advisory complement*
55	Do not pass below
56	Do not pass above
57	Do not turn left
58	Do not turn right

A bit set to ONE shall indicate that the associated RAC is active. A bit set to ZERO shall indicate that the associated RAC is inactive.

4.3.8.4.2.2.1.3 *RAT (RA terminated indicator).* This 1-bit (59) subfield shall indicate when an RA previously generated by ACAS has ceased being generated.

Coding	
0	The RA indicated by the ARA subfield is currently active
1	The RA indicated by the ARA subfield has been terminated

Note 1.— After an RA has been terminated by ACAS, it is still required to be reported by the Mode S transponder for 18±1 s (4.3.11.4.1). The RA terminated indicator may be used, for example, to permit timely removal of an RA indication from an air traffic controller's display, or for assessments of RA duration within a particular airspace.

Note 2.— RAs may terminate for a number of reasons: normally, when the conflict has been resolved and the treat is diverging in range; or when the treat's Mode S transponder for some reason ceases to report altitude during the conflict. The RA terminated indicator is used to show that the RA has been removed in each of these cases.

4.3.8.4.2.2.1.4 *MTE (multiple threat encounter).* This 1-bit (60) subfield shall indicate whether two or more simultaneous threats are currently being processed by the ACAS threat resolution logic.

Coding

0	One threat is being processed by the resolution logic (when ARA bit 41 = 1); or no threat is being processed by the resolution logic (when ARA bit 41 = 0)
1	Two or more simultaneous threats are being processed by the resolution logic

4.3.8.4.2.2.1.5 *TTI (threat type indicator subfield).* This 2-bit subfield (61-62) shall define the type of identity data contained in the TID subfield.

Coding

0	No identity data in TID
1	TID contains a Mode S transponder address
2	TID contains altitude, range and bearing data
3	Not assigned

4.3.8.4.2.2.1.6 *TID (threat identity data subfield).* This 26-bit subfield (63-88) shall contain the Mode S address of the threat or the altitude, range, and bearing if the threat is not Mode S equipped. If two or more threats are simultaneously processed by the ACAS resolution logic, TID shall contain the identity or position data for the most recently declared threat. If TTI = 1, TID shall contain in bits 63-86 the Mode S address of the threat, and bits 87 and 88 shall be set to ZERO. If TTI = 2, TID shall contain the following three subfields.

4.3.8.4.2.2.1.6.1 *TIDA (threat identity data altitude subfield).* This 13-bit subfield (63-75) shall contain the most recently reported Mode C altitude code of the threat.

Coding

Bit	63	64	65	66	67	68	69	70	71	72	73	74	75
Mode C code bit	C_1	A_1	C_2	A_2	C_4	A_4	0	B_1	D_1	B_2	D_2	B_4	D_4

4.3.8.4.2.2.1.6.2 *TIDR (threat identity data range subfield).* This 7-bit subfield (76-82) shall contain the most recent threat range estimated by ACAS.

Coding (n)

n	*Estimated range (NM)*
0	No range estimate available
1	Less than 0.05
2-126	(n-1)/10 ± 0.05
127	Greater than 12.55

4.3.8.4.2.2.1.6.3 *TIDB (threat identity data bearing subfield).* This 6-bit subfield (83-88) shall contain the most recent estimated bearing of the threat aircraft, relative to the ACAS aircraft heading.

Coding (n)

n	*Estimated bearing (degrees)*
0	No bearing estimate available
1-60	Between 6(n-1) and 6n
61-63	Not assigned

Note.— Structure of MB for an RA report:

33	37	41	55	59	60	61	63
BDS1 = 3	BDS2 = 0	ARA	RAC	RAT	MTE	TTI = 1	TID
36	40	54	58	59	60	62	88

33	37	41	55	59	60	61	63	76	83
BDS1 = 3	BDS2 = 0	ARA	RAC	RAT	MTE	TTI = 2	TIDA	TIDR	TIDB
36	40	54	58	59	60	62	75	82	88

4.3.8.4.2.2.2 *Subfields in MB for the data link capability report.* When BDS1 = 1 and BDS2 = 0, the following bit patterns shall be provided to the transponder for its data link capability report:

Bit 48

Bit 48 shall be set to ONE by an ACAS operating at a sensitivity level in the range 2 through 7, and it shall be set to ZERO by an ACAS in sensitivity level 1 or on being powered down.

Bits 69 and 70

ACAS shall set bits 69 and 70, according to its capability as follows:

When bit 48 = 1, *coding*:
0 ACAS II is operating, generating TAs only
1 ACAS II is operating, generating TAs and RAs
2 ACAS III is operating, generating TAs only
3 ACAS III is operating, generating TAs and RAs

When bit 48 = 0, *coding*:
0 ACAS is not fitted, ACAS is not operational or ACAS has failed
1 ACAS II on standby
2 Not assigned
3 ACAS III on standby

Note.— A summary of the MB subfields for the data link capability report structure is described in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.10.2.2.2.

4.3.8.4.2.3 *MU field.* This 56-bit (33-88) field of long air-air surveillance interrogations (Figure 4-1) shall be used to transmit resolution messages, ACAS broadcasts and RA broadcasts.

4.3.8.4.2.3.1 *UDS (U-definition subfield).* This 8-bit (33-40) subfield shall define the remainder of MU.

Note.— For convenience in coding, UDS is expressed in two groups of four bits each, UDS1 and UDS2.

4.3.8.4.2.3.2 *Subfields in MU for a resolution message.* When UDS1 = 3 and UDS2 = 0 the following subfields shall be contained in MU:

4.3.8.4.2.3.2.1 *MTB (multiple threat bit).* This 1-bit (42) subfield shall indicate the presence or absence of multiple threats.

Coding
0 Interrogating ACAS has one threat
1 Interrogating ACAS has more than one threat

4.3.8.4.2.3.2.2 *VRC (vertical RAC).* This 2-bit (45-46) subfield shall denote a vertical RAC relating to the addressed aircraft.

Coding
0 No vertical RAC sent
1 Do not pass below
2 Do not pass above
3 Not assigned

4.3.8.4.2.3.2.3 *CVC (cancel vertical RAC).* This 2-bit (43-44) subfield shall denote the cancellation of a vertical RAC previously sent to the addressed aircraft. This subfield shall be set to ZERO for a new threat.

Coding
0 No cancellation
1 Cancel previously sent "Do not pass below"
2 Cancel previously sent "Do not pass above"
3 Not assigned

4.3.8.4.2.3.2.4 *HRC (horizontal RAC).* This 3-bit (50-52) subfield shall denote a horizontal RAC relating to the addressed aircraft.

Coding
0 No horizontal RAC or no horizontal resolution capability
1 Other ACAS sense is turn left; do not turn left
2 Other ACAS sense is turn left; do not turn right
3 Not assigned
4 Not assigned
5 Other ACAS sense is turn right; do not turn left
6 Other ACAS sense is turn right; do not turn right
7 Not assigned

4.3.8.4.2.3.2.5 *CHC (cancel horizontal RAC).* This 3-bit (47-49) subfield shall denote the cancellation of a horizontal RAC previously sent to the addressed aircraft. This subfield shall be set to ZERO for a new threat.

Coding
0 No cancellation or no horizontal resolution capability
1 Cancel previously sent "Do not turn left"
2 Cancel previously sent "Do not turn right"
3-7 Not assigned

4.3.8.4.2.3.2.6 *VSB (vertical sense bits subfield).* This 4-bit (61-64) subfield shall be used to protect the data in the CVC and VRC subfields. For each of the 16 possible combinations of bits 43-46 the following VSB code shall be transmitted:

	CVC		VRC		VSB			
Coding	43	44	45	46	61	62	63	64
0	0	0	0	0	0	0	0	0
1	0	0	0	1	1	1	1	0
2	0	0	1	0	0	1	1	1
3	0	0	1	1	1	0	0	1
4	0	1	0	0	1	0	1	1
5	0	1	0	1	0	1	0	1
6	0	1	1	0	1	1	0	0
7	0	1	1	1	0	0	1	0
8	1	0	0	0	1	1	0	1
9	1	0	0	1	0	0	1	1

	CVC		VRC		VSB			
Coding	43	44	45	46	61	62	63	64
10	1	0	1	0	1	0	1	0
11	1	0	1	1	0	1	0	0
12	1	1	0	0	0	1	1	0
13	1	1	0	1	1	0	0	0
14	1	1	1	0	0	0	0	1
15	1	1	1	1	1	1	1	1

Note.— The rule used to generate the VSB subfield bit setting is a distance 3 Hamming code augmented with a parity bit, producing the ability to detect up to three errors in the eight transmitted bits.

4.3.8.4.2.3.2.7 *HSB (horizontal sense bits subfield).* This 5-bit (56-60) subfield shall be used to protect the data in the CHC and HRC subfields. For each of the 64 possible combinations of bits 47-52 the following HSB code shall be transmitted:

	CHC			HRC			HSB				
Coding	47	48	49	50	51	52	56	57	58	59	60
0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	1	0	1	0	1	1
2	0	0	0	0	1	0	1	0	0	1	1
3	0	0	0	0	1	1	1	1	0	0	0
4	0	0	0	1	0	0	1	1	1	0	0
5	0	0	0	1	0	1	1	0	1	1	1
6	0	0	0	1	1	0	0	1	1	1	1
7	0	0	0	1	1	1	0	0	1	0	0
8	0	0	1	0	0	0	0	1	1	0	1
9	0	0	1	0	0	1	0	0	1	1	0
10	0	0	1	0	1	0	1	1	1	1	0
11	0	0	1	0	1	1	1	0	1	0	1
12	0	0	1	1	0	0	1	0	0	0	1
13	0	0	1	1	0	1	1	1	0	1	0
14	0	0	1	1	1	0	0	0	0	1	0
15	0	0	1	1	1	1	0	1	0	0	1
16	0	1	0	0	0	0	1	0	1	0	1
17	0	1	0	0	0	1	1	1	1	1	0
18	0	1	0	0	1	0	0	0	1	1	0
19	0	1	0	0	1	1	0	1	1	0	1
20	0	1	0	1	0	0	0	1	0	0	1
21	0	1	0	1	0	1	0	0	0	1	0
22	0	1	0	1	1	0	1	1	0	1	0
23	0	1	0	1	1	1	1	0	0	0	1
24	0	1	1	0	0	0	1	1	0	0	0
25	0	1	1	0	0	1	1	0	0	1	1
26	0	1	1	0	1	0	0	1	0	1	1
27	0	1	1	0	1	1	0	0	0	0	0
28	0	1	1	1	0	0	0	0	1	0	0
29	0	1	1	1	0	1	0	1	1	1	1
30	0	1	1	1	1	0	1	0	1	1	1
31	0	1	1	1	1	1	1	1	1	0	0
32	1	0	0	0	0	0	1	1	0	0	1
33	1	0	0	0	0	1	1	0	0	1	0
34	1	0	0	0	1	0	0	1	0	1	0
35	1	0	0	0	1	1	0	0	0	0	1
36	1	0	0	1	0	0	0	0	1	0	1
37	1	0	0	1	0	1	0	1	1	1	0

Coding	CHC 47	48	49	HRC 50	51	52	HSB 56	57	58	59	60
38	1	0	0	1	1	0	1	0	1	1	0
39	1	0	0	1	1	1	1	1	1	0	1
40	1	0	1	0	0	0	1	0	1	0	0
41	1	0	1	0	0	1	1	1	1	1	1
42	1	0	1	0	1	0	0	0	1	1	1
43	1	0	1	0	1	1	0	1	1	0	0
44	1	0	1	1	0	0	0	1	0	0	0
45	1	0	1	1	0	1	0	0	0	1	1
46	1	0	1	1	1	0	1	1	0	1	1
47	1	0	1	1	1	1	1	0	0	0	0
48	1	1	0	0	0	0	0	1	1	0	0
49	1	1	0	0	0	1	0	0	1	1	1
50	1	1	0	0	1	0	1	1	1	1	1
51	1	1	0	0	1	1	1	0	1	0	0
52	1	1	0	1	0	0	1	0	0	0	0
53	1	1	0	1	0	1	1	1	0	1	1
54	1	1	0	1	1	0	0	0	0	1	1
55	1	1	0	1	1	1	0	1	0	0	0
56	1	1	1	0	0	0	0	0	0	0	1
57	1	1	1	0	0	1	0	1	0	1	0
58	1	1	1	0	1	0	1	0	0	1	0
59	1	1	1	0	1	1	1	1	0	0	1
60	1	1	1	1	0	0	1	1	1	0	1
61	1	1	1	1	0	1	1	0	1	1	0
62	1	1	1	1	1	0	0	1	1	1	0
63	1	1	1	1	1	1	0	0	1	0	1

Note.— The rule used to generate the HSB subfield bit setting is a distance 3 Hamming code augmented with a parity bit, producing the ability to detect up to three errors in the eleven transmitted bits.

4.3.8.4.2.3.2.8 *MID (Mode S address).* This 24-bit (65-88) subfield shall contain the 24-bit aircraft address of the interrogating ACAS aircraft.

Note.— Structure of MU for a resolution message:

33	37	41	42	43	45	47	50	53	56	61	65
UDS1 = 3	UDS2 = 0	-1-	MTB	CVC	VRC	CHC	HRC	-3-	HSB	VSB	MID
36	40	41	42	44	46	49	52	55	60	64	88

4.3.8.4.2.3.3 *Subfield in MU for an ACAS broadcast.* When UDS1 = 3 and UDS2 = 2, the following subfield shall be contained in MU:

4.3.8.4.2.3.3.1 *MID (Mode S address).* This 24-bit (65-88) subfield shall contain the 24-bit aircraft address of the interrogating ACAS aircraft.

Note.— Structure of MU for an ACAS broadcast:

33	37	41	65
UDS1 = 3	UDS2 = 2	----- 24 -----	MID
36	40	64	88

4.3.8.4.2.3.4 *Subfields in MU for an RA broadcast.* When UDS1 = 3 and UDS2 = 1, the following subfields shall be contained in MU:

4.3.8.4.2.3.4.1 *ARA (active RAs).* This 14-bit (41-54) subfield shall be coded as defined in 4.3.8.4.2.2.1.1.

4.3.8.4.2.3.4.2 *RAC (RACs record).* This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.1.2.

4.3.8.4.2.3.4.3 *RAT (RA terminated indicator).* This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.1.3.

4.3.8.4.2.3.4.4 *MTE (multiple threat encounter).* This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.1.4.

4.3.8.4.2.3.4.5 *AID (Mode A identity code).* This 13-bit (63-75) subfield shall denote the Mode A identity code of the reporting aircraft.

Coding

Bit	63	64	65	66	67	68	69	70	71	72	73	74	75
Mode A code bit	C_1	A_1	C_2	A_2	C_4	A_4	0	B_1	D_1	B_2	D_2	B_4	D_4

4.3.8.4.2.3.4.6 *CAC (Mode C altitude code).* This 13-bit (76-88) subfield shall denote the Mode C altitude code of the reporting aircraft.

Coding

Bit	76	77	78	79	80	81	82	83	84	85	86	87	88
Mode C code bit	C_1	A_1	C_2	A_2	C_4	A_4	0	B_1	D_1	B_2	D_2	B_4	D_4

Note.— Structure of MU for an RA broadcast:

33	37	41	55	59	60	61	63	76
UDS1 = 3	UDS2 = 1	ARA	RAC	RAT	MTE	-2-	AID	CAC
36	40	54	58	59	60	62	75	88

4.3.8.4.2.4 *MV field.* This 56-bit (33-88) field of long air-air surveillance replies (Figure 4-1) shall be used to transmit air-air co-ordination reply messages.

4.3.8.4.2.4.1 *VDS (V-definition subfield).* This 8-bit (33-40) subfield shall define the remainder of MV.

Note.— For convenience in coding, VDS is expressed in two groups of four bits each, VDS1 and VDS2.

4.3.8.4.2.4.2 *Subfields in MV for a co-ordination reply.* When VDS1 = 3 and VDS2 = 0, the following subfields shall be contained in MV:

4.3.8.4.2.4.2.1 *ARA (active RAs).* This 14-bit (41-54) subfield shall be coded as defined in 4.3.8.4.2.2.1.1.

4.3.8.4.2.4.2.2 *RAC (RACs record).* This 4-bit (55-58) subfield shall be coded as defined in 4.3.8.4.2.2.1.2.

4.3.8.4.2.4.2.3 *RAT (RA terminated indicator).* This 1-bit (59) subfield shall be coded as defined in 4.3.8.4.2.2.1.3.

4.3.8.4.2.4.2.4 *MTE (multiple threat encounter).* This 1-bit (60) subfield shall be coded as defined in 4.3.8.4.2.2.1.4.

Note.— Structure of MV for a co-ordination reply:

33	37	41	55	59	60	61
VDS1 = 3	VDS2 = 0	ARA	RAC	RAT	MTE	-28-
36	40	54	58	59	60	88

4.3.8.4.2.5 *SL (sensitivity level report).* This 3-bit (9-11) downlink field shall be included in both short and long air-air reply formats (DF = 0 and 16). This field shall denote the sensitivity level at which ACAS is currently operating.

Coding

0	ACAS inoperative
1	ACAS is operating at sensitivity level 1
2	ACAS is operating at sensitivity level 2
3	ACAS is operating at sensitivity level 3
4	ACAS is operating at sensitivity level 4
5	ACAS is operating at sensitivity level 5
6	ACAS is operating at sensitivity level 6
7	ACAS is operating at sensitivity level 7

4.3.9 ACAS equipment characteristics

4.3.9.1 *Interfaces.* As a minimum, the following input data shall be provided to the ACAS:

a) Mode S address code;

b) air-air and ground-air Mode S transmissions received by the Mode S transponder for use by ACAS (4.3.6.3.2);

c) own aircraft's maximum cruising true airspeed capability (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.2.2);

d) pressure altitude; and

e) radio altitude.

Note.— Specific requirements for additional inputs for ACAS II and III are listed in the appropriate sections below.

4.3.9.2 *Aircraft antenna system.* ACAS shall transmit interrogations and receive replies via two antennas, one mounted on the top of the aircraft and the other on the bottom of the aircraft. The top-mounted antenna shall be directional and capable of being used for direction finding.

4.3.9.2.1 *Polarization.* Polarization of ACAS transmissions shall be nominally vertical.

4.3.9.2.2 *Radiation pattern.* The radiation pattern in elevation of each antenna when installed on an aircraft shall be nominally equivalent to that of a quarter-wave monopole on a ground plane.

4.3.9.2.3 *ANTENNA SELECTION*

4.3.9.2.3.1 *Squitter reception.* ACAS shall be capable of receiving squitters via the top and bottom antennas.

4.3.9.2.3.2 *Interrogations.* ACAS interrogations shall not be transmitted simultaneously on both antennas.

4.3.10 Monitoring

4.3.10.1 *Monitoring function.* ACAS shall continuously perform a monitoring function in order to provide a warning if any of the following conditions at least are satisfied:

a) there is no interrogation power limiting due to interference control (4.3.2.2.2) and the maximum radiated power is reduced to less than that necessary to satisfy the surveillance requirements specified in 4.3.2; or

b) any other failure in the equipment is detected which results in a reduced capability of providing TAs or RAs; or

c) data from external sources indispensable for ACAS operation are not provided, or the data provided are not credible.

4.3.10.2 *Effect on ACAS operation.* The ACAS monitoring function shall not adversely affect other ACAS functions.

4.3.10.3 *Monitoring response.* When the monitoring function detects a failure (4.3.10.1), ACAS shall:

a) indicate to the flight crew that an abnormal condition exists;

b) prevent any further ACAS interrogations; and

c) cause any Mode S transmission containing own aircraft's resolution capability to indicate that ACAS is not operating.

4.3.11 Requirements for a Mode S transponder used in conjunction with ACAS

4.3.11.1 *Transponder capabilities.* In addition to the minimum transponder capabilities defined in Annex 10, Volume I, Part I, Chapter 3, 3.8, the Mode S transponder used in conjunction with ACAS shall have the following capabilities:

a) ability to handle the following formats:

Format No.	*Format name*
UF = 16	Long air-air surveillance interrogation
DF = 16	Long air-air surveillance reply

b) ability to receive long Mode S interrogations (UF = 16) and generate long Mode S replies (DF = 16) at a continuous rate of 16.6 ms (60 per second);

c) means for delivering the ACAS data content of all accepted interrogations addressed to the ACAS equipment;

d) antenna diversity (as specified in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.10.4);

e) mutual suppression capability; and

f) inactive state transponder output power restriction.

When the Mode S transponder transmitter is in the inactive state, the peak pulse power at 1 090 MHz ± 3 MHz at the terminals of the Mode S transponder antenna shall not exceed –70 dBm.

4.3.11.2 DATA TRANSFER BETWEEN ACAS AND ITS MODE S TRANSPONDER

4.3.11.2.1 *Data transfer from ACAS to its Mode S transponder:*

a) The Mode S transponder shall receive from its ACAS RA information for transmission in an RA report (4.3.8.4.2.2.1) and in a co-ordination reply (4.3.8.4.2.4.2);

b) the Mode S transponder shall receive from its ACAS current sensitivity level for transmission in a sensitivity level report (4.3.8.4.2.5); and

c) the Mode S transponder shall receive from its ACAS capability information for transmission in a data link capability report (4.3.8.4.2.2.2) and for transmission in the RI field of air-air downlink formats DF = 0 and DF = 16 (4.3.8.4.1.2).

4.3.11.2.2 *Data transfer from Mode S transponder to its ACAS:*

a) The Mode S transponder shall transfer to its ACAS received sensitivity level control commands (4.3.8.4.2.1.1) transmitted by Mode S stations;

b) the Mode S transponder shall transfer to its ACAS received ACAS broadcast messages (4.3.8.4.2.3.3) transmitted by other ACASs; and

c) the Mode S transponder shall transfer to its ACAS received resolution messages (4.3.8.4.2.3.2) transmitted by other ACASs for air-air co-ordination purposes.

4.3.11.3 COMMUNICATION OF ACAS INFORMATION TO OTHER ACAS

4.3.11.3.1 *Surveillance reply.* The ACAS Mode S transponder shall use the short (DF = 0) or long (DF = 16) surveillance formats for replies to ACAS surveillance interrogations. The surveillance reply shall include the VS field as specified in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.2, the RI field as specified in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.2 and in 4.3.8.4.1.2, and the SL field as specified in 4.3.8.4.2.5.

4.3.11.3.2 *Co-ordination reply.* The ACAS Mode S transponder shall transmit a co-ordination reply upon receipt of a co-ordination interrogation from an equipped threat subject to the conditions of 4.3.11.3.2.1. The co-ordination reply shall use the long air-air surveillance reply format, DF = 16, with the VS field as specified in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.2, the RI field as specified in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.2 and in 4.3.8.4.1.2, the SL field as specified in 4.3.8.4.2.5 and the MV field as specified in 4.3.8.4.2.4. Co-ordination replies shall be transmitted even if the minimum reply rate limits of the transponder (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.10.3.7.2) are exceeded.

4.3.11.3.2.1 The ACAS Mode S transponder shall reply with a co-ordination reply to a co-ordination interrogation received from another ACAS if and only if the transponder is able to deliver the ACAS data content of the interrogation to its associated ACAS.

4.3.11.4 COMMUNICATION OF ACAS INFORMATION TO GROUND STATIONS

4.3.11.4.1 *RA reports to Mode S ground stations.* During the period of an RA and for 18±1 s following the end of the RA, the ACAS Mode S transponder shall indicate that it has an RA report by setting the appropriate DR field code in replies to a Mode S sensor as specified in 4.3.8.4.1.1. The RA report shall include the MB field as specified in 4.3.8.4.2.2.1. The RA report shall describe the most recent RA that existed during the preceding 18±1 s period.

Note.— Upon receipt of a reply with DR = 2, 3, 6 or 7, a Mode S ground station may request downlink of the RA report by setting RR = 19 and either DI ≠ 7, or DI = 7 and RRS = 0 in a surveillance or Comm-A interrogation to the ACAS aircraft. When this interrogation is received, the transponder replies with a Comm-B reply whose MB field contains the RA report.

4.3.11.4.2 *Data link capability report.* The presence of an ACAS shall be indicated by its Mode S transponder to a ground station in the Mode S data link capability report.

Note.— This indication causes the transponder to set codes in a data link capability report as specified in 4.3.8.4.2.2.2.

4.3.12 Indications to the flight crew

4.3.12.1 CORRECTIVE AND PREVENTIVE RAs

Recommendation.— *Indications to the flight crew should distinguish between preventive and corrective RAs.*

4.3.12.2 ALTITUDE CROSSING RAs

Recommendation.— *If ACAS generates an altitude crossing RA, a specific indication should be given to the flight crew that it is crossing.*

4.4 ACAS II CHARACTERISTICS

Recommendation.— *The capabilities of ACAS II systems should be equal or better than those of the reference ACAS II system described in Section 4 of the guidance material in Attachment A.*

Note.— Caution is to be observed when considering potential improvements since changes may affect more than one aspect of the system performance. It is essential that alternative designs would not degrade the performances of other designs and that such compatibility is demonstrated with a high degree of confidence.

ATTACHMENT A TO VOLUME IV

Guidance material related to airborne collision avoidance system (ACAS)

Note.— The following material is intended to provide guidance concerning the technical characteristics of the airborne collision avoidance system (ACAS) having vertical resolution capability (ACAS II). ACAS SARPs are contained in Chapter 4.

1. EQUIPMENT, FUNCTIONS AND CAPABILITIES

1.1 ACAS equipment characteristics

1.1.1 ACAS equipment includes an ACAS processing unit, Mode S transponder, control unit, appropriate antennas and means of providing advisories.

1.1.2 ACAS equipment in the aircraft interrogates SSR transponders on other aircraft in its vicinity and listens for the transponder replies. By computer analysis of these replies, the ACAS equipment determines which aircraft represent potential collision threats and provides appropriate indications (advisories) to the flight crew to avoid collisions.

1.1.3 ACAS equipment is capable of providing two classes of advisories. Traffic advisories (TAs) indicate the approximate positions of intruding aircraft that may later cause resolution advisories. Resolution advisories (RAs) propose vertical manoeuvres that are predicted to increase or maintain separation from threatening aircraft.

1.2 Advisories provided

1.2.1 TRAFFIC ADVISORIES

TAs may indicate the range, range rate, altitude, altitude rate, and bearing of the intruding aircraft relative to own aircraft. TAs without altitude information may also be provided on Mode C or Mode S-equipped aircraft that do not have an automatic altitude reporting capability. The information conveyed in ACAS TAs is intended to assist the flight crew in sighting nearby traffic.

1.2.2 RESOLUTION ADVISORIES

1.2.2.1 If the threat detection logic in the ACAS computer determines that an encounter with a nearby aircraft could lead to a near-collision or collision, the computer threat resolution logic determines an appropriate vertical manoeuvre that will ensure the safe vertical separation of the ACAS aircraft. The selected manoeuvre ensures adequate vertical separation within constraints imposed by the climb rate capability and proximity to the ground of the ACAS aircraft.

1.2.2.2 The RAs provided to the pilot can be divided into two categories: corrective advisories, which instruct the pilot to deviate from the current flight path (e.g. "CLIMB" when the aircraft is in level flight); and preventive advisories, which advise the pilot to maintain or avoid certain vertical speeds (e.g. "DON'T CLIMB" when the aircraft is in level flight).

1.2.2.3 Under normal circumstances, ACAS issues only one RA during an encounter with one or multiple intruders. The RA is issued when, or shortly after, the (first) intruder becomes a threat, is maintained as long as the (any) intruder remains a threat, and is cancelled when the (last) intruder ceases to be a threat. However, the indication given to the flight crew as part of that RA may be modified. It may be strengthened or even reversed when a threat modifies its altitude profile or when the detection of a second, or third threat changes the initial assessment of the encounter. It may also be weakened when adequate separation has been achieved but the (any) intruder temporarily remains a threat.

1.2.3 WARNING TIMES

If a threat is detected, the ACAS equipment generates an RA some time before the closest approach of the aircraft. The amount of warning time depends on the protected volume selected for ACAS system use. The nominal resolution advisory time before closest approach used by ACAS varies from 15 to 35 seconds. A TA will nominally be issued between 5 and 20 seconds in advance of an RA. Warning times depend on sensitivity level as described in 3.5.12.

1.2.4 AIR-AIR CO-ORDINATION OF RESOLUTION ADVISORIES

1.2.4.1 If the aircraft detected by the ACAS equipment has only a Mode A/C transponder and automatic pressure altitude reporting equipment, its pilot will not be aware that he is being tracked by the ACAS-equipped aircraft. When the pilot of the ACAS aircraft receives an RA in an encounter with such an aircraft and manoeuvres as advised, the ACAS aircraft will be able to avoid the intruding aircraft provided the intruder does not accelerate so as to defeat the manoeuvre of the ACAS aircraft.

1.2.4.2 If the intruding aircraft is equipped with ACAS, a co-ordination procedure is performed via the air-to-air Mode S data link in order to ensure that the ACAS RAs are compatible.

1.2.5 AIR-GROUND COMMUNICATION

1.2.5.1 ACAS may communicate with ground stations using the Mode S air-ground data link. The transmission of sensitivity level control commands to ACAS equipment by Mode S ground stations is one aspect of communication. This feature permits a Mode S ground station to adapt the RA warning time to the local traffic environment as an ACAS aircraft moves through the region of coverage of the station. An effective trade-off between collision warning time and alert rate is thereby ensured.

1.2.5.2 The Mode S air-ground data link may also be used to transmit ACAS RAs to Mode S ground stations. This information can then be used by air traffic services to monitor ACAS RAs within an airspace of interest.

1.2.6 FUNCTIONS PERFORMED BY ACAS

1.2.6.1 The functions executed by ACAS are illustrated in Figure A-1. To keep the illustration simple, the functions "own aircraft tracking" and "intruder aircraft tracking" have been represented once in Figure A-1, under "surveillance". However, the trackers that are intended to support the collision avoidance function may not be suitable to support the surveillance function. Separate tracking functions may be required to adequately support both the collision avoidance and the surveillance functions.

1.2.6.2 Surveillance is normally executed once per cycle; however, it may be executed more frequently or less frequently for some intruders. For example, surveillance may be executed less frequently for some non-threatening intruders to respect interference limiting inequalities or it may be executed more frequently for some intruders to improve the azimuth estimate.

1.2.6.3 Parameters used in the implementation of the ACAS functions are adjusted automatically or manually to maintain collision avoidance protection with minimal interference to normal air traffic control (ATC) operations.

1.3 Intruder characteristics

1.3.1 TRANSPONDER EQUIPAGE OF INTRUDER

ACAS provides RAs on aircraft equipped with altitude reporting Mode A/C or Mode S transponders. Some aircraft are equipped with SSR transponders but do not have altitude encoders. ACAS cannot generate RAs in conflicts with such aircraft because, without altitude information, a collision threat assessment cannot be made. ACAS equipment can generate only TAs on such aircraft, describing their ranges, range rates and bearings. Aircraft equipped with Mode A only transponders and those not equipped with or not operating Mode A/C or Mode S transponders cannot be tracked by ACAS.

1.3.2 INTRUDER CLOSING SPEEDS AND TRAFFIC DENSITIES

1.3.2.1 ACAS equipment designed for operation in high density airspace is capable of providing over-all surveillance performance on intruders as defined in Chapter 4, 4.3.2 and Table 4-1.

1.3.2.2 The conditions enumerated in Table 4-1, which define two distinct density regions in the multi-dimensional condition space that affects ACAS performance, were extrapolated from airborne measurements of the performance of a typical ACAS. The airborne measurement data indicated that the track establishment probability will not drop abruptly when any of the condition bounds is exceeded.

1.3.2.3 The performance is stated in terms of probability of tracking a target of interest at a maximum closing speed in a given traffic density at least 30 seconds before the point of closest approach. The maximum traffic density associated with each of the two density regions is defined as:

$$\rho = n(r)/\pi r^2$$

where $n(r)$ is the maximum 30-second time average of the count of SSR transponder-equipped aircraft (not counting own aircraft) above a circular area of radius r about the ACAS aircraft ground position. In the airborne measurements, the radii were different for the two density regions. In the high-density measurements the radius was 9.3 km (5 NM). In the low-density measurements the radius was 19 km (10 NM). Traffic density outside the limits of the circular area of constant density may be assumed to decrease inversely proportional to range so that the number of aircraft is given by:

$$n(r) = n(r_0)r/r_0$$

where r_0 is the radius of the constant density region.

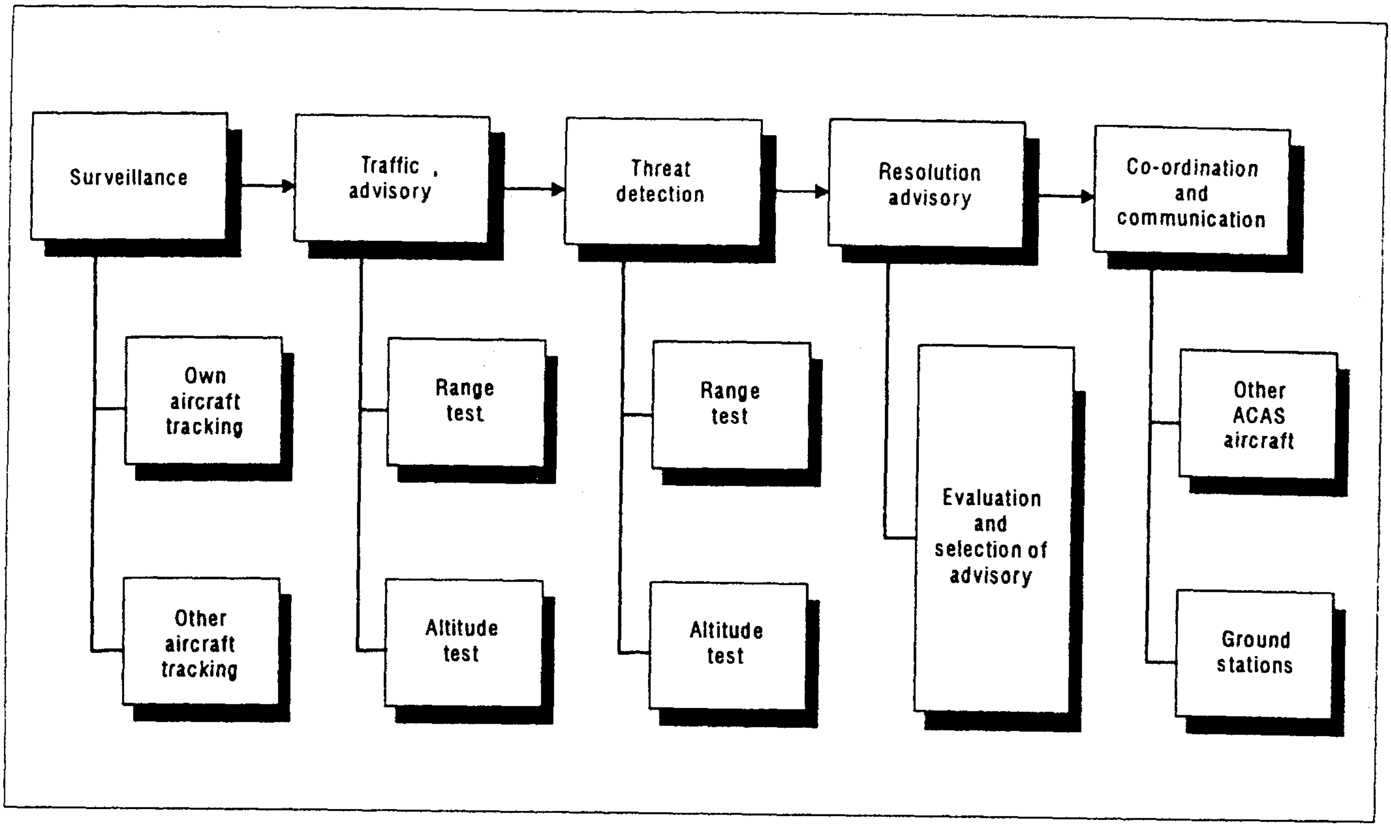


Figure A-1. Illustration of ACAS functions

1.3.2.4 When the density is greater than 0.017 aircraft/km² (0.06 aircraft/NM²), the nominal radius of uniform density r_0 is taken to be 9.3 km (5 NM). When the density is equal to or less than indicated above, r_0 is nominally 18.5 km (10 NM).

1.3.2.5 The table is based on an additional assumption that at least 25 per cent of the total transponder-equipped aircraft in the highest density 0.087 aircraft/km² (0.3 aircraft/NM²) airspace are Mode S equipped. If fewer than 25 per cent are Mode S equipped, the track probability for Mode A/C aircraft may be less than 0.90 because of increased synchronous garble. If the traffic density within r_0 exceeds the limits given in the table or if the traffic count outside of r_0 continues increasing faster than r, the actual track establishment probability for Mode A/C aircraft may also be less than 0.90 because of increased synchronous garble. If the closing speed exceeds the given limits, the tracks for Mode A/C and Mode S aircraft may be established late. If the number of other ACAS in the area exceeds the limits given in the table, the interference limiting requirements of Chapter 4, 4.3.2.2 require that the ACAS transmitter power and receiver sensitivity be further reduced, thereby resulting in a later establishment time. However, the track probability is expected to degrade gradually as any of these limits is exceeded.

1.3.2.6 The table reflects the fact that the ACAS tracking performance involves a compromise between closing speed and traffic density. Although it may not be possible to maintain a high probability of track when the traffic density and the intruder closing speed are both simultaneously large, the ACAS design is capable of reliable track establishment on high-speed intruders when operating in relatively low-density en-route airspace (typically characterized by densities of less than 0.017 aircraft/km², i.e. 0.06 aircraft/NM²) or when operating in higher density, low-altitude terminal airspace where the closing speeds are typically below 260 m/s (500 kt) for operational reasons.

1.3.2.7 The table also accounts for the fact that higher closing speeds are associated with the forward direction than with the side or back directions so that the ACAS surveillance design is not required to provide reliable detection for the highest closing speeds in the side or back directions.

1.3.3 SYSTEM RANGE LIMITATIONS

The required nominal tracking range of the ACAS is 26 km (14 NM). However, when operating in high density, the interference limiting feature may reduce system range to approximately 9.3 km (5 NM). A 9.3 km (5 NM) range is adequate to provide protection for a 260 m/s (500 kt) encounter.

1.4 Control of interference to the electromagnetic environment

1.4.1 The ACAS equipment is capable of operating in all traffic densities without degrading the electromagnetic environment. Each ACAS equipment knows the number of other ACAS units operating in the local airspace. This knowledge is used to ensure that no transponder is suppressed by ACAS activity for more than 2 per cent of the time and to ensure that ACAS does not contribute to an unacceptably high fruit rate that would degrade ground SSR surveillance performance. Multiple ACAS units in the vicinity co-operatively limit their own transmissions. As the number of such ACAS units increases, the interrogation allocation for each of them decreases. Thus, every ACAS unit monitors the number of other ACAS units within detection range. This information is then used to limit its own interrogation rate and power as necessary. When this limiting is in full effect, the effective range of the ACAS units may not be adequate to provide acceptable warning times in encounters in excess of 260 m/s (500 kt). This condition is normally encountered at low altitude where this closing speed capability is sufficient. Whenever the ACAS aircraft is on the ground, ACAS automatically limits the power of its interrogations. This limiting is done by setting the count of a number of other ACAS II and III aircraft in the interference limiting inequalities to an artificially high number. This value is selected to ensure that an ACAS unit on the ground does not contribute any more interference to electromagnetic environment than is unavoidable. The selected value of the count of a number of other ACAS II and III aircraft (60) will still provide an approximate surveillance range of 10 km (6 NM) to support reliable ground ACAS surveillance of local airborne traffic.

1.4.2 The presence of an ACAS unit is announced to other ACAS units by the periodic transmission of an ACAS interrogation containing a message that gives the Mode S address of the ACAS aircraft. This transmission is sent nominally every 8 to 10 seconds using a Mode S broadcast address. Mode S transponders are designed to accept message data from a broadcast interrogation without replying. The announcement messages received by the ACAS aircraft's Mode S transponder are monitored by the interference limiting algorithms to develop an estimate of the number of ACAS units in the vicinity.

2. FACTORS AFFECTING SYSTEM PERFORMANCE

2.1 Synchronous garble

When a Mode C interrogation is transmitted, all the transponders that detect it reply. Since the reply duration is 21 microseconds, aircraft whose ranges from ACAS are within about 2.8 km (1.5 NM) of each other generate replies that persistently and synchronously overlap each other at the interrogating aircraft. The number of overlapping replies is proportional to the density of aircraft and their range from ACAS. Ten or more overlapping replies might be received in moderate density terminal areas. It is possible to decode reliably only about three overlapping replies. Hence, there is a need to reduce the number of transponders that reply to each interrogation. Whisper-shout and directional transmit techniques are available for controlling such synchronous garble (see 3.2 and 3.3). They are both needed in ACAS equipment operating in the highest traffic densities.

2.2 Multipath from terrain reflections

2.2.1 SSR transponders use quarter-wave monopole antennas mounted on the bottom of the aircraft. A stub antenna of this sort has a peak elevation gain at an angle of 20 to 30 degrees below the horizontal plane. This is suitable for ground-air surveillance, but the direct air-air surveillance path may operate at a disadvantage relative to the ground reflection path, particularly over water.

2.2.2 If the ACAS unit uses a bottom-mounted antenna, there are geometries for which the reflected signal is consistently stronger than the direct signal. However, when a top-mounted antenna is used for interrogation, its peak gain occurs at a positive elevation angle and the signal-to-multipath ratio is improved. Thus, when ACAS transmits from the top-mounted antenna, the effects of multipath are reduced significantly. Even when a top-mounted antenna is used, the multipath will still occasionally exceed the receiver threshold. Thus, there is need to reject low-level multipath. ACAS can achieve this rejection through the use of variable receiver thresholds (see 3.4).

2.3 Altimetry data quality

2.3.1 MEASUREMENT ERRORS

2.3.1.1 The vertical separation between two conflicting aircraft is measured as the difference between own altitude and the intruder's altitude as reported in its Mode C or Mode S reply. If the ACAS aircraft is an air carrier, it will normally have accurate altimetry; an intruding aircraft might have less accurate altimetry.

2.3.1.2 Errors in altimetry can cause two types of effects: first, if the aircraft are on a near collision course, errors could indicate safe passage, and the impending near mid-air collision might not be resolved by ACAS; second, if the aircraft are on a near collision course, but are separated in altitude, errors could lead to an ACAS manoeuvre in the wrong direction which could induce an even closer encounter.

2.3.1.3 ACAS attempts to achieve a difference of at least 90 m (300 ft) between aircraft at closest approach based on reported altitude. Thus, if the combination of intruder and ACAS altimetry errors approached 90 m (300 ft), there would be finite risk of inadequate vertical separation despite the presence of ACAS. Studies of the expected altimetry errors of both ACAS and non-ACAS aircraft at altitudes from sea level to FL 400 have concluded that the risk is essentially negligible if both aircraft are equipped with high accuracy altimetry systems that can achieve root-sum-square (RSS) errors of approximately 15 m (50 ft). It was further concluded that if an ACAS with high accuracy altimetry operates in a traffic environment consisting of typical general aviation aircraft (with RSS errors of approximately 30 m (100 ft), normally distributed), then altimetry errors will occasionally lead to inadequate ACAS RAs. However, this will not occur often enough to seriously interfere with the effectiveness of the system. Performance was considered to be inadequate if both aircraft in an encounter had a low accuracy altimetry system. This led to the requirement that ACAS possess a high accuracy system.

2.3.2 ALTITUDE BIT FAILURE

If the Mode C or Mode S altitude reports from the intruding aircraft contain bit errors, ACAS may develop erroneous estimates of the vertical position and/or rate of the intruder. These errors can have effects similar to the effects of measurement errors.

2.3.3 CREDIBILITY OF OWN AIRCRAFT ALTITUDE

All sources of own altitude data are required to be checked for credibility, including fine altitude data (which can come from various sources: gyro, air data computer, etc.) and radar altitude data.

2.4 Potential for ground-based SSR site monitors (PARROTS) to cause spurious traffic and resolution advisories

An ACAS interrogates all SSR transponders within range, including ground-based transponder installations used to monitor the operation of ground radar systems, or test transponders. If these ground-based transponders reply with false altitude data, the potential exists for an ACAS to generate spurious TAs and RAs. To prevent this problem, information on the operation of position adjustable range reference orientation transponders (PARROTS) and transponder test facilities is provided in the *Manual on Secondary Surveillance Radar (SSR) Systems* [in preparation].

2.5 Allocation and assignment of SSR Mode S addresses

To ensure safe operation, the system requires that all Mode S-equipped aircraft have unique addresses. Multiple aircraft with the same address or aircraft with addresses not compliant with Annex 10, Volume I, Part I, Chapter 2, 2.5.6 can adversely affect the surveillance and co-ordination functions.

3. CONSIDERATIONS ON TECHNICAL IMPLEMENTATION

3.1 System operation

3.1.1 SURVEILLANCE OF INTRUDERS

3.1.1.1 The main purposes of the surveillance processes described below are to obtain position reports and to correlate these to form tracks. This involves the use of trackers and requires the estimation of rates.

3.1.1.2 The ACAS unit transmits an interrogation sequence nominally once per second. When these interrogations are received by Mode A/C and Mode S altitude reporting transponders, the transponders transmit replies that report their altitude. The ACAS unit computes the range of each intruding aircraft by using the round-trip time between the transmission of the interrogation and the receipt of the reply. Altitude rate and range rate are determined by tracking the reply information.

3.1.1.3 In the absence of interference, overload, interference-limiting conditions, or other degrading effects, the equipment will nominally be capable of providing surveillance for Mode A/C and Mode S targets out to a range of 26 km (14 NM). However, because the surveillance reliability degrades as the range increases, the equipment should assess as possible collision threats only those targets within a maximum range of 22 km (12 NM). No target outside of this range should be eligible to generate an RA. However, ACAS is able to detect ACAS broadcast interrogations from ACAS-equipped aircraft out to a nominal range of 56 km (30 NM).

3.1.1.4 The equipment should have the capacity for surveillance of any mix of Mode A/C or Mode S targets up to a total peak target capacity of 30 aircraft. ACAS equipment is nominally capable of reliable surveillance of high-closing-speed targets in a peak traffic density of up to 0.017 aircraft per square km (0.06 aircraft per square NM) or approximately 27 aircraft in a 26 km (14 NM) radius.

3.1.1.5 When the average traffic density exceeds the above value, the reliable surveillance range decreases. ACAS equipment is capable of providing reliable surveillance of targets closing only up to 260 m/s (500 kt) in an average traffic density of 0.087 aircraft per square km (0.3 aircraft per square NM). The surveillance range required for 260 m/s (500 kt) targets is about 9.3 km (5 NM). It is possible to provide 9.3 km (5 NM) surveillance in a short-term peak traffic density of 0.087 aircraft/km² (0.3 aircraft/NM²) or more without exceeding a total target capacity of 30. If the over-all target count ever exceeds 30 at any range up to 26 km (14 NM), the long-range targets may always be dropped without compromising the ability to provide reliable surveillance of lower-speed targets. Thus a peak capability of 30 targets (any mix of Mode A/C or Mode S) is adequate for ACAS and if the number of Mode A/C plus Mode S targets under surveillance exceeds 30, excess targets are to be deleted in order of decreasing range without regard to target type.

3.1.2 Surveillance of intruders with Mode A/C transponders

3.1.2.1 Surveillance of Mode A/C transponders is accomplished by the periodic transmission of a Mode C-only all-call (intermode) interrogation (Annex 10, Volume I, Part I, Chapter 3, 3.8.2.1.5.1.2). This elicits replies from Mode A/C transponders, but not from Mode S transponders, thus preventing the replies of Mode S transponders from synchronously garbling the replies of Mode A/C transponders. Other techniques for reducing synchronous garble are (1) the use of directional antennas to interrogate only those aircraft in an azimuth wedge, and (2) the use of a sequence of variable power suppressions and interrogations (known as "whisper-shout") that interrogates only aircraft that have similar link margins (see 3.2.2). The use of both of these techniques together provides a powerful tool for overcoming the effects of synchronous garble.

3.1.2.2 Whisper-shout employs a sequence of interrogations at different power levels transmitted during each surveillance update period. Each of the interrogations in the sequence, other than the one at lowest power, is preceded by a suppression transmission, where the first pulse of the interrogation serves as the second pulse of the suppression transmission. The suppression transmission pulse begins at a time 2 microseconds before the first pulse of the interrogation. The suppression pulse is transmitted at a power level lower than the accompanying interrogation so that the transponders that reply are only those that detect the interrogation and do not detect the suppression. To guard against the possibility that some transponders do not reply to any interrogation in the sequence, the suppression pulse is transmitted at a power level somewhat lower than that of the next lower interrogation. The time interval between successive interrogations should be at least 1 millisecond. This ensures that replies from transponders at long range are not mistaken for replies to the subsequent interrogation. All interrogations in the sequence are transmitted within a single surveillance update interval.

3.1.2.3 Responses to each Mode C-only all-call interrogation are processed to determine the range and altitude code of each reply. It is possible to determine the altitude codes for up to three overlapping replies if care is taken to identify the location of each of the received pulses.

3.1.2.4 After all of the replies are received in response to the whisper/shout sequence, duplicate replies should be merged so that only one "report" is produced for each detected aircraft. Reports may be correlated in range and altitude with the predicted positions of known intruders (i.e., with existing tracks). Since intruding aircraft are interrogated at a high rate (nominally once per second), good correlation performance is achieved using range and altitude. Mode A code is not needed for correlation. Reports that correlate are used to extend the associated tracks. Reports that do not correlate with existing tracks may be compared to previously uncorrelated reports to start new tracks. Before a new track is started, the replies that lead to its initiation may be tested to ensure that they agree in all of the most significant altitude code bits. A geometric calculation may be performed to identify and suppress specular false targets caused by multipath reflections from the terrain.

3.1.2.5 Tracks being initiated may be tested against track validity criteria prior to being passed to the collision avoidance algorithms. The purpose of these tests is to reject spurious tracks caused by garble and multipath. Spurious tracks are generally characterized by short track life.

3.1.2.6 Aircraft not reporting altitude in Mode C replies are detected using the Mode C reply framing pulses. These aircraft are tracked using range as the correlation criterion. The additional use of bearing for correlation will help to reduce the number of false non-Mode C tracks.

3.1.2.7 *Reply merging.* Multiple replies may be generated by a Mode A/C target that responds to more than one whisper-shout interrogation during each whisper-shout sequence or by a target that responds to interrogations from both the top and bottom antennas. The equipment is expected to generate no more than one position report for any target even though that target may respond to more than one interrogation during each surveillance update interval.

3.1.2.8 *Mode A/C surveillance initiation.* The equipment will pass the initial position reports to the collision avoidance algorithms only if the conditions in a) and b) below are satisfied:

a) initially, a Mode C reply is received from the target in each of three consecutive surveillance update periods, and:

   1) the replies do not correlate with surveillance replies associated with other tracks;

   2) the range rate indicated by the two most recent replies is less than 620 m/s (1 200 kt);

   3) the oldest reply is consistent with the above range rate in the sense that its range lies within 95.3 m (312.5 ft) of a straight line passing through the two most recent replies;

4) the replies correlate with each other in their altitude code bits;

b) a fourth correlating reply is received within five surveillance update intervals following the third reply of the three consecutive replies in a) above.

3.1.2.8.1 The following is an example of an acceptable set of rules for assessing correlation of reply code bits and determining the initial altitude track code estimate for a target. Three replies correlate only if:

a) all eight of their D, A and B code pulses agree; or

b) seven of their D, A, and B code pulses agree and at least one of their C code pulses agree.

3.1.2.8.2 The test for code agreement among the three replies is made individually for each of the reply pulse positions. This test is based on the presence of code pulses alone; agreement occurs for a given reply pulse position if all three replies are detected with ONE in the position or all three replies are detected with a ZERO in that position. The confidence associated with those pulse detections does not affect agreement.

3.1.2.8.3 The confidence flag for a reply pulse position is set "low" whenever there exists another received reply (either real or phantom) that could have had a pulse within ±0.121 microsecond of the same position. Otherwise, the confidence flag is set "high".

3.1.2.8.4 When agreement among the three replies does not occur for a given reply pulse position, the initial track pulse code estimate for that position is based on the values of the individual pulse codes and the confidence flags associated with those pulse codes in three replies.

3.1.2.8.5 When agreement fails for a given pulse position, the rules for estimating the initial track code for that position are based on the principle that "low" confidence ONES are suspect. The rules are as follows:

a) If in the most recent (third) reply the detected code for a given pulse position is "high" confidence or a ZERO, the initial track pulse code estimate for that position is the same as the code detected in that position in the most recent reply.

b) If in the most recent reply the detected code for a given pulse position is a "low" confidence ONE, the initial track pulse code estimate for the position is the same as the code detected in that position in the second reply provided that was not also a "low" confidence ONE. If the second was also a "low" confidence ONE, the initial track pulse code estimate is the same as the code detected in that position in the first reply.

3.1.2.9 *MODE A/C SURVEILLANCE EXTENSION*

3.1.2.9.1 *General.* The equipment should continue to pass position reports for a target to the collision avoidance algorithms only if:

a) the track has not been identified as an image (see 3.1.2.9.6); and

b) the reply altitudes occur within an altitude window of ±60 m (200 ft) centred on the altitude predicted from previous reply history; and

c) all replies used for threat assessment after the initiation procedure occur within a range window centred on the range predicted from previous reply history.

3.1.2.9.2 *Range correlation.* The following is an example of an acceptable set of rules for determining the size of the range window:

a) The tracks are processed individually in increasing range order with input range precision of at least 15 m (50 ft) and retained computational accuracy of at least 1.8 m (6 ft). Range is estimated and predicted by a recursive (alpha-beta) tracker with alpha of 0.67 and beta of 0.25.

b) After each surveillance update a new range measurement is available for each target. Since the measurement includes errors, it must be smoothed based on previous measurements to obtain improved estimates of the current target position and velocity. The range and range rate estimation equations are as follows:

$$r(t) \text{ estimate} = r(t) \text{ prediction} + [\text{alpha} \times (r(t) \text{ measurement} - r(t) \text{ prediction})]$$

$$r(t) \text{ estimate} = \dot{r}(t-T_p) \text{ estimate} + [(\text{beta}/T_p) \times (r(t) \text{ measurement} - r(t) \text{ prediction})],$$

where T_p is the time difference between the current and previous measurements.

c) The gains, alpha and beta determine the relative degree of reliance on current and previous measurements; gains of unity would place complete reliance on the current measurement and result in no smoothing.

d) The estimates obtained from the above equations are subsequently used to predict the range at the time of the next measurement as follows:

$$r(t + T_n) \text{ prediction} = r(t) \text{ estimate} + [\dot{r}(t) \text{ estimate} \times T_n]$$

where T_n is the time difference between the next measurement and the current measurement.

e) The range correlation window is centred at the predicted range and has a half-window width as follows:

760 ft if coasted last interval 570 ft if updated last interval	+	**If track is not established:** 0 **If track is established:** 2 000 ft, if 0.00 NM ≤ r <0.17 NM 1 000 ft, if 0.17 NM ≤ r < 0.33 NM 600 ft, if 0.33 NM ≤ r <1.00 NM 240 ft, if 1.00 NM ≤ r <1.50 NM 0 ft, if 1.50 NM ≤ r

f) If the track is above 3 050 m (10 000 ft), the term contained within the second pair of brackets is multiplied times four.

3.1.2.9.3 *Altitude correlation.* For the purposes of altitude correlation, altitude is estimated and predicted by an alpha-beta tracker with alpha of 0.28 and beta of 0.06. The tracker has retained computational accuracy of (30 m) (100 ft) divided by 16. The altitude prediction is rounded to the nearest 30 m (100 ft) increment and converted to grey code. The grey codes of the predicted altitude ±30 m (100 ft) are also computed. The longer-term altitude predictions performed by the threat detection logic require a more accurate altitude tracking procedure (see 3.5.3). The reply(s) that lies in the range correlation window is tested for altitude correlation in increasing range order. The track is updated with the first reply that has exact agreement (in all bits) with any of the three grey codes computed above. If no reply matches, two additional grey codes are computed and the process tried again. The two codes are the predicted altitude ±60 m (200 ft).

3.1.2.9.4 *Track updating — establishment.* The updating reply (if any) is eliminated from further consideration in updating other tracks, or in the track initiation process. If there is no updating reply, the range and altitude estimates are set equal to the corresponding predicted values. If this is the sixth (6th) consecutive interval having no updating reply, the track is dropped. If there is an updating reply, and if the track is not identified as an image (see 3.1.2.9.6), the track is flagged as established, that is, it is now available for use by the threat detection logic. Once established, a track remains established until it is dropped, even if it subsequently satisfies the conditions for an image track.

3.1.2.9.5 *Test for track splits.* When all tracks have been processed, they are combined with the tracks that are newly initiated during the current scan, and then all the tracks are examined pairwise to determine if a given pair of tracks is likely to represent the same intruder. If:

a) the ranges differ by at most 150 m (500 ft)

b) the range rates differ by at most 4.6 m/s (8.9 kt)

c) either

1) the altitudes differ by at most 30 m (100 ft), or

2) the altitude rates differ by at most 3 m/s (10 ft/s) and both tracks were initiated during the same scan,

only one of the tracks is retained, preference being given to the track showing the larger number of replies since initiation.

3.1.2.9.6 *Image track processing.* Those tracks that could have been formed by replies specularly reflected from the ground are referred to as image tracks. A track is identified as an image if there exists a track at shorter range (referred to as the real track) such that:

a) the difference between the real altitude and the image altitude is less than or equal to 60 m (200 ft) for altitude-reporting targets, or both the image track and the real track are non-altitude-reporting; and

b) the difference between the measured image range rate and the calculated image range rate $\dot{r}_i$ is less than or equal to 21 m/s (40 kt), where the calculated image range rate is either (for the single-reflection case):

$$\dot{r}_i = \left(\frac{1}{2}\right)\left[\dot{r} + \left(\frac{1}{2r_i - r}\right)\left[((2r_i - r)^2 - r^2 + (Z_0 - Z)^2)^{\frac{1}{2}}(\dot{Z}_0 + \dot{Z}) + r\dot{r} - (Z_0 - Z)(\dot{Z}_0 - \dot{Z})\right]\right]$$

or (for the double-reflection case):

$$\dot{r}_i = \left(\frac{1}{r_i}\right)\left[(r_i^2 - r^2 + (Z_0 - Z)^2)^{\frac{1}{2}}(\dot{Z}_0 + \dot{Z}) + r\dot{r} - (Z_0 - Z)(\dot{Z}_0 - \dot{Z})\right].$$

where:

r_i is the image range,

r is the real range,

Z is the real altitude, for altitude reporting targets or Z is set to own altitude for non-altitude reporting targets, and

Z_0 is own altitude

If a track is identified as an image, it may be retained, but it cannot be flagged as established for use by the threat detection logic.

3.1.2.10 *Missing Mode A/C reports.* The equipment continues to pass to the collision avoidance algorithms predicted position reports for Mode A/C targets for six surveillance update intervals following the receipt of the last valid correlating reply. The equipment does not pass position reports for more than six surveillance update intervals following the receipt of the last valid correlating reply unless the target again satisfies the surveillance initiation criteria of 3.1.2.8.

3.1.3 SURVEILLANCE OF INTRUDERS WITH MODE S TRANSPONDERS

3.1.3.1 Efficient air-air surveillance techniques have been developed for intruders equipped with Mode S transponders. Because of Mode S selective address, there is no synchronous garble associated with surveillance of Mode S transponders. However, multipath must be dealt with and the surveillance of Mode S transponders should be accomplished with as few interrogations as possible to minimize interference.

3.1.3.2 The Mode S modulation formats are inherently more resistant to multipath than are the Mode A/C modulation formats. However, the greater length of the Mode S transmission makes it more likely to be overlapped by multipath. The use of top-mounted antennas and variable receiver thresholds (to protect the Mode S reply preamble) increases the multipath resistance to an acceptable level for reliable air-air surveillance. The use of antenna diversity transponders on ACAS aircraft provides an additional reliability margin for co-ordination between pairs of conflicting ACAS aircraft.

3.1.3.3 Mode S interrogation rates are kept low by passive detection of transponder transmissions and by interrogating only those intruders that could become immediate threats. Passive address acquisition prevents unnecessary interference with other elements of the SSR and ACAS system. ACAS listens to Mode S all-call replies (DF = 11, acquisition squitter transmissions, Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.4.1). These may occur in response to Mode S ground station all-call interrogations or as spontaneous replies (called squitters) at intervals ranging from 0.8 to 1.2 seconds. Reception of squitters may be alternated between the top and bottom antennas. If reception is switched, it will be necessary to control the switching times to avoid undesirable synchronism with the squitters transmitted by Mode S antenna diversity transponders.

3.1.3.4 The 24-bit aircraft address in the squitter is protected by error coding to ensure a high probability of obtaining a correct address. Since the squitter transmission does not contain altitude information, ACAS attempts to obtain altitude passively from Mode S replies generated in response to ground interrogations or interrogations from other ACAS aircraft. If altitude is not received shortly after address detection, the Mode S aircraft is actively interrogated to obtain altitude.

3.1.3.5 After ACAS has determined the altitude of a detected Mode S aircraft, it compares the altitude of this aircraft to its own altitude to determine whether or not the target can be ignored or should be interrogated to determine its range and speed capability (if not already known). If the measured range and the reported speed capability indicate that it is (or could soon be) a collision threat, the intruder should be regularly interrogated and the resulting track data fed to the collision avoidance algorithms. An aircraft at longer range should be interrogated only as often as necessary to ensure that it will be tracked before it becomes a collision threat. Until this occurs, its address should be declared "dormant" and interrogations to that address should be temporarily suspended. Mode S targets may be exempt from dormancy provided that the number or power of interrogations was not reduced by the interference limiting algorithms or that the ACAS aircraft is not operating below a pressure altitude of 3 050 m (10 000 ft). When the interference limiting algorithms indicate that the number or power of interrogations is reduced or when the ACAS aircraft is below a pressure altitude of 3 050 m (10 000 ft), dormancy is applied.

3.1.3.6 The use of passive detection in combination with altitude comparison and dormant interference limiting reduces the Mode S interrogation rate automatically when the local densities of other ACAS aircraft are very high.

3.1.3.7 *MODE S SURVEILLANCE INITIATION*

3.1.3.7.1 The equipment is intended to provide Mode S surveillance with a minimum of Mode S interrogations. The identity of Mode S targets is determined by passively monitoring transmissions received with DF = 11. Error detection is applied to the received squitters to reduce the number of addresses to be processed. The altitude of the Mode S targets from which a squitter has been received is determined by monitoring transmissions received with DF = 0 (short air-air surveillance replies, Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.2) or DF = 4 (surveillance altitude replies, Annex 10, Volume I, Part I, Chapter 3, 3.8.2.6.5). The equipment monitors squitter and altitude replies whenever it is not transmitting, or receiving replies to, Mode S or Mode C interrogations. Each received reply is examined to determine what further action should be taken.

3.1.3.7.2 To reduce the number of unnecessary interrogations, a squitter target is not interrogated if so few squitters and altitude replies are received from it that no threat is indicated. Targets that might be a threat are called valid targets. The equipment is not intended to interrogate a target unless the altitude information indicates that it is within 900 m (3 000 ft) of own altitude or is closing in altitude at a rate that would cause it to become co-altitude within 60 seconds. The ACAS aircraft interrogates targets from which it does not receive altitude information but does continue to receive error-free squitters. The 900 m (3 000 ft) relative altitude boundary for interrogations may be increased provided that the number or power of interrogations was not reduced by the interference limiting algorithms or provided that an ACAS aircraft is not operating below a pressure altitude of 3 050 m (10 000 ft). When the interference limiting algorithms indicate that the number or power of interrogations is reduced or when an ACAS aircraft is below a pressure altitude of 3 050 m (10 000 ft), the number or power of interrogations to aircraft outside the 900 m (3 000 ft) boundary is reduced first.

3.1.3.7.3 The following is an example of one acceptable means of processing squitters and altitude replies to reduce unneeded interrogations:

a) When a valid squitter is first received, a running sum initialized at 0 is associated with it. During each succeeding surveillance update interval the sum is decremented by 1 if no squitters or altitude replies with a particular address are received, and the sum is incremented by 16 for each reception of either a squitter or an altitude reply. The process continues until the sum equals or exceeds 20. When the sum becomes less than or equal to −20, the address is removed from the system. When it equals or exceeds +20, the target is declared to be valid.

b) When a target has been declared to be valid, it is interrogated unless its altitude differed from the ACAS altitude by:

1) more than 2 700 m (9 000 ft) within the last 30 seconds, or

2) more than 900 m (3 000 ft) within the last 30 seconds and the predicted time for it to become co-altitude, based on a computation of its altitude rate, exceeds 60 seconds.

c) When any of these conditions are satisfied, the running sum continues to be incremented and decremented even though its value may exceed 20.

3.1.3.8 *MODE S RANGE ACQUISITION*

3.1.3.8.1 The equipment should transmit an acquisition interrogation (UF = 0, 16, AQ = 1, Annex 10, Volume I, Part I, Chapter 3, 3.8.2.8.1.1) to determine the range of each valid target that is co-altitude as defined above, or from which inadequate altitude information has been received.

3.1.3.8.2 If an acquisition interrogation fails to elicit a valid reply, additional interrogations should be transmitted. The total number of acquisition interrogations addressed to a single target must not exceed three within a single surveillance update period. The first acquisition interrogation is to be transmitted using the top antenna. If two acquisition interrogations to a target fail to elicit valid replies, the next two acquisition interrogations to that target are to be transmitted using the bottom antenna. If in the acquisition attempt in the first surveillance update period, valid replies are not received, ACAS transmits a total of nine acquisition interrogations distributed over the first six successive surveillance update periods. If acquisition interrogations fail to elicit replies within six surveillance update intervals, the acquisition process is to cease until enough additional squitters/fruit are received indicating that a successful acquisition is likely. One means of accomplishing this is to process subsequent squitters/fruit as described in 3.1.3.7, but with the increment 16 replaced by 8. If a second failure to acquire occurs, the process is repeated with an increment of 4. After any subsequent failure, an increment of 2 is used.

3.1.3.8.3 If additional attempts are made to acquire the target, they conform to the pattern described above except that:

a) On the second and third attempt, only one interrogation is to be made during a single surveillance update interval; and in the absence of valid replies, six interrogations are to be transmitted during the first six surveillance update intervals.

b) Any further attempts consist of a single interrogation during the entire six update intervals.

3.1.3.8.4 The range of the target is used with its reported maximum speed capability and own aircraft maximum speed capability to determine the "time-to-endanger", i.e., the earliest possible time a collision could take place assuming a head-on encounter at maximum speed. If the time-to-endanger is less than 42 seconds, one or more interrogations are to be transmitted to the target within two surveillance update intervals from the time that the range determination is made, and periodic surveillance interrogations (designated as "tracking" interrogations) are to be initiated for that target unless the altitude information received indicates that this is not necessary.

3.1.3.8.5 If the time-to-endanger of a Mode S target is greater than or equal to 42 seconds, the equipment is not intended to transmit additional interrogations to that target until a time equal to the "time-to-endanger" minus 42 seconds has elapsed. (Such a target is referred to as dormant.) When a target ceases to be dormant, its address is treated as a new address as described in 3.1.3.7; i.e. it is to be initiated again if squitters continue to be received.

3.1.3.9 *MODE S SURVEILLANCE EXTENSION*

3.1.3.9.1 The equipment passes position reports for a Mode S target to the collision avoidance algorithms only if all replies used for threat assessment after the initial range acquisition occur within a range window centred on a range predicted from previous reply history. The range window is the same as that used for Mode A/C tracking in 3.1.2.9.2.

3.1.3.9.2 If a tracking interrogation fails to elicit a valid reply, additional interrogations are transmitted. The total number of tracking interrogations addressed to a single target is not expected to exceed five during a single surveillance update period or sixteen distributed over six successive surveillance update periods. The first tracking interrogation is transmitted using the antenna that was used in the last successful interrogation of that target. If two successive tracking interrogations fail to elicit valid replies from a target, the next two interrogations to that target are transmitted using the other antenna.

3.1.3.10 *Missing Mode S replies.* The equipment continues to pass to the collision avoidance algorithms predicted position reports for Mode S targets for six surveillance update intervals following the receipt of the last valid reply to a tracking interrogation. The equipment does not pass position reports for Mode S targets for more than six surveillance update intervals following the receipt of the last reply to a tracking interrogation unless the target again satisfies the range acquisition criteria of 3.1.3.7. The Mode S address of a dropped track is retained for four additional seconds to shorten the reacquisition process if squitters are received.

3.1.3.11 *Mode S overload.* The equipment passes position reports for all Mode S targets regardless of the distribution of targets in range, provided the total peak target count does not exceed 30.

3.1.3.12 *Mode S power programming.* The transmit power level of Mode S tracking interrogations to targets (but not air-to-air co-ordination interrogations) is to be automatically reduced as a function of range for targets within 18.5 km (10 NM) as follows:

$$P_T = P_{max} + 20 \log \frac{r}{10},$$

where P_T is the adjusted power level, P_{max} is the nominal power level (typically 250 W), which is transmitted to targets at ranges of 18.5 km (10 NM) or more, and r is the predicted range of the target. The actual transmitted power is the lesser of P_T and the limit imposed by the interference limiting inequalities of Chapter 4, 4.3.2.2.2.2.

3.1.3.13 *Mode S track capacity.* When the aircraft density is nominally 0.087 Mode S aircraft per km² (0.3 aircraft per NM²) in the vicinity of the ACAS aircraft, there will be about 24 aircraft within 9.3 km (5 NM) and about 142 aircraft within 56 km (30 NM) of the ACAS aircraft. Thus, the ACAS equipment is expected to have capacity for at least 150 Mode S addresses.

3.1.3.14 *USE OF BEARING ESTIMATES FOR MODE S SURVEILLANCE*

3.1.3.14.1 Bearing estimation capability is not required for high-density Mode S surveillance. However, if bearing estimates are available, it is seen that the use of directional Mode S interrogations significantly reduces the transmitter power requirement of the equipment. Directional Mode S interrogations may also be used in the absence of bearing information, provided the interference limits are not exceeded.

3.1.3.14.2 Bearing estimates may also be used in conjunction with knowledge of own airspeed to reduce the over-all Mode S interrogation rate. The following is one possible way of achieving such a reduction.

3.1.3.14.3 Instead of calculating time-to-endanger based on the conservative assumption that the two aircraft are on a head-on collision course, the time-to-endanger can be increased by taking into account the threat bearing and the limited turn-rate of own aircraft and allowing for the time that would be required for own aircraft to turn in the direction of the threat. Such computation would continue to assume that the target aircraft is travelling at its reported maximum capable speed directly toward the collision point.

3.2 Transmitter

3.2.1 POWER LEVELS

3.2.1.1 In the absence of interference and when using an antenna whose pattern is identical to that of a quarter-wave monopole above a ground plane, it is possible to provide reliable air-to-air surveillance of transponders at ranges of 26 km (14 NM) by using a nominal transmitted power of 54 dBm (250 W) at the terminals of the antenna.

3.2.1.2 The transmitter output power is to be carefully limited between transmissions because any leakage may severely affect the performance of the Mode S transponder on board the ACAS aircraft. The leakage power into the transponder at 1 030 MHz is generally to be kept at a level below −90 dBm. If the physical separation between the transponder antenna and the ACAS antenna is no less than 50 cm, the coupling loss between the two antennas will exceed 20 dB. Thus, if the RF power at 1 030 MHz at the ACAS antenna terminal does not exceed −70 dBm in the inactive state, and if a minimum antenna spacing of 50 cm is adhered to, the direct interference from the ACAS antenna to the transponder antenna will not exceed −90 dBm. This requirement is to ensure that, when not transmitting an interrogation, ACAS does not radiate RF energy that could interfere with, or reduce the sensitivity of, the SSR transponder or other radio equipment in nearby aircraft or ground facilities.

3.2.1.3 Measures must also be taken to ensure that direct 1 030 MHz leakage from the ACAS enclosure to the transponder enclosure is below −110 dBm when the two units are mounted side-by-side in a typical aircraft installation.

3.2.1.4 It is expected that the ACAS equipment be tested side-by-side with Mode S transponders of equivalent classification to ensure that each unit meets its sensitivity requirements in the presence of transmitter leakage from the other.

3.2.2 CONTROL OF SYNCHRONOUS INTERFERENCE BY WHISPER-SHOUT

3.2.2.1 To control Mode A/C synchronous interference and facilitate ACAS operation in airspace with higher traffic densities, a sequence of interrogations at different power levels may be transmitted during each surveillance update period. Each of the interrogations in the sequence, other than the one at lowest power, is preceded by a suppression pulse (designated S_1) 2 microseconds preceding the P_1 pulse. The combination of S_1 and P_1 serves as a suppression transmission. S_1 is transmitted at a power level lower than that of

P_1. The minimum time between successive interrogations is to be 1 millisecond. All interrogations in the sequence should be transmitted within a single surveillance update interval.

3.2.2.2 Because the suppression transmission in each step is always at a lower power level than the following interrogation, this technique is referred to as whisper-shout. The intended mechanism is that each aircraft replies to only one or two of the interrogations in a sequence. A typical population of Mode A/C transponders at any given range may have a large spread in effective sensitivity due to variation in receivers, cable losses, and antenna shielding. Ideally, each transponder in the population will respond to two interrogations in the sequence, and will be turned off by the higher power suppression transmissions accompanying higher-power interrogations in the sequence. Given a situation in which several aircraft are near enough to each other in range for their replies to synchronously interfere, it is unlikely they would all reply to the same interrogation and, as a result, the severity of synchronous interference is reduced. Use of whisper-shout also reduces the severity of the effects of multipath on the interrogation link.

3.2.2.3 Figure A-2 defines a whisper-shout sequence that is matched to the requirements for high-density surveillance. Five distinct subsequences are defined; one for each of the four beams of the top-mounted antenna and one for the bottom-mounted omnidirectional antenna. The interrogations may be transmitted in any order. When the sequence is truncated to limit interference, the steps are dropped in the order shown in the column Interference limiting priority. The lowest numbered steps are dropped first. The timing of individual pulses or steps in the sequence is defined in Figure A-3 which illustrates the three lowest-power steps in the top-forward antenna sequence. The first pulse of the interrogation serves as the second pulse of the suppression.

3.2.2.4 The minimum triggering level (MTL) values tabulated in Figure A-2 are based on the assumption that replies to all interrogations are received omnidirectionally. If a directional-receive antenna is used, the MTL values must be adjusted to account for the antenna gain. For example, for a net antenna gain of 3 dB, all MTL values in the table would be raised by 3 dB; and the MTL for step number 1 would be −71 dBm rather than −74 dBm.

3.2.2.5 The power is defined as the nominal total radiated power for the interrogation, which is equal to the net power delivered to the antenna terminals assuming a lossless antenna. All power levels are to be within ±2 dB of nominal. The tolerance of the step increments is to be ±1/2 dB and the increments are to be monotonic throughout the entire power range of the sequence.

3.2.2.6 Most of the interrogations are transmitted from the top antenna because it is less susceptible to multipath interference from the ground.

3.2.3 INTERFERENCE LIMITING

3.2.3.1 ACAS equipment conforms to a set of three specific inequalities (Chapter 4, 4.3.2.2.2.2) for controlling interference effects. The three inequalities are associated with the following physical mechanisms: (1) reduction in "on" time of other transponders caused by ACAS interrogations, (2) reduction in "on" time of own transponder caused by mutual suppression during transmission of interrogations, and (3) Mode A/C fruit caused by ACAS Mode A/C interrogations.

3.2.3.2 Inequality (1) ensures that a "victim" transponder will never detect more than 280 ACAS interrogations in a one-second period from all the ACAS interrogators within 56 km (30 NM). The left-hand side of the inequality allows an ACAS unit to increase its interrogation rate if it transmits at less than 250 W since low power transmissions are detected by fewer transponders. The denominator of the first term on the right-hand side of this inequality accounts for other ACAS interrogators in the vicinity and the fact that all ACAS units must limit their interrogation rate and power in a similar manner so that, as the number of ACAS units in a region increases, the interrogation rate and power from each of them decreases and the total ACAS interrogation rate for any nearby transponder remains less than 280 per second.

3.2.3.3 Within an airspace in which ACAS aircraft are distributed uniformly-in-area, and provided that the "victim" is taken off the air for 35 microseconds by suppression or reply dead time whenever it receives an ACAS interrogation, the total "off" time caused by ACAS interrogations will then never exceed 1 per cent. Measurements and simulations indicate that the total "off" time can be as high as 2 per cent in high-density terminal areas because of an ACAS aircraft distribution that is more nearly uniform-in-range and because of a Mode S transponder recovery time to certain interrogations that is expected to be 45 microseconds instead of 35 microseconds. The fixed term on the right-hand side ensures that an individual ACAS unit never transmits more average power than it would if there were approximately 15 other ACAS units nearby.

3.2.3.4 Inequality (2) ensures that the transponder on board the ACAS aircraft will not be turned off by mutual suppression signals from the ACAS unit on the same aircraft more than 1 per cent of the time.

3.2.3.5 Inequality (3) ensures that a "victim" Mode A/C transponder will not generate more than 40 Mode A/C replies in a one-second period in response to interrogations from all the ACAS interrogators within its detection range. Like inequality (1) it includes terms to account for reduced transmit power, to account for the other ACAS interrogators in the vicinity, and to limit the power of a single ACAS unit. Forty Mode A/C replies per second is approximately 20 per cent of the reply rate for transponder operating without ACAS in a busy area of multiple Mode A/C ground sensor coverage.

3.2.3.6 *EXAMPLE OF INTERFERENCE LIMITING*

3.2.3.6.1 As an example, when interrogation limiting is not invoked, the over-all Mode A/C and Mode S interrogation rates of an omni-directional ACAS unit would typically be as follows: the Mode A/C interrogation rate k_t is typically constant at 30 or more whisper-shout interrogations per second. Assume that the sum of the normalized whisper-shout powers, i.e. the Mode A/C contribution to the left-hand side of inequality (1), is approximately 5. The Mode S interrogation rate depends on the number of Mode S aircraft in the vicinity. In en-route airspace it is typically an average of about 0.08 interrogations per second for each Mode S aircraft within 56 km (30 NM). In a uniform aircraft density of 0.006 aircraft per square km (0.02 aircraft per square NM), the number of aircraft within 56 km (30 NM) is 57. If 20 per cent of these are ACAS equipped, n_a = 12 and the variable term on the right-hand side of inequality (1) is 21.5. If the number of ACAS aircraft in the area does not exceed 15, the fixed term continues to govern and no limiting occurs until there are approximately 160 Mode S aircraft within 56 km (30 NM).

3.2.3.6.2 Similar considerations hold for inequalities (2) and (3). In inequality (2) the mutual suppression interval associated with each top antenna interrogation is 70 microseconds. The bottom antenna mutual suppression interval is 90 microseconds. Thus the Mode A/C contribution to the left-hand side of inequality (2) is 0.0024 and the Mode S interrogation rate can be as high as 109 top antenna interrogations per second before violating the limit. With a typical whisper-shout sequence, the left-hand side of inequality (3) is approximately 5. The number of ACAS aircraft within 56 km (30 NM) can be as high as 15 without violating inequality (3).

3.2.3.6.3 When the interrogation rate or density increases to the point at which one of the limits is violated, either the Mode A/C or Mode S normalized interrogation rate or both must be reduced to satisfy the inequality. If the density were to reach 0.029 aircraft per km² (0.1 aircraft per NM²) uniformly out to 56 km (30 NM), there would be 283 aircraft within a 56 km (30 NM) radius. If 10 per cent of these were equipped with ACAS, n_a = 28. The right-hand limits in inequalities (1) and (3) would then be 9.66 and 2.76 respectively. To satisfy these lower limits, the Mode A/C and Mode S contributions to the left-hand side of inequality (1) would both have to be reduced. As a result, the surveillance range of both Mode A/C and Mode S targets would be less.

3.2.3.7 *INTERFERENCE LIMITING PROCEDURES*

3.2.3.7.1 At the beginning of each surveillance update interval, n_a is to be determined as indicated above. n_a is then used to evaluate the current right-hand limits in inequalities (1) and (3). Smoothed values of the Mode S variables in the inequalities are also to be calculated.

3.2.3.7.2 All air-to-air co-ordination interrogations and RA and ACAS broadcast interrogations are transmitted at full power. Air-to-air co-ordination interrogations and RA and ACAS broadcast interrogations are not included in the summations of Mode S interrogations in the left-hand terms of these inequalities. Whenever an RA is posted, surveillance interrogations to that intruder may be transmitted at full power to allow for maximum link reliability. Because the frequency of RAs is very low, these transmissions do not result in a measurable increase in interference.

3.2.3.7.3 If the smoothed value of the left-hand side of either inequality (1) or (2) equals or exceeds the current limit, both the Mode S and Mode A/C surveillance parameters are to be modified to satisfy the inequalities. If the left-hand side of inequality (3) exceeds the current limit, Mode A/C surveillance parameters are modified to satisfy the inequalities.

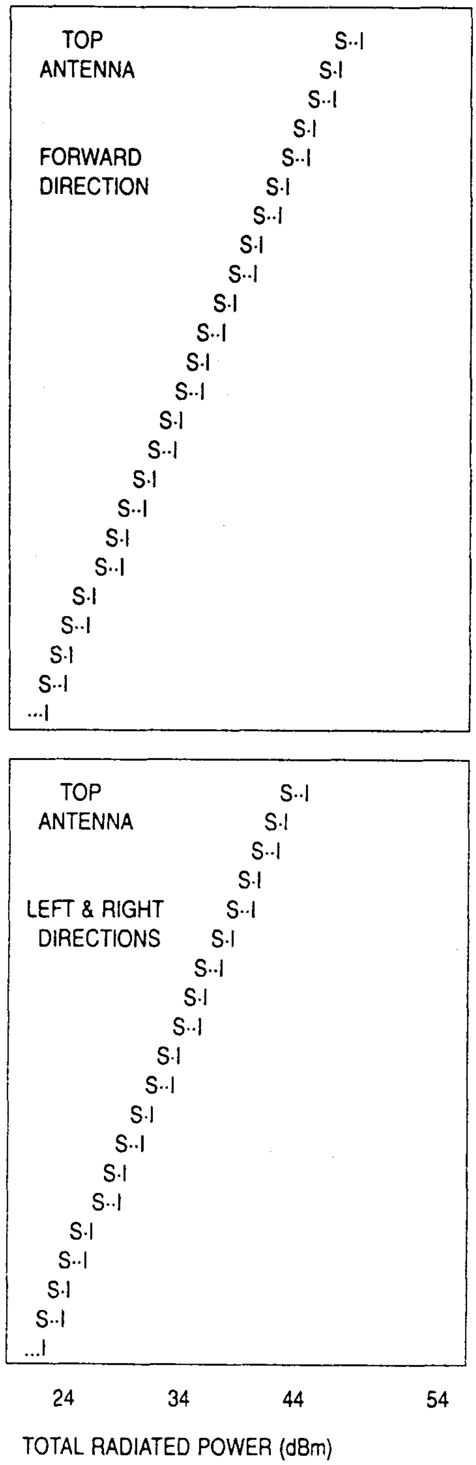
3.2.3.7.4 Mode A/C surveillance can be modified by sequentially eliminating steps from the whisper-shout sequence described in 3.2.2. Each whisper-shout step is uniquely associated with a receiver MTL setting. Thus, the receiver sensitivity in Mode A/C surveillance periods will be automatically tailored to match these power reductions.

3.2.3.7.5 The over-all surveillance sensitivity for Mode S targets can be reduced by reducing the interrogation power and by increasing the receiver MTL during all Mode S squitter listening periods. This will indirectly reduce the Mode S interrogation rate by reducing the target count. Many Mode S interrogations are acquisition interrogations transmitted to targets of unknown range. It is thus not effective to directly control the Mode S interrogation rate simply by dropping long-range targets from the track file.

3.2.3.7.6 The Mode A/C and Mode S surveillance sensitivity reductions are to be accomplished such that the ACAS equipment is not prematurely limited and has the capability of using at least 75 per cent of the allowance specified in the three limiting equations for all mixes of target types and for all densities up to the maximum density capability of the system. When the value of any of the smoothed limits is exceeded, the appropriate action is required to limit interference within one surveillance update interval. Means are to be provided for gradually restoring the surveillance sensitivity when the environment subsequently improves enough to allow the interference limits to be relaxed.

3.2.3.8 *IMPLEMENTATION OF A TYPICAL INTERFERENCE LIMITING PROCEDURE*

3.2.3.8.1 The following describes one possible implementation of an interference limiting procedure. It varies the system parameters appearing in inequalities (1), (2), and (3) to maximize and maintain approximate equality between the estimated surveillance ranges for Mode S and Mode A/C targets. In evaluating these inequalities, 16-second averages of the Mode S parameters are used, and current or anticipated values of the Mode A/C parameters are used. The procedure is illustrated in the flow chart of Figure A-4.



STEP NUMBER	NOMINAL TOTAL RADIATED INTERROGATION POWER (dBm)	INTERFERENCE LIMITING PRIORITY	MTL (−dBm)
1	49	1	74
2	48	5	74
3	47	9	74
4	46	13	74
5	45	17	74
6	44	21	74
7	43	25	74
8	42	29	73
9	41	33	72
10	40	37	71
11	39	41	70
12	38	45	69
13	37	49	68
14	36	53	67
15	35	57	66
16	34	61	65
17	33	64	64
18	32	67	63
19	31	70	62
20	30	73	61
21	29	76	60
22	28	77	59
23	27	78	58
24	26	79	57
25, 26	45	2, 3	74
27, 28	44	6, 7	74
29, 30	43	10, 11	74
31, 32	42	14, 15	73
33, 34	41	18, 19	72
35, 36	40	22, 23	71
37, 38	39	26, 27	70
39, 40	38	30, 31	69
41, 42	37	34, 35	68
43, 44	36	38, 39	67
45, 46	35	42, 43	66
47, 48	34	46, 47	65
49, 50	33	50, 51	64
51, 52	32	54, 55	63
53, 54	31	58, 59	62
55, 56	30	62, 63	61
57, 58	29	65, 66	60
59, 60	28	68, 69	59
61, 62	27	71, 72	58
63, 64	26	74, 75	57

Figure A-2. Example of whisper-shout sequence

STEP NUMBER	TOTAL RADIATED POWER (dBm) (24 – 34 – 44 – 54)	NOMINAL TOTAL RADIATED INTERROGATION POWER (dBm)	INTERFERENCE LIMITING PRIORITY	MTL (−dBm)
65	S·I (TOP ANTENNA AFT DIRECTION)	42	4	71
66	S··I	41	8	70
67	S·I	40	12	69
68	S··I	39	16	68
69	S·I	38	20	67
70	S··I	37	24	66
71	S·I	36	28	65
72	S··I	35	32	64
73	S·I	34	36	63
74	S··I	33	40	62
75	S·I	32	44	61
76	S··I	31	48	60
77	S·I	30	52	59
78	S··I	29	56	58
79	...I	28	60	57
80	S··I (BOTTOM OMNI ANTENNA)	38	80	62
81	S··I	36	81	60
82	S··I	34	82	58
83	I	32	83	56

NOTES: "I" indicates TRP of P_1, P_3, and P_4 interrogation pulses.

"S" indicates TRP of S_1 suppression pulse.

"S·I" means that the S_1 TRP is 2 dB less than the interrogation TRP.

"S··I" means that the S_1 TRP is 3 dB less than the interrogation TRP.

All transmissions are from the top antenna, unless labelled "bottom".

In steps 24, 63, 64, 79, and 83 no S_1 pulses are transmitted.

Figure A-2. Example of whisper-shout sequence (cont.)

3.2.3.8.2 *Step 1.* The first step in the control process is to reduce the number of whisper-shout steps tentatively scheduled for use during the present scan if either:

a) inequality (3) is violated; or

b) inequality (1) or (2) is violated and the Mode S surveillance range of the last scan does not exceed the Mode A/C surveillance range that would result from use of the scheduled whisper-shout sequence.

Whisper-shout steps are eliminated in the order dictated by the design of the Mode A/C processor and the number of steps eliminated is just large enough to ensure that neither of the above conditions is satisfied. The value of the number of whisper-shout steps tentatively scheduled for use is initialized at the number used on the last scan.

The relative magnitudes of the Mode S and Mode A/C surveillance ranges are determined from the estimated effective radiated power (ERP) seen by targets with Mode S and Mode A/C transponders located directly ahead of the ACAS aircraft. The ERP in a given direction is determined by the product of the power input to the antenna, and the antenna pattern gain in that direction. If the transponder sensitivities were identical, the Mode S range would be more or less than the Mode A/C range according to whether the Mode S transmitted power was more or less than the Mode A/C transmitted power. Since Mode A/C transponders may have somewhat lower sensitivities than Mode S transponders, the Mode A/C range is assumed to be greater than the Mode S range if, and only if, the Mode A/C power exceeds the Mode S power by 3 dB.

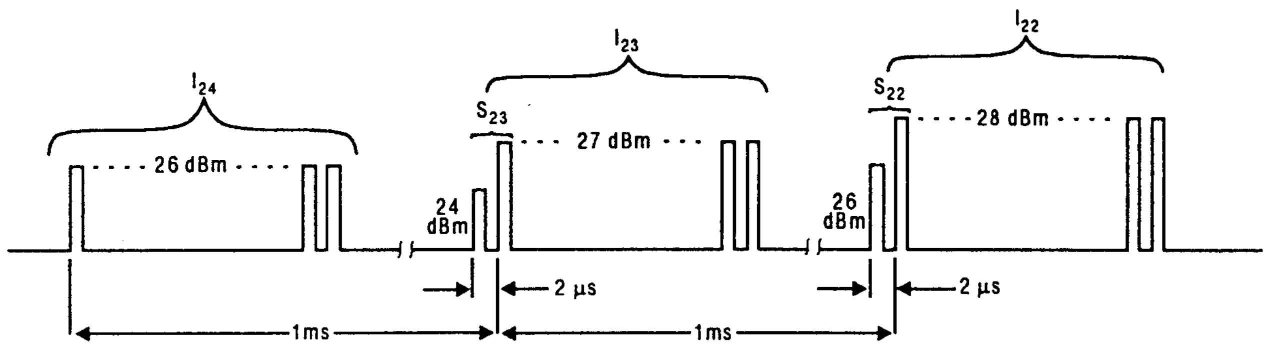


Figure A-3. Timing for lowest power steps in omnidirectional whisper-shout sequence for top antenna

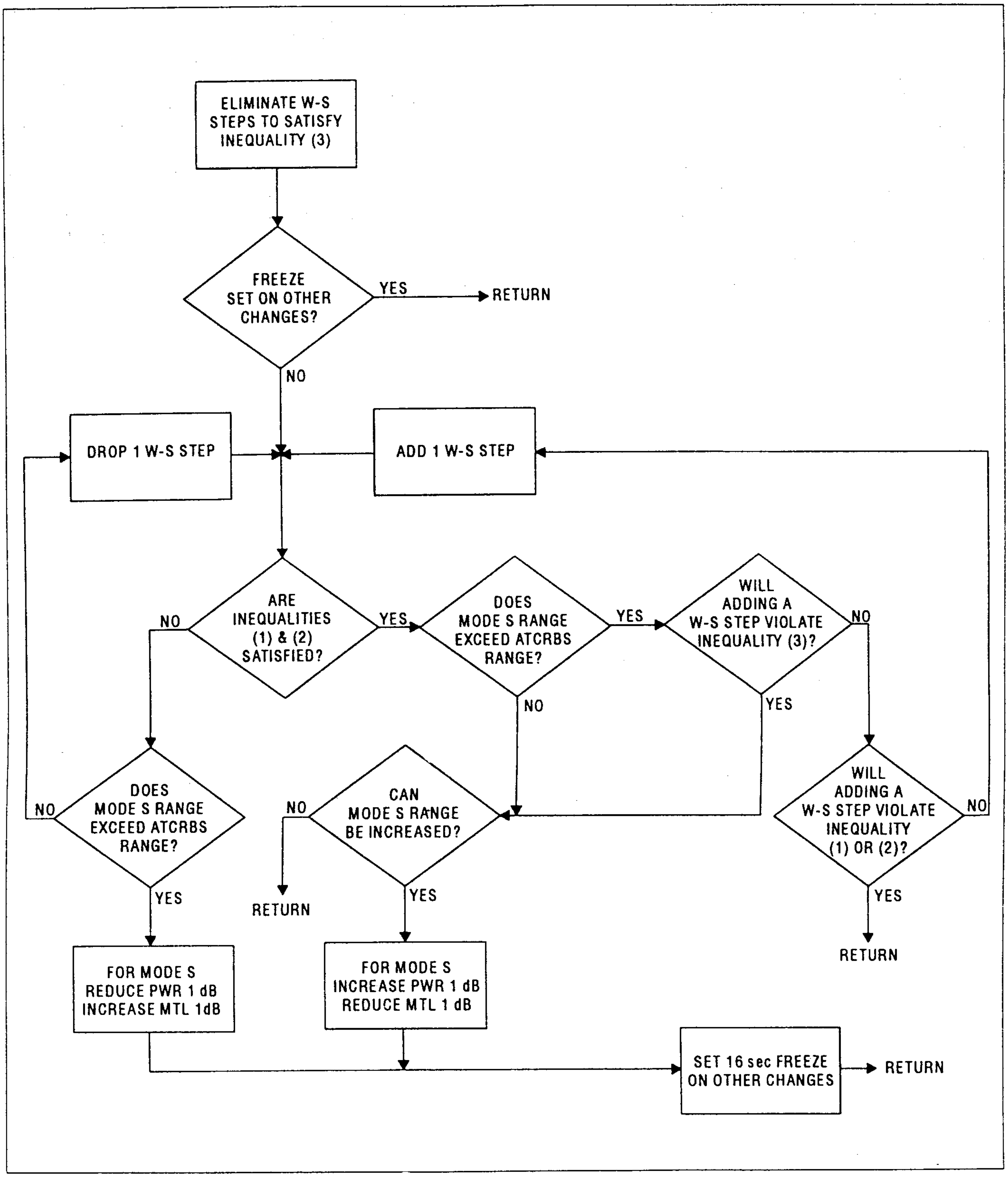


Figure A-4. Interference limiting flow diagram

3.2.3.8.3 *Step 2.* The second step in the controlling process is to reduce the Mode S interrogation power for acquisition by 1 dB, and to increase the MTL for Mode S squitter listening by 1 dB from the values last used, if inequality (1) or (2) is violated and the Mode S surveillance range of the last scan exceeds the Mode A/C surveillance range that would result from use of the scheduled whisper-shout sequence.

Once such a change has been made, the only change allowed during the ensuing 16 seconds is a reduction in the number of whisper-shout steps if such is needed to satisfy inequality (3). This 16-second freeze allows the effect of the Mode S changes to become apparent since the 16-second averages used in inequalities (1) and (2) then will be determined by the behaviour of the system since the change.

3.2.3.8.4 *Step 3.* The third step is to add a whisper-shout step to those tentatively scheduled, when it is not prevented by a 16-second freeze, and the following conditions are satisfied:

a) inequalities (1), (2), and (3) are satisfied and will continue to be satisfied after the step is added; and

b) the Mode S surveillance range of the last scan exceeds the Mode A/C surveillance range that would result from use of the scheduled sequence; and

As many steps are added as possible without violating a) or b) above.

3.2.3.8.5 *Step 4.* Finally, if condition a) of 3.2.3.8.4 above is satisfied, but condition b) is not, an estimate is made of the effects of increasing the Mode S interrogation power for acquisition by 1 dB and reducing the MTL for Mode S squitters/fruit by 1 dB. If the estimate indicates that inequalities (1) and (2) will not continue to be satisfied, the 1 dB change is not made. If the estimate indicates that they will continue to be satisfied the 1 dB change is made and no further changes in either the Mode A/C or Mode S parameters are made for the ensuing 16 seconds, except as described in 3.2.3.8.3 above.

3.2.4 INTERROGATION JITTER

Mode A/C interrogations from ACAS equipment are intentionally jittered to avoid chance synchronous interference with other ground-based and airborne interrogators. It is not necessary to jitter the Mode S surveillance interrogations because of the inherently random nature of the Mode S interrogation scheduling process for ACAS.

3.3 Antennas

3.3.1 USE OF DIRECTIONAL INTERROGATIONS

3.3.1.1 A directional antenna is recommended for reliable surveillance of Mode A/C targets in aircraft densities up to 0.087 aircraft per square km (0.3 aircraft per square NM). The recommended antenna system consists of a four-beam antenna mounted on top of the aircraft and an omnidirectional antenna on the bottom. A directional antenna may also be used instead of the omnidirectional antenna on the bottom of the aircraft. The directional antenna sequentially generates beams that point in the forward, aft, left, and right directions. Together these provide surveillance coverage for targets at all azimuth angles without the need for intermediate pointing angles.

3.3.1.2 The directional antenna typically has a 3-dB beamwidth (BW) in azimuth of 90±10 degrees for all elevation angles between +20 and −15 degrees. The interrogation beamwidth is to be limited by transmission of a P_2 sidelobe suppression pulse following each P_1 interrogation pulse by 2 microseconds. The P_2 pulse is transmitted on a separate control pattern (which may be omnidirectional).

3.3.1.3 There is need for timely detection of aircraft approaching with low closing speeds from above and below. Detection of such aircraft suggests a need for sufficient antenna gain within a ±10-degree elevation angle relative to the ACAS aircraft pitch plane. An ACAS directional antenna typically has a nominal 3 dB vertical beamwidth of 30 degrees.

3.3.1.4 The shape of the directional antenna patterns and the relative amplitude of the P_2 transmissions is controlled such that a) a maximum suppression transponder located at any azimuth angle between 0 and 360 degrees and at any elevation angle between +20 and −15 degrees would reply to interrogations from at least one of the four directional beams and b) a minimum suppression transponder would reply to interrogations from no more than two adjacent directional beams. A maximum suppression transponder is defined as one that replies only when the received ratio of P_1 to P_2 exceeds 3 dB. A minimum suppression transponder is defined as one that replies when the received ratio of P_1 to P_2 exceeds 0 dB.

3.3.1.5 The total radiated power (TRP) from each antenna beam (forward, left, right, aft, omni) is expected to be within ±2 dB of its respective nominal value as given in Figure A-2.

3.3.1.6 A forward directional transmission, for which TRP = 49 dBm and BW = 90° has a power gain product at beam centre of approximately,

$$PG = \frac{TRP}{BW/360°} = 55 \text{ dBm}$$

This is 1 dB greater than the nominal and allows for adequate coverage at the cross-over points of the directional beams. The TRP of the side and aft beams is reduced relative to the front beam to account for the lower closing speeds that occur when aircraft approach from these directions. Mode A/C surveillance performance will generally improve as the directivity (and hence the number of beams) is increased for the top-mounted antenna. However, the use of a directional antenna on the bottom would provide only marginal improvement in detectability and would, if used at full power, degrade the over-all performance of the equipment by increasing the false track rate due to ground-bounce multipath.

3.3.2 DIRECTION FINDING

The angle-of-arrival of the transmissions from the replying transponders can be determined with better than 10-degree RMS accuracy by means of several simple and practical direction finding techniques. These techniques typically employ a set of four or five monopole radiating elements mounted on the aircraft surface in a square array with quarter-wave spacing. The signals from these elements may be combined so as to generate from two to four distinct beams which may be compared in phase or amplitude to provide an estimate of the direction of arrival of the received signal. This level of direction finding accuracy is adequate to provide the pilot with TAs to effectively aid the visual acquisition of intruding aircraft.

3.3.3 DIRECTIONAL TRANSMISSION FOR CONTROL OF SYNCHRONOUS GARBLE

3.3.3.1 The use of directional interrogation is one technique for reducing synchronous garble. The directional interrogation can reduce the size of the interrogation region. Coverage must be provided in all directions. Hence, multiple beams are used to elicit replies from all aircraft in the vicinity of the ACAS-equipped aircraft. Care must be taken to overlap the beams so that gaps in coverage do not exist between beams.

3.3.3.2 The antenna may be a relatively simple array capable of switching among typically four or eight discrete beam positions. For four beam positions, the antenna beamwidth is expected to be on the order of 100°. The effective antenna beamwidth for interrogating Mode A/C transponders can be made more narrow than the 3-dB beamwidth by means of transmitter sidelobe suppression.

3.3.4 ANTENNA LOCATION

The top-mounted directional antenna is to be located on the aircraft centre line and as far forward as possible. The ACAS antennas and the Mode S transponder antennas are to be mounted as far apart as possible on the airframe to minimize coupling of leakage energy from unit to unit. The spacing must never be less than 0.5 m (1.5 ft), as this spacing results in a coupling loss of at least 20 dB.

3.4 Receiver and processor

3.4.1 SENSITIVITY

A sensitivity equivalent to that of a Mode S transponder (minimum triggering level of −74 dBm) will provide adequate link margin to provide reliable detection of near co-altitude aircraft in level flight at a range of 26 km (14 NM) provided those aircraft are themselves equipped with transponders of nominal transmit power.

3.4.2 CONTROL OF RECEIVER THRESHOLD

3.4.2.1 ACAS receivers use a variable (dynamic) threshold to control the effects of multipath. When the first pulse of a reply is received, the variable receiver threshold technique raises the receiver threshold from the minimum triggering level (MTL) to a level at a fixed amount (e.g. 9 dB) below the peak level of the received pulse. The receiver threshold is maintained at this level for the duration of a Mode A/C reply, at which time it returns to the MTL. When multipath returns are weak compared to the direct-path reply, the first pulse of the direct-path reply raises the receiver threshold sufficiently so that the multipath returns are not detected.

3.4.2.2 Variable receiver thresholds have historically been avoided in Mode A/C reply processors because such thresholding tends to discriminate against weak replies. However, when used in conjunction with whisper-shout interrogations, this disadvantage is largely overcome. On any given step of the interrogation sequence it is possible for a strong reply to raise the threshold and cause the rejection of a weaker overlapping reply. However, with whisper-shout interrogations, the overlapping replies received in response to each interrogation are of approximately equal amplitudes since the whisper-shout process sorts the targets into groups by signal strength.

3.4.2.3 The ACAS receiver MTL used in the reply listening period following each whisper-shout interrogation relates to the interrogation power in a prescribed manner. In particular, less sensitive MTLs are used with the lower interrogation powers in order to control the Mode A/C fruit rate in the ACAS receiver while still maintaining a balance between the interrogation link and the reply link so that all elicited replies are detected.

3.4.3 PULSE PROCESSING

3.4.3.1 A relatively wide dynamic range receiver faithfully reproduces the received pulses. Provisions may be included for locating the edges of received pulses with accuracy, and logic may be provided for eliminating false framing pulses that are synthesized by code pulses from real replies. The processor is capable of resolving pulses in situations where overlapped pulse edges are clearly distinguishable. It is also capable of reconstructing the positions of hidden pulses when overlapping pulses of nearly the same amplitude cause the following pulses to be obscured. The reply processor has the capacity for handling and correctly decoding at least three overlapping replies. Means are also provided for rejecting out-of-band signals and for rejecting pulses with rise times exceeding 0.5 microsecond (typically, DME pulses).

3.4.3.2 If a Mode S reply is received during a Mode C listening period, a string of false Mode C fruit replies may be generated. The ACAS equipment is expected to reject these false replies.

3.4.4 ERROR DETECTION AND CORRECTION

3.4.4.1 ACAS avionics intended for use in airspace characterized by closing speeds greater than 260 m/s (500 kt) and densities greater than 0.009 aircraft per km^2 (0.03 aircraft per NM^2) or closing speeds less than 260 m/s (500 kt) and densities greater than 0.04 aircraft per km^2 (0.14 aircraft per NM^2) requires a capability for Mode S reply error correction. In these high densities, error correction is necessary to overcome the effects of Mode A/C fruit. Mode S error correction permits successful reception of a Mode S reply in the presence of one overlapping Mode A/C reply.

3.4.4.2 Error correction decoding is to be used for the following replies: DF = 11 all-call replies, DF = 0 short air-air surveillance replies, and DF = 16 long air-air surveillance replies (both acquisition and non-acquisition).

3.4.4.3 If two or more acquisition replies requiring error correction are received within the Mode S range acquisition window, it may be impractical to apply error correction to more than the first received reply. Acquisition replies other than the first do not need to be corrected when this occurs.

3.4.5 RECEIVER SIDELOBE SUPPRESSION

ACAS equipment that interrogates directionally may use receiver sidelobe suppression techniques to eliminate replies (fruit) generated by nearby aircraft that are outside the interrogated sector. This reduces the number of replies processed during the surveillance update period.

3.5 Collision avoidance algorithms

3.5.1 GENERAL

3.5.1.1 The ACAS algorithms operate in a cycle repeated nominally once per second. At the beginning of the cycle, surveillance reports are used to update the tracks of all intruders and to initiate new tracks as required. Each intruder is then represented by a current estimate of its range, range rate, altitude, altitude rate, and perhaps, its bearing. Own aircraft altitude and altitude rate estimates are also updated.

3.5.1.2 After the tracks have been updated, the threat detection algorithms are used to determine which intruders are potential collision threats. These algorithms may be used at more than one level. One level may determine which intruders are sufficiently close to warrant TAs while a second, more stringent level is used to determine which intruders warrant RAs.

3.5.1.3 The threat resolution algorithms generate an RA for collision threats identified by the threat detection algorithms. When the threat is also equipped with ACAS, air-air co-ordination occurs following the threat resolution process. Following air-air co-ordination, TAs and RAs are updated.

3.5.2 THREAT DETECTION

3.5.2.1 Collision threat detection is based on simultaneous proximity in range and altitude. ACAS uses range rate and altitude rate data to extrapolate the positions of the intruder and own aircraft. If within a short time interval (e.g. 25 seconds hence) the range of the intruder is expected to be "small" and the altitude separation is expected to be "small", the intruder is declared a threat. Alternatively, the threat declaration may be based on current range and altitude separations which are "small". The algorithm parameters which establish how far into the future positions are extrapolated, and which establish thresholds for determining when separations are "small", are selected in accordance with the sensitivity level at which the threat detection algorithms are operating.

3.5.2.2 Each sensitivity level defines a specific set of values for the detection parameters used by the algorithms. These include threshold values for the predicted time, the minimum slant range, and the vertical separation. Through the process of sensitivity level control, these parameters are assigned different values to account for the smaller aircraft separations that occur in dense terminal airspace. Sensitivity level may be selected automatically using the altitude of own aircraft, or may be selected by command from a Mode S ground station, or by a manual pilot switch (see 3.5.12).

3.5.2.3 The values used for threat detection parameters cannot be optimum for all situations because ACAS is handicapped by its lack of knowledge of intruder intent. The result is that a balance has to be struck between the need to give adequate warning of an impending collision and the possible generation of unnecessary alerts. The latter may result from encounters that are resolved at the last moment by intruder manoeuvres. A feature of ACAS that helps in this respect is the variability of the protected volume of airspace. This volume is automatically coupled in size to the relative speed between the two aircraft, and is automatically aligned in a direction parallel to the relative velocity vector. Bearing plays no part in this process. Each encounter gives rise to a protected volume tailored to that encounter. In a multi-aircraft situation there is an individual protected volume for the ACAS aircraft paired with each threat.

3.5.3 PROTECTED VOLUME

An intruder becomes a threat when it penetrates a protected volume enclosing own aircraft. The protected volume is defined by means of a range test (using range data only) and an altitude test (using altitude and range data). Application of these tests delivers a positive or a negative result (implying that the threat is inside or outside the appropriate part of the protected volume). An intruder is declared a threat when both tests give a positive result.

3.5.3.1 *PROTECTED VOLUME TERMS' DESCRIPTION*

Collision plane. The plane containing the range vector and the instantaneous relative velocity vector originating at the intruder.

Critical cross-sectional area. The maximum cross-sectional area of the protected volume in a plane orthogonal to the major axis.

Instantaneous relative velocity (s). The modulus of the current value of relative velocity.

Linear miss distance (m_a). The minimum value that range will take on the assumption that both the intruder and own aircraft proceed from their current positions with unaccelerated motions.

Linear time to closest approach (t_a). The time it would take to reach closest approach if both the intruder and own aircraft proceed from their current positions with unaccelerated motions.

Given that the only information available to ACAS to make range predictions are range and range rate estimates, both the linear miss distance and the linear time to closest approach are unobservable quantities.

The unobservable quantities, linear miss distance and linear time to closest approach, are related to the observable quantities range and range rate by the following equality:

$$t_a = \frac{(r^2 - m_a^2)}{(-r\dot{r})}$$

Major axis. In the context of the protected volume, the line through the ACAS II aircraft which is parallel to the instantaneous relative velocity vector.

Range convergence. The aircraft is deemed to be converging in range if the range rate is less than or equal to zero.

3.5.4 RANGE TEST

3.5.4.1 The protected volume resulting from the range test is defined for ACAS in terms of the maximum dimensions of a realizable implementation of the test which is illustrated by Figure A-5. This shows a section through the protected volume generated by a range test in the plane containing both aircraft and the instantaneous relative velocity vector. The protected volume is that which would be produced by rotating the solid curve about the x axis. Note that the length of the major axis is a function of the relative speed, s. For the realizable range test, the radius of the maximum cross section through the protected volume in a plane normal to the instantaneous relative velocity vector is m_c. This represents the maximum miss distance for which an alert can be generated if the relative velocity at the time of entry to the protected volume is maintained to closest approach. Both m_c and the length of the major axis are constrained by the standards for ACAS. The length of the major axis is the principal feature determining warning time while m_c controls the projected miss distance which is likely to generate an alert. Ideally, the warning time would be T seconds and m_c would be such that only intruders projected to have miss distances less than D_m (the radius of the broken-line circle in Figure A-5) would qualify for an alert. The significance of D_m is that, to a good approximation, it represents the lateral displacement experienced by an aircraft over the time T when turning with a constant acceleration of $g/3$ (bank angle = 18°). Thus an encounter with a projected miss distance of D_m when the time to closest approach is T can result in a collision if either aircraft is manoeuvring with an acceleration of $g/3$. In the absence of adequate bearing rate or range acceleration data, ACAS cannot achieve the ideal. Figure A-6 shows the maximum allowable value for m_c (i.e. $\hat{m}_c$ as a function of relative speed and sensitivity level). When the relative speed is very low, as can occur in a tail-chase, the protected volume produced by the range test becomes a sphere of radius D_m centred on the ACAS aircraft.

3.5.4.2 Essentially, the range test gives a positive result if, when approximately T seconds remain before closest approach, the relative velocity vector can be projected to pass through a circle of radius m_c centred on the ACAS aircraft and placed in the plane normal to the relative velocity vector. Since the value of m_c is very large compared to the value for adequate vertical separation, the use of the range test alone would generate a large number of unnecessary alerts. It is therefore necessary to tailor the range test protected volume to more modest proportions using altitude data. Inevitably, this reduces the immunity to manoeuvres in the vertical plane.

3.5.4.3 The constraints on the range test are designed to give a nominal warning time of T seconds allowing for a manoeuvre producing a displacement of D_m normal to the relative velocity vector. It may be demonstrated that, for an encounter having a reasonably large relative velocity, the relative acceleration produced by a turning aircraft is nearly normal to the relative velocity vector. For low relative speed there can be a substantial component of acceleration in the direction of a relative velocity. Erosion of the warning time due to this component is compensated by having a minimum length for the major axis of the protected volume which is greater than sT.

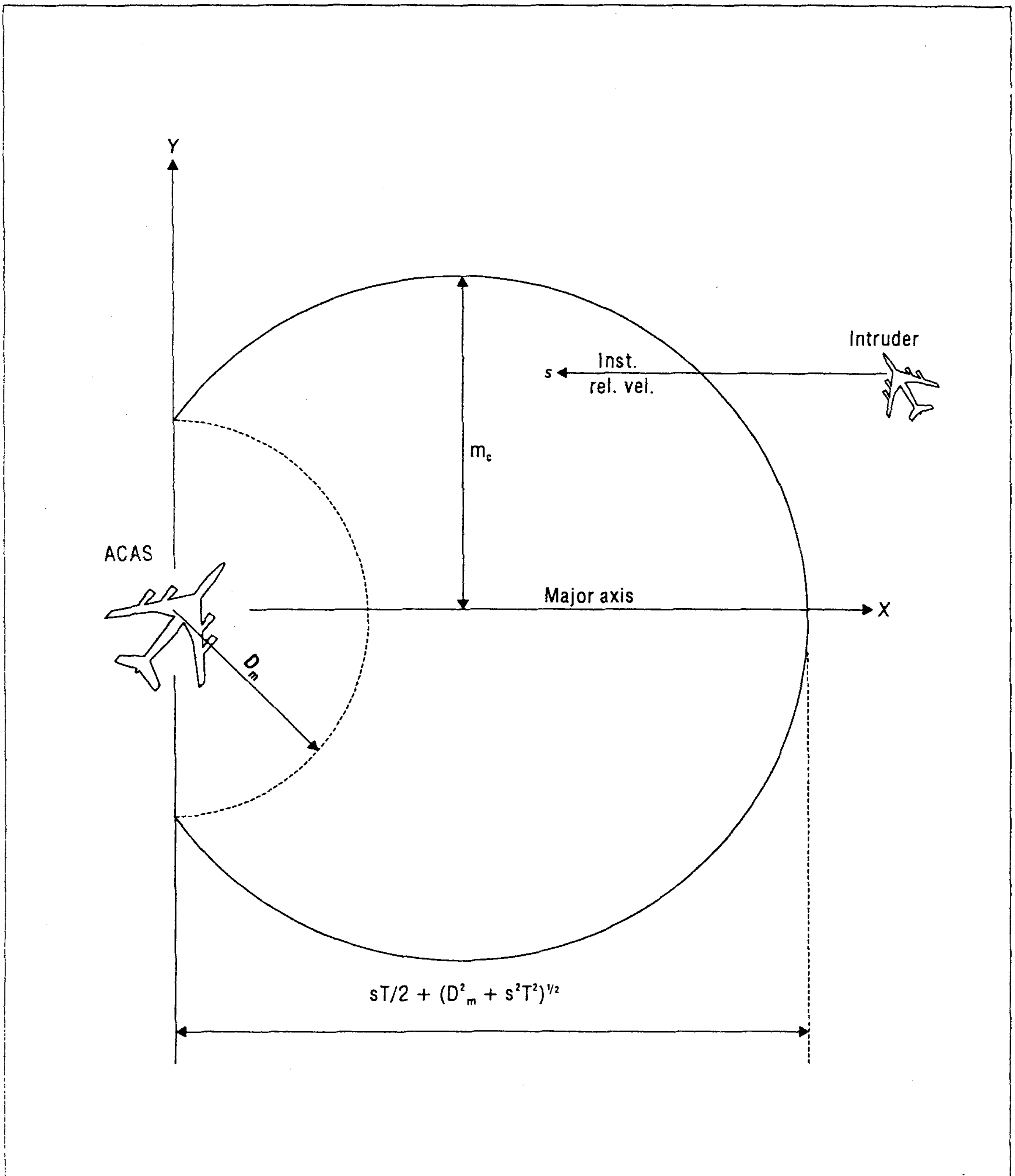


Figure A-5. Section through protected volume in the instantaneous collision plane

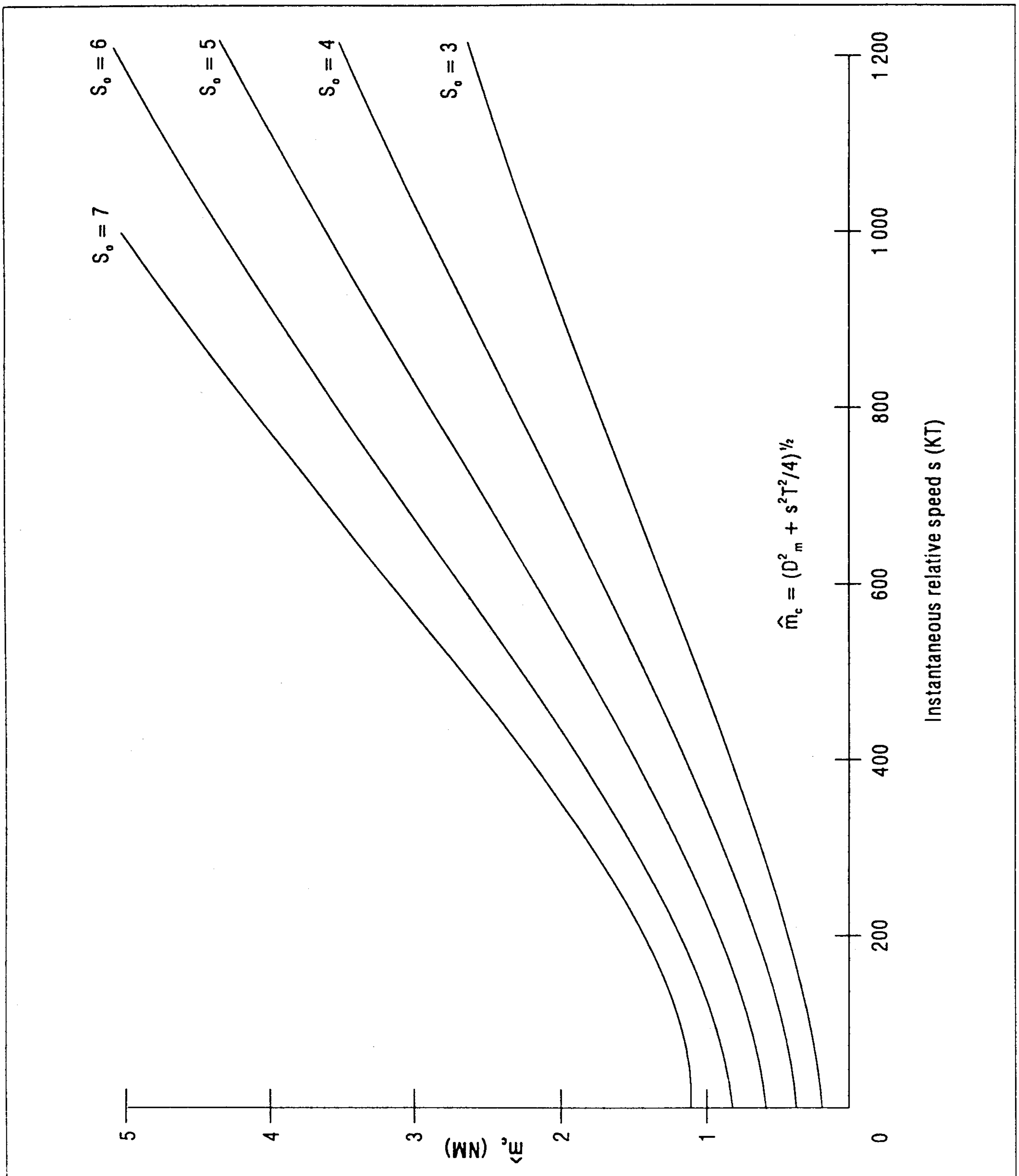


Figure A-6. Critical miss distance

3.5.5 ALTITUDE TEST

3.5.5.1 The objective of the altitude test is to filter out intruders that give a positive result for the range test but are nevertheless adequately separated in the vertical dimension. The altitude test is used to reduce alert rate in the knowledge that the standard vertical separation distances for aircraft are normally much less than the standard horizontal separation distances. An inevitable result is that the acceleration protection, nominally provided by the range test in all planes, is largely restricted to the horizontal plane. Also, even in the absence of relative acceleration, the altitude test can delay warnings if some vertical separation at closest approach is predicted to exist. A view in elevation of the relative motion of two aircraft is shown in Figure A-7a. AOB represents a plane normal to the relative velocity vector and containing the ACAS aircraft. The intruder may be horizontally displaced from the ACAS so it is not necessarily in the plane of the diagram. The essential feature of the altitude test is that it aims to give a positive result if the projected vertical miss distance is less than Z_m. Z_m varies with altitude in steps from 180 m (600 ft) to 240 m (800 ft).

3.5.5.2 Since the main interest is in intruders with projected miss distances less than D_m, an ideal altitude test (in combination with an ideal range test) would give a positive result if, inter alia, the relative velocity vector were projected to pass through the critical area shown by the solid outline in Figure A-7b. In practice, the altitude test and the range test outlined in 3.5.1.2.1 tend to be satisfied if the vector passes through the larger area defined by the broken outline. Those intruders passing through the shaded areas are likely to give rise to unnecessary alerts.

3.5.5.3 The altitude test is no better placed to predict the time to closest approach than is the range test. This means that, if no other conditions are applied, the range test determines the time of the alert. However, an additional feature of the altitude test attempts to guard against the eventuality that one of the aircraft levels off above or below the other, thus avoiding a close encounter. Two types of encounter are recognized: the first in which the current altitude separation is less than Z_t (see 4.3.4.2); and a second, in which the current altitude separation is greater than Z_t and the aircraft are converging in altitude. For the first type, the ACAS altitude test requires only that the critical area is projected to be penetrated. For the second an additional condition is that the time to reach co-altitude is to be less than or equal to T, the nominal warning time. The effect is that warning time is controlled by the range test for intruders that are projected to cross in altitude before closest approach while later warnings are given for altitude crossings beyond closest approach.

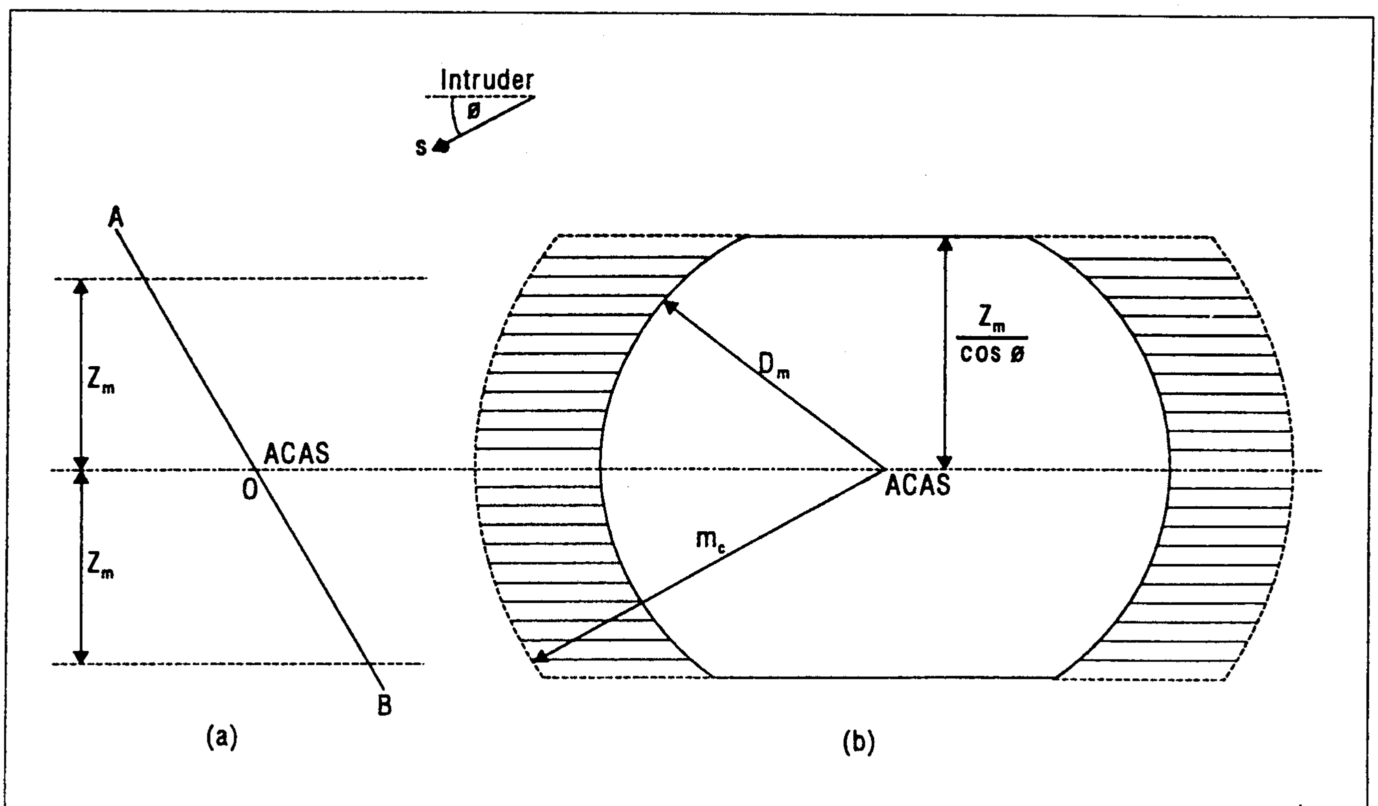


Figure A-7. Critical area for ideal altitude test

3.5.6 ESTABLISHED THREATS

The requirement to give a positive result for both the range test and the altitude test on the same cycle of operation before declaring an intruder to be a threat applies only for new threats. Subsequently, only the range test is applied and a positive result has the effect of maintaining threat status. The reason for omitting the altitude test is that a rapid pilot response, or the fact that the intruder initially only just satisfied the altitude criteria may result in cancellation of threat status before reaching closest approach.

3.5.7 ALERT RATE

3.5.7.1 The principal variables controlling alert rate are relative velocity, miss distance and the ambient aircraft density. The principal ACAS parameters affecting alert rate are T, D_m and Z_m. Alert rates can be calculated for constant velocity random traffic but the influences of see-and-avoid and ATC make such calculations for real traffic very difficult. Figure A-6 gives some guidance on some features of an encounter that might give rise to an alert although it gives no assistance concerning the result of the altitude test. For example, it can be seen that, for sensitivity level 5 (altitudes between FL 50 and FL 100) there can be no alert if the horizontal separation is greater than 5.5 km (3 NM) and the relative speed is less than about 440 m/s (850 kt).

3.5.7.2 Simulations using ground-based radar surveillance data and initial experience with ACAS equipments have indicated that the over-all alert rate ranges from about 1 in 30 flight hours to 1 in 50 flight hours in typical busy airspaces.

3.5.8 THREAT RESOLUTION

3.5.8.1 *CO-ORDINATION*

If the threat aircraft is equipped with ACAS II or ACAS III, own ACAS is required to co-ordinate with the threat aircraft's ACAS via the Mode S data link to ensure that compatible RAs are selected. The nature of the advisory selected can also be influenced by the fact that the threat is ACAS-equipped.

3.5.8.2 *CLASSIFICATION OF RESOLUTION ADVISORIES*

3.5.8.2.1 ACAS escape manoeuvres are confined to the vertical plane and can be characterized by a sense (up or down) and a strength. The objective of an RA with an upward sense is to ensure that own aircraft will safely pass above the threat. The objective of an RA with a downward sense is to ensure that own aircraft will safely pass below the threat. Examples of RA strengths with the upward sense are "limit vertical speed" (to a specified target descent speed), "do not descend", or "climb". Examples of equivalent RA strengths with the downward sense are "limit vertical speed" (to a specified target climb speed), "do not climb", or "descend". RAs are of two types: "positive", meaning a requirement to climb or descend at a particular rate; and "vertical speed limit", meaning that a prescribed range of vertical speed must be avoided. Any advisory may be "corrective" or "preventive". A corrective advisory requires a change in own aircraft's current vertical rate whereas a preventive advisory does not.

3.5.8.2.2 It is expected that the RA generated be consistent with flight path limitations in some regimes of flight, due to flight envelope restrictions and aircraft configurations that reduce climb capability. It is expected that the aircraft's manoeuvre limitation indications available to ACAS will offer a conservative assessment of the actual aircraft performance capabilities. This is particularly true of climb inhibit. In the rare and urgent case of a high altitude downward sense RA being reversed to a climb, it is expected that, very often, the aircraft performance capabilities needed to comply with the RA will be available despite the climb inhibit. When such capabilities are not available, it is expected that the pilot will always be able to comply with the reversal at least partially by promptly levelling-off.

3.5.8.3 *REQUIRED ALTITUDE SEPARATION*

3.5.8.3.1 To be certain of avoiding a collision ACAS must provide a true altitude separation at closest approach which is commensurate with aircraft dimensions and worst-case orientation of the aircraft. Since only measured altitude data are available, due allowance must be made for altimetry errors in both aircraft. Furthermore, the avoiding action must be commenced before closest approach so it is possible that this action will be based on predicted altitude separation at closest approach, which introduces a further source of error. These factors lead to a requirement that the RA provided to the pilot should be such that the desired altitude separation at closest approach can be achieved in the time available. This target value, A_p, for altitude separation is a function of altitude and it varies in steps from 90 m (300 ft) to 210 m (700 ft). The dependence on altitude arises because altimetry error increases with altitude. Also, prediction error increases with altitude because longer escape times are required to accommodate greater altimetry errors.

3.5.8.3.2 The time to closest approach cannot be estimated accurately because the miss distance is not known, the threat could manoeuvre and the range observations are imperfect. The recommended limits are the times to closest approach assuming the miss distance to take the largest value of concern (D_m) and the value zero, and that all other sources of error have been neglected. This interval is critical for encounters in which the range rate takes on very small values. By maintaining the altitude separation over the entire interval, the selection of the RA is made immune to potentially large errors in estimating the time of minimum range. Such errors can result from small absolute errors in estimating range rate. For preventive RAs, the assumption of an immediate change of rate to the limit recommended by the RA will cause the calculation to deliver a bound (upper for downward RAs, lower for upward RAs) on the altitude of own aircraft at closest approach.

3.5.8.4 *MINIMUM DISRUPTION*

3.5.8.4.1 In principle, the larger required altitude separations could be achieved by a more vigorous escape manoeuvre but constraints are passenger comfort, aircraft capability and deviation from ATC clearance. The ACAS parameters described in Section 4 below are based on an anticipation that the typical altitude rate needed to avoid a collision is 1 500 ft/min.

3.5.8.4.2 The initial choice of the direction and strength of the advisory is intended, subject to the exceptions described below, to require the smallest possible change in the vertical trajectory of the ACAS aircraft. And the advisory is expected to be appropriately weakened, if possible, at later stages of the encounter, and removed altogether when the desired separation has been achieved at closest approach. A prime consideration is the minimization of any departure from an ATC clearance.

3.5.8.5 *PILOT RESPONSE*

Since the pilot exercises such a major influence on the effectiveness of the system, it is necessary for ACAS to make certain assumptions concerning the response of the pilot. The ACAS uses a response delay of 5 seconds for a new advisory and a vertical acceleration of $g/4$ to establish the escape velocity. The response time reduces to 2.5 seconds for subsequent advisory changes. ACAS may not provide adequate vertical separation if the pilot response delay exceeds the expected pilot response delay described above.

3.5.8.6 *INTRUDERS IN LEVEL FLIGHT*

3.5.8.6.1 Intruders that are flying level at the time of the alert and continue thereafter in level flight present few problems for ACAS. If own aircraft is also in level flight the altitude prediction problem does not exist. All the ACAS aircraft has to do is to move in the direction which increases the current altitude separation to the target value. Assuming the required data is available, possible problems are that the ACAS aircraft is unable to climb if this is required, or it is dangerous to descend because of ground proximity.

3.5.8.6.2 The manoeuvre limitation problems largely disappear when the ACAS aircraft is in climb or descent since separation can then often be obtained simply by levelling-off. And the prediction problem is likely to be a minor one if ACAS is fed with high resolution data for own altitude.

3.5.8.7 *INTRUDERS IN CLIMB/DESCENT*

Intruders in climb or descent provide more difficulty than intruders in level flight. It is often a problem to determine their altitude rates. There is also evidence that a climbing or descending threat that is projected to pass close to own aircraft is more likely to level-off than to maintain its observed altitude rate thus avoiding the close encounter. Therefore the selection of RAs by ACAS should be biased by an expectation that threats might level-off, e.g. in response to ATC. A low confidence in the threat's tracked altitude rate may cause RA generation to be delayed pending a better estimate of this rate.

3.5.8.8 *ALTITUDE CROSSING RAS*

3.5.8.8.1 Intruders that are projected to cross the altitude of an ACAS aircraft make the design of a totally effective ACAS extremely difficult because such intruders might level-off. Some of the altitude crossing RAs occasionally generated have been found counter-intuitive by pilots. Indeed, such RAs require the pilot to initially manoeuvre toward the intruder, temporarily losing vertical separation. Nevertheless, encounters for which altitude crossing RAs are clearly appropriate have been observed, and it is not yet demonstrated that it is desirable or possible to avoid them entirely. The frequency of altitude crossing RAs is likely to depend on the management and behaviour of aircraft. It is known that aircraft climbing and descending at high rates more frequently give rise to RAs, including crossing RAs, than other aircraft. The potential effect of approaching a cleared flight level at high speed and then levelling-off in close horizontal and vertical proximity to another aircraft is described below. The measures taken within ACAS to mitigate these effects are described in 3.5.8.9, but it must be noted that not all these measures are designed for situations in which neither aircraft is level.

3.5.8.8.2 For the scenario illustrated in Figure A-8, suppose that the alert occurs while the intruder is climbing towards the level ACAS aircraft. Given that the climb continues, the best escape strategy would be for own aircraft to descend towards the threat, in so doing crossing through the threat's altitude. A climb away could possibly provide enough vertical clearance but, for the same escape velocity, a descent will give greater clearance. If own aircraft does descend it can be seen that a hazardous situation arises if the threat levels off at the cardinal flight level below own aircraft. Such manoeuvres are commonplace in some controlled airspaces since they are used by controllers to cross aircraft safely with the required altitude separation in situations where the horizontal separation is small. An ACAS design based on the choice of sense likely to give the greatest altitude separation could induce a close encounter where one would not otherwise occur. Provisions have been made to make ACAS as immune as possible from such an eventuality.

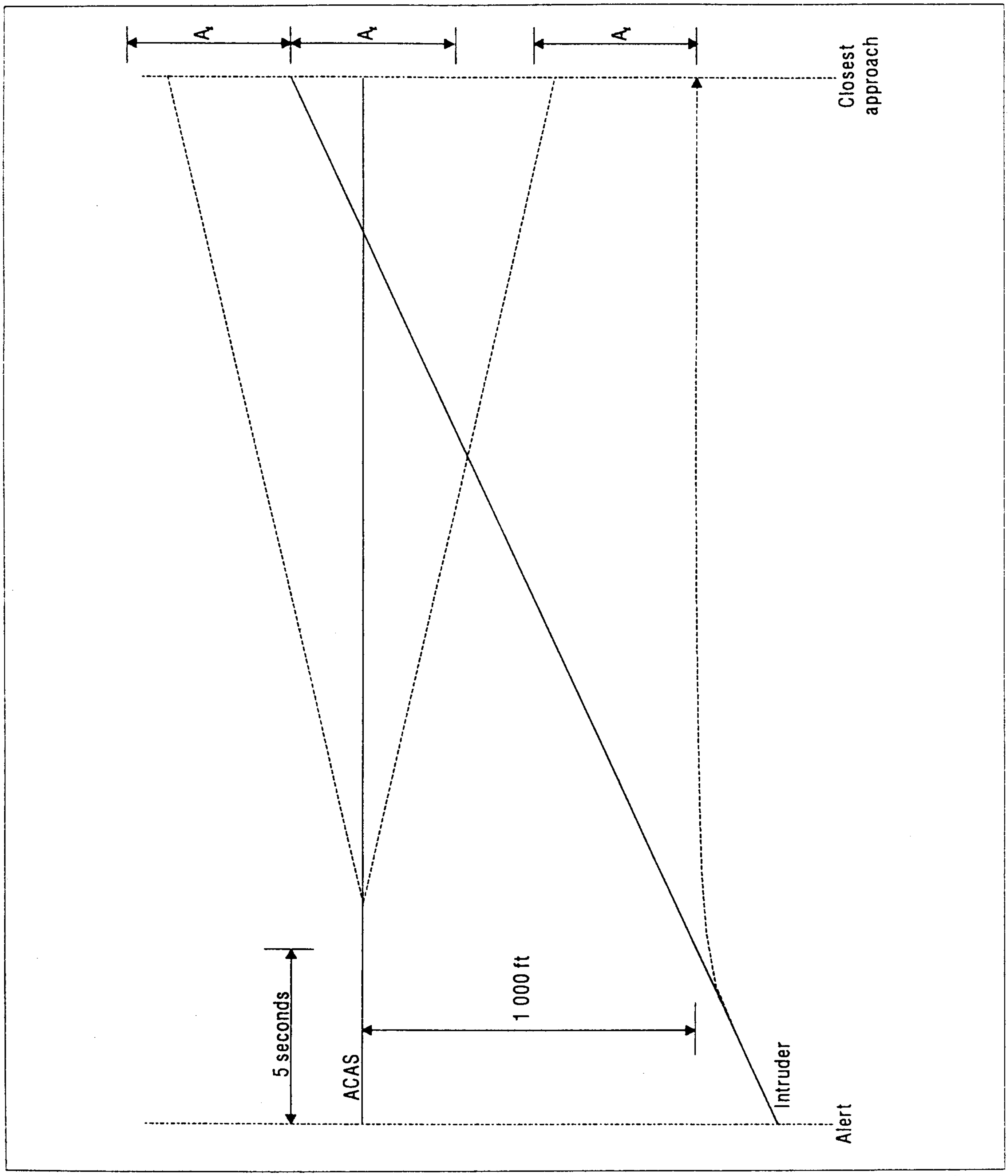


Figure A-8. Induced close encounter

3.5.8.9 *Provisions for avoiding induced close encounters.* In the absence of any knowledge concerning the intent of the threat, the characteristic of ACAS is such that it assumes that the threat will continue with its current altitude rate but chooses the RA in an attempt to mitigate the effect of a likely threat manoeuvre. Other features provide for the contingency that a subsequent threat manoeuvre is detected.

3.5.8.9.1 *Biasing the choice of sense.* If a positive non-altitude crossing advisory is predicted to give at least adequate altitude separation at closest approach ($A_l/2$ to A_l), then preference is given to the sense that prevents the aircraft from crossing in altitude before closest approach if the threat does not level-off. There is evidence that, in some circumstances, altitude crossing RAs are more disruptive than non altitude-crossing RAs.

3.5.8.9.2 *Increased rate resolution advisory.* If the sense chosen as a result of the process described in 3.5.8.9.1 results in own aircraft moving away from the threat the encounter may still not be resolved if the threat increases its altitude rate. In such a case the pilot of the ACAS aircraft can be invited to increase own altitude rate in an attempt to outrun the threat.

3.5.8.9.3 *Altitude separation test*

3.5.8.9.3.1 Sense choice biasing will not always result in an RA to move away from the threat and the altitude separation test is provided further to decrease the chance of an induced close encounter due to a threat levelling off or reducing its altitude rate. The test involves delaying the issue of the RA until the intent of the threat can be deduced with greater confidence. It is therefore not without risk of causing ACAS to be unable to resolve the encounter. For a scenario of the type shown in Figure A-8 illustrating a threat with a significant altitude rate, the alert, without this delay, would be given when the aircraft were still well separated in altitude. For example, when the warning time is 25 seconds and the altitude rate is 900 m/min (3 000 ft/min), the initial separation is 380 m (1 250 ft). If the situation is such that an altitude crossing RA would be required, i.e. biased sense choice is ineffective, ACAS delays the issue of an advisory until the current altitude separation falls below a threshold (A_c) that is smaller than the standard IFR separation. If the threat actually levels off at any altitude before crossing that threshold, as is most likely, the alert state will either be cancelled (for level-offs outside Z_m), or a non-altitude crossing advisory will be generated. Otherwise, apart from the possibility that the threat has just overshot its cleared altitude, there is every indication that it is carrying on to, or through, own aircraft's level and the altitude crossing advisory can be issued with more confidence. If the situation is such that non-altitude crossing advisory would be required, a reduced time threshold (T_v) is used for the altitude test. This vertical threshold test (VTT) is designed to hold off the RA just long enough so that a level-off manoeuvre initiated by the intruder might be detected.

3.5.8.9.3.2 The altitude separation test was intended principally to alleviate problems experienced in an IFR traffic-only environment. It may appear to be desirable to select the value for A_c such that altitude overshoots or even non-IFR separations are covered. However, the risk of ACAS to be unable to resolve the encounters is to be taken into careful consideration.

3.5.8.9.3.3 The test takes advantage of the co-operation between two equipped aircraft by causing the ACAS in the level aircraft to delay the choice of an RA until it has received a resolution message from the equipped intruder. The ACAS in the latter must almost certainly choose a reduction in its own altitude rate and the co-ordination process would then result in the level aircraft being able to maintain its level status. In practice the delay in starting to resolve the encounter will be small, but the risk of failure to resolve is less sensitive to delay because both aircraft are taking avoiding action. The delay is limited to 3.0 s, which is normally sufficient for the threat to have initiated co-ordination.

3.5.8.9.4 *Sense reversal.* In spite of the precautions taken to avoid induced close encounters described above, there are still situations which are not covered. For example, in airspace containing VFR traffic, threat levelling-off can occur with a nominal separation of 150 m (500 ft). The altitude separation test could be less effective in such circumstances. When ACAS determines that a threat manoeuvre has defeated its initial choice of RA, the advisory sense can be reversed. The requirement to achieve the target altitude separation at closest approach may be relaxed when this course of action is taken.

3.5.8.10 *OTHER CAUSES OF INDUCED CLOSE ENCOUNTERS*

3.5.8.10.1 *Altimetry errors.* The allowance made for altimetry error in the required altitude separation parameter A_l is sufficient to give a high probability of not causing an ACAS-equipped aircraft to provoke a close encounter where none really existed. For gross altimetry errors, however, there remains a low probability that a close encounter will be induced when the original separation is adequate. Similarly, there is a low probability that ACAS will be unable to resolve a close encounter due to altimetry error.

3.5.8.10.2 *Mode C errors*

3.5.8.10.2.1 Errors in encoding the threat's altitude to provide Mode C data can, when sufficiently large, induce close encounters in much the same way as gross altimetry error. The incidence of such encounters will be very low in airspaces where ATC takes steps to advise the pilot that an aircraft's reported altitude is incorrect.

3.5.8.10.2.2 A more severe form of Mode C error occurs when the error is confined to the C bits. These are unchecked by ATC, which is normally content to find that an aircraft is within the specified tolerance value of its reported altitude. A stuck or missing C bit can produce an error of only 30 m (100 ft). However, such a fault can have a more serious effect on the intruder's altitude rate as perceived by ACAS and in this way can cause an induced close encounter or result in failure to resolve a close encounter.

3.5.8.10.3 *Contrary pilot response.* Manoeuvres opposite to the sense of an RA may result in a reduction in vertical separation with the threat aircraft and therefore must be avoided. This is particularly true in the case of an ACAS-ACAS co-ordinated encounter.

3.5.8.11 *MULTI-AIRCRAFT ENCOUNTERS*

3.5.8.11.1 ACAS takes account of the possibility of three or more aircraft being in close proximity and it is required to produce an over-all RA that is consistent with each of the advisories that it would give against each threat treated on an individual basis. In such circumstances it cannot always be expected that the ACAS aircraft will achieve an altitude separation of A_l with respect to all threats.

3.5.8.11.2 Simulations based on recorded ground-based radar surveillance data and initial experience with ACAS equipment have indicated that multi-aircraft conflicts are rare. Also, there is no evidence of a "domino" effect whereby the ACAS aircraft's manoeuvre to avoid a threat brings it into an encounter with a third aircraft which is equipped and so on. Such an event might be expected to take place in a holding pattern, but the available evidence does not confirm this.

3.5.9 VERTICAL RATE ESTIMATION

3.5.9.1 The ACAS vertical tracking algorithm uses altitude information quantized in either 25 or 100 ft increments to produce estimates of aircraft vertical rates. This tracker must avoid overestimating vertical rate when a jump in reported altitude occurs because an aircraft with a small vertical rate moves from one quantized altitude level to another. But response limitation cannot be achieved by merely increasing tracker smoothing, since the tracker would then be slow to respond to actual rate changes. Consequently, ACAS uses special track update procedures that suppress the response to an isolated altitude transition (altitude report that differs from the preceding altitude report) without sacrificing response to acceleration. The tracker also includes several features that contribute to reliability.

3.5.9.2 Some key features of the vertical tracking algorithm are as follows:

a) Before any altitude report is accepted for use by the update routines, tests are made to determine if the report appears reasonable, given the sequence of reports previously received. If the report appears unreasonable, it is discarded, although it may subsequently be used in checking the credibility of later reports.

b) The algorithm used by the reference tracker recursively averages the time between altitude transitions rather than altitude reports.

c) The tracker strictly limits the response to isolated altitude transitions (i.e. transitions that are not part of any trend in altitude). An isolated altitude transition results in initialization of the rate estimate to a specified modest rate in the direction of the transition. The rate estimate will be decayed toward zero on each successive scan without a transition.

d) When a transition is observed that is consistent in direction with the preceding transition, a trend is declared. The altitude rate is initialized to a value consistent with the time between the two transitions.

e) Rate oscillations due to quantization effects are suppressed when a trend or level track has been declared. During a trend period, altitude reports that indicate no altitude transition are tested to determine if the lack of a transition is consistent with the previously estimated rate. If not consistent, the rate is reset to a lower value. If consistent, the rate remains unchanged.

f) When a trend has been declared and a transition is observed, then a test is made to see if the transition is consistent in both direction and timing with the previously estimated rate. If not consistent, the rate is reset. If consistent, the rate is updated by smoothing. The transition may be due to jitter and in reality the trend may be continuing.

g) During each scan the tracker provides a track confidence index that indicates the degree of confidence that can be placed in the altitude rate estimate. "High" confidence is declared when recent altitude reports are consistent with both altitude and altitude rate estimates of the tracker. "Low" confidence is declared when altitude reports are not consistent, implying a possible vertical acceleration or when altitude reports are missing for two or more successive cycles. "Low" confidence might justify a delay in the generation of an RA.

h) The tracker provides upper and lower bounds within which the true altitude rate is expected to lie. The altitude rate bounds are used to determine if RA generation are to be delayed and in assessing the need for a sense reversal when the altitude rate confidence is "low".

3.5.9.3 The tracks are classified (4.1.3.3.6.3), and the transitions between track's classifications are shown in Figure A-9. Tracks are classified in order to determine how new measurements should be used to update the altitude rate estimate.

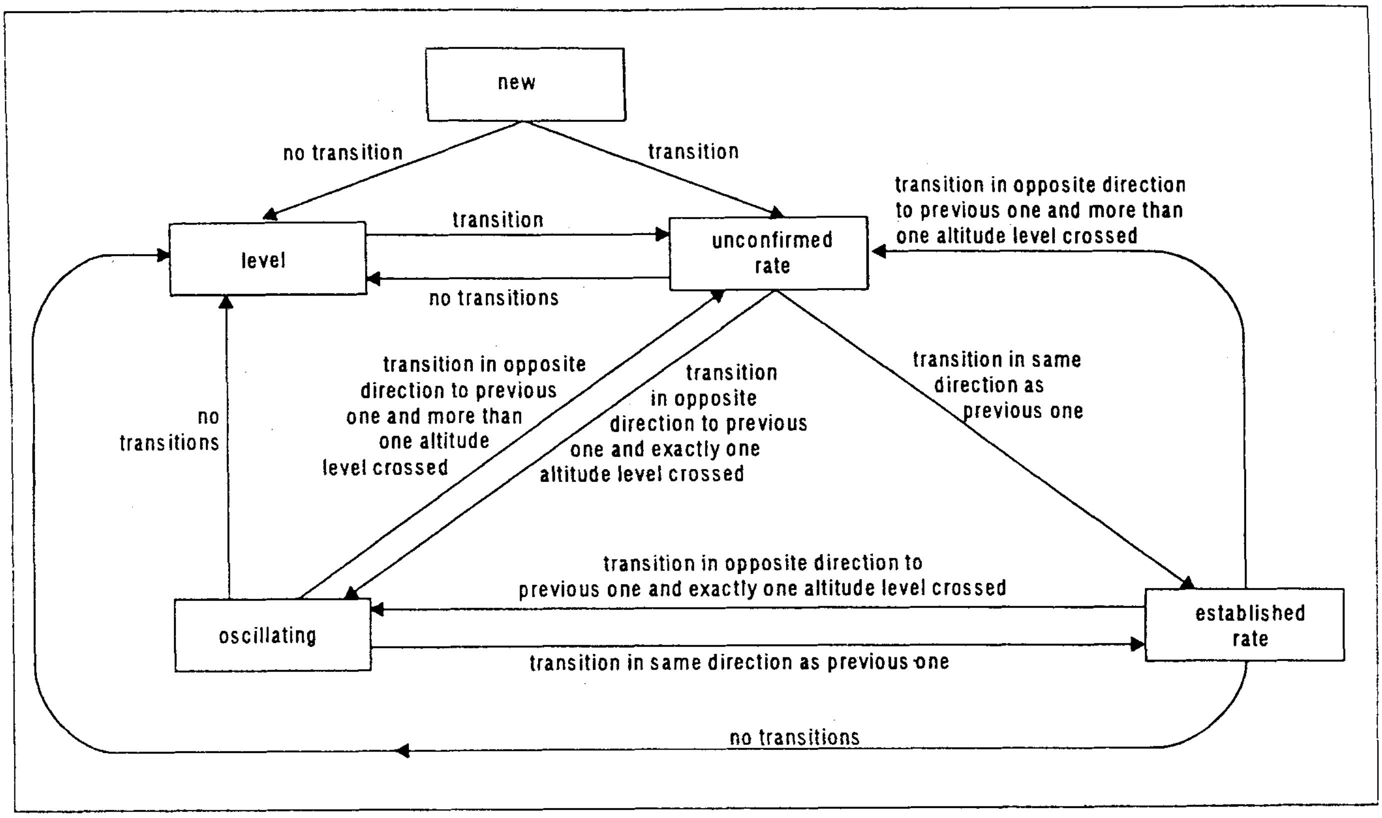


Figure A-9. Changes between track classifications

3.5.10 AIR-AIR CO-ORDINATION

3.5.10.1 *Co-ordination interrogations.* When ACAS declares a similarly equipped intruder to be a threat, interrogations are transmitted to the latter for RA co-ordination via the Mode S data link. These interrogations, which contain resolution messages, are made once per processing cycle as long as the intruder remains a threat. The equipped threat always acknowledges receipt of a resolution message by transmitting a co-ordination reply.

3.5.10.2 *CO-ORDINATION INTERROGATION PROCESSING*

3.5.10.2.1 ACAS processes a resolution message received from another ACAS-equipped intruder by storing the RAC for that intruder and by updating the RAC record.

3.5.10.2.2 RAC is a general term that is used to mean a vertical RAC (VRC) and/or a horizontal RAC (HRC) as appropriate. Specifically, the information provided in the Mode S interrogation is the VRC for ACAS II and the VRC and/or HRC for ACAS III.

3.5.10.2.3 The RAC record is a composite of all currently active RACs (VRCs and/or HRCs) that have been received by ACAS. The four bits in the RAC record correspond to the two VRC values ("do not pass below" and "do not pass above") followed by the two HRC values ("do not turn left" and "do not turn right"). If a bit in the RAC record is set, it means that the corresponding RAC has been received from one or more ACAS. Each time an RAC is received from another ACAS, the corresponding bit(s) in the RAC record is (are) set. Each time an RAC cancellation is received from another ACAS, the corresponding bit(s) is (are) cleared so long as no other ACAS is also currently causing the bit(s) to be set.

3.5.10.3 *CO-ORDINATION SEQUENCE*

3.5.10.3.1 The sequence of co-ordination messages and associated processing is illustrated in Figure A-10. Failure to complete the co-ordination may result in the choice by the threat of an incompatible RA sense.

3.5.10.4 *CO-ORDINATION PROTOCOL*

3.5.10.4.1 After declaring an equipped intruder to be a threat, ACAS first checks to see if it has received a resolution message from that threat. If so, ACAS selects an RA that is compatible with the threat's vertical sense. If not, ACAS selects an RA based on the geometry of the encounter (3.5.2). In either case, ACAS begins to transmit vertical sense information to the threat once per scan in the form of an RA complement in a resolution message. The RA complement for any upward sense RA is "don't pass above" while the complement for any downward sense advisory is "don't pass below".

3.5.10.4.2 Upon detecting ACAS as a threat, the threat goes through a comparable process. If for any reason the two aircraft select the same (incompatible) sense, the aircraft with the higher 24-bit aircraft address reverses its sense. This could happen if the two aircraft detect each other as threats simultaneously or if there were a temporary link failure preventing successful communication.

3.5.10.4.3 In order to prevent the immediate reversal of a displayed RA in such cases, display is deferred under certain conditions. If own ACAS is in an encounter with an ACAS-equipped threat, has the higher 24-bit aircraft address, and has not received a valid RA complement from the threat, then own ACAS will delay up to three seconds in displaying the RA to the pilot, waiting for an RA complement from the threat. Thus a reversal occurring within three seconds would not be perceived as a reversal by the pilot. A reversal occurring after three seconds would result in reversal of the RA. In an ACAS-ACAS encounter, own ACAS may reverse sense based on the encounter geometry (3.5.8.9.4) only if own ACAS aircraft has the lower 24-bit aircraft address.

3.5.10.5 *CO-ORDINATION LOCKING*

ACAS stores the current RA and the active RAC(s) received from other ACAS-equipped aircraft that perceive own aircraft to be a threat. In order to ensure that the stored information is not modified in response to one or more ACAS while it is being used for RA selection by own ACAS, the data is protected so that it is available to, or capable of being modified in response to, only one ACAS at a time. This is accomplished by entering the co-ordination lock state whenever the data store is accessed by own ACAS or offered new data from a threat ACAS. If a resolution message is received while the co-ordination lock state is active, the data is held until the current co-ordination lock state is ended. The potential for simultaneous data access by different processes within ACAS exists because incoming threat resolution messages are received asynchronously to the ACAS processing, effectively interrupting this processing.

3.5.11 GROUND COMMUNICATION

3.5.11.1 *Report of ACAS resolution advisories to the ground.* Whenever an RA exists, ACAS indicates to the aircraft's Mode S transponder that it has an RA report available for a Mode S ground station. This causes the transponder to set a flag indicating that a message is waiting to be transmitted to the ground. Upon receipt of this flag a Mode S sensor may request transmission of the RA report. When this request is received, own Mode S transponder provides the message in a

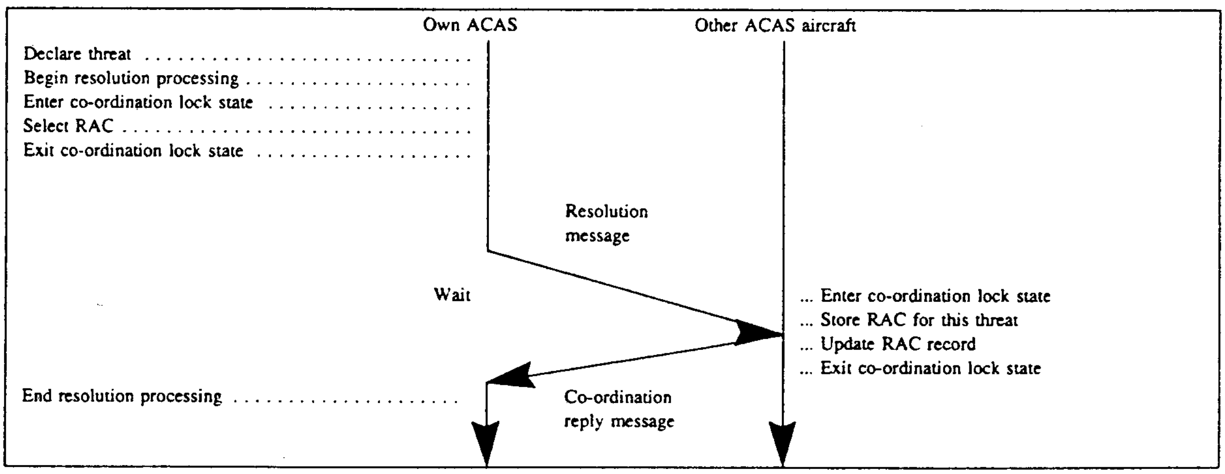


Figure A-10. Co-ordination sequence

Comm-B reply format. In addition, ACAS generates periodic broadcasts at 8-second intervals for the time during which an RA is indicated to the pilot. The broadcast reports any RA that existed during the previous 8-second period even if the advisory has been terminated. This allows ACAS RA activity to be monitored in areas where Mode S ground station surveillance coverage does not exist by using special RA broadcast signal receivers on the ground. RA broadcasts are normally destined for ground equipment but are defined as uplink transmissions.

3.5.11.2 *Ground station control of threat detection parameters.* Threat detection parameters can be controlled by one or more Mode S ground stations by transmitting interrogations containing sensitivity level control (SLC) command messages addressed to the ACAS aircraft. Upon receipt of an SLC command message from a given Mode S ground station, ACAS stores the SLC command value indexed by ground station number. ACAS uses the lowest of the values received if more than one ground station has sent such a message. ACAS times out each site's SLC command separately and cancels it if it is not refreshed by another message from that site within 4 minutes. ACAS can also immediately cancel an SLC command from a ground station if a specified cancellation code is received from that station. SLC commands cannot be used within linked Comm-A interrogations.

3.5.12 SENSITIVITY LEVEL CONTROL

Control of the ACAS threat detection parameters can be effected by means of SLC commands provided as follows:

a) an internally generated value based on altitude band;

b) from a Mode S ground station (see 3.5.11.2); and

c) from a pilot-operated switch.

The sensitivity level used by ACAS is set by the smallest non-zero SLC command provided by these three sources. When a Mode S ground station or the pilot has no particular interest in the sensitivity level setting, the value zero is delivered to ACAS from that source and it is not considered in the selection process. The sensitivity level will normally be set by the internally generated value based on altitude band. Hysteresis is used around the altitude thresholds to prevent fluctuations in the SLC command value when the ACAS aircraft remains in the region of an altitude threshold.

3.6 Compatibility with on-board Mode S transponders

3.6.1 Compatible operation of ACAS and the Mode S transponder is achieved by co-ordinating their activities via the avionics suppression bus. The Mode S transponder is suppressed during and shortly after an ACAS transmission. Typical suppression periods are a) 70 microseconds from the top antenna and b) 90 microseconds from the bottom antenna. These suppression periods prevent multipath caused by the ACAS interrogation from eliciting an SSR reply from the Mode S transponder.

3.6.2 Unwanted power restriction on a Mode S transponder associated with ACAS is more stringent than in Annex 10, Volume I, Part I, Chapter 3, 3.8.2.10.2.1 in order to ensure that the Mode S transponder does not prevent ACAS from meeting its requirements. Assuming a transponder undesired radiation power level of −70 dBm (Chapter 4, 4.3.11.1) and a transponder to ACAS antenna isolation of −20 dBm, the resultant interference level at the ACAS RF port will then be below −90 dBm.

3.6.3 An additional compatibility requirement is to keep the leakage power of the ACAS transmitter at a low level (see 3.2.1).

3.7 Indications to the flight crew

3.7.1 DISPLAYS

3.7.1.1 ACAS uses two types of displays to present advisory information to the flight crew. The TA display presents the crew with a plan view of nearby traffic. The RA display presents the crew with manoeuvres to be executed or avoided in the vertical plane. The TA display and the RA display may utilize separate indicators or instruments to convey information to the pilot, or the two functions may be combined on a single display. The ACAS information can either be integrated with existing displays available on the flight deck or presented on a dedicated display.

3.7.1.2 *TRAFFIC ADVISORIES*

3.7.1.2.1 The TA display presents the flight crew with a plan view of nearby traffic. The information thus conveyed is intended to assist the flight crew in sighting nearby traffic. Simulation has demonstrated that tabular alphanumeric displays of traffic are difficult for the flight crew to read and assimilate, and the use of this type of display as the primary means of displaying traffic information is not recommended. The TA display provides the capability to display the following information for intruders:

a) position (range and bearing);

b) altitude (relative or absolute if the intruder is reporting altitude); and

c) altitude rate indication for an altitude reporting intruder (climbing or descending).

3.7.1.2.2 The TA display may use shapes and colours to indicate the threat level of each displayed intruder, i.e. RAs, TAs, and proximate traffic. The essential differences between the tests for TA generation and the tests for threat detection are the uses of larger values for warning time.

3.7.1.2.3 The continuous display of proximate traffic is not a required component of ACAS. However, pilots need guidance concerning proximate traffic as well as potential threats to ensure that they identify the correct aircraft as the potential threat. The word "display" is not intended to imply that a visual display is the only acceptable means of indicating the position of intruders.

3.7.1.2.4 Ideally, an RA would always be preceded by a TA, but this is not always possible; e.g. the RA criteria might be already satisfied when a track is first established, or a sudden and sharp manoeuvre by the intruder could cause the TA lead time to be less than a cycle.

3.7.1.3 *RESOLUTION ADVISORIES*

The RA display presents the flight crew with an indication of vertical speed to be attained or avoided. The RA display may be incorporated into the instantaneous vertical speed indicator (IVSI) or into the primary flight display (PFD). The RA display may provide a means to differentiate between preventive and corrective RAs.

3.7.2 AURAL AND VOICE ALERTS

Aural alerts are used to alert the flight crew that a TA or RA has been issued. When the vocabulary used to announce RAs is selected, care must be taken to select phrases that minimize the probability of a misunderstood command. An aural annunciation is also provided to the flight crew to indicate that the ACAS aircraft is clear of conflict with all threatening aircraft.

3.8 Crew control functions

As a minimum, it is expected that a means be provided manually through flight crew action for either selecting an "AUTOMATIC" mode in which sensitivity levels are based on other inputs, selecting a mode in which only TAs are able to be issued, or selecting specific sensitivity levels including at least sensitivity level 1. When sensitivity level 1 is selected, the ACAS equipment is essentially in a "stand-by" condition. The term STAND-BY may be used to designate this selection. The current ACAS sensitivity level may be different from that selected by the flight crew. Provisions are to be made for indicating to the flight crew when ACAS is in STAND-BY or when only TAs will be issued. The control for ACAS may be integrated with the controls for the Mode S transponder, or the two systems may have separate controls. If the ACAS and Mode S controls are integrated, a means must be provided to allow the flight crew to select a transponder-only mode of operation.

3.9 Performance monitoring

ACAS equipment is expected to include an automatic performance monitoring function for determining on a continuing basis the technical status of all critical ACAS functions without interfering with or otherwise interrupting the normal operation of the equipment. Provisions are to be made for indicating to the flight crew the existence of abnormal conditions as determined by this monitoring function.

4. TYPICAL ALGORITHMS AND PARAMETERS FOR THREAT DETECTION AND GENERATION OF ADVISORIES

Note 1.— The characteristics given below describe a reference design for the ACAS II collision avoidance logic. This description, however, does not preclude the use of alternative designs of equal or better performance.

Note 2.— Lower case mathematical symbols are used to represent variables throughout this chapter. Upper case symbols are used for parameters. The dot notation used for some parameters does not indicate that they are derived quantities but rather that they have the dimensions suggested by the notation, e.g. distance/time for a speed parameter.

4.1 Tracking performance characteristics

4.1.1 RANGE RESOLUTION AND TRACKING

4.1.1.1 *Range resolution.* Range is measured with a resolution of 14.5 m (1/128 NM) or better.

4.1.1.2 *Range tracking.* Range and range rate are estimated by means of a tracker whose performance is, in all respects, equal to or better than that of a recursive (alpha-beta) tracker with an alpha of 0.4 and a beta of 0.15.

4.1.2 *Angular accuracy.* The error in the measurement of relative bearing does not exceed 10 degrees rms.

4.1.3 ALTITUDE TRACKING

4.1.3.1 *Sources of altitude data.* Intruder aircraft's altitude is obtained from intruder Mode C or Mode S reports. Own aircraft's altitude is obtained from the source that provides the basis for own Mode C or Mode S reports and is used at the finest quantization available.

4.1.3.1.1 *Altitude report credibility.* Before any altitude report is accepted, a test is made to determine whether the report is credible. A credibility window is calculated on the basis of the previous estimated altitude and altitude rate. The altitude report is discarded and the altitude track updated as though the report was missing (4.1.3.3.7) if the report is outside the credibility window.

4.1.3.1.2 Altitude reports may be reconsidered against subsequent reports to determine whether their initial classification as credible or not credible was in fact correct.

4.1.3.2 *Own altitude rate.* Own ACAS aircraft's altitude rate is obtained from a source having errors that are as small as possible and in any event no greater than those of the rate output of the tracker described in 4.1.3.3.6.

4.1.3.3 *INTRUDER ALTITUDE TRACKING*

4.1.3.3.1 *Altitude tracking terms' description*

Established rate track. An altitude track for which the pattern of the last few altitude reports received from the intruder allows the inference that that intruder is climbing or descending with a constant, non-zero altitude rate.

Level track. An altitude track for which the pattern of the last few altitude reports received from the intruder allows the inference that that intruder is level.

New track. An altitude track newly initialized.

Oscillating track. An altitude track for which the pattern of the last few altitude reports received from the intruder oscillates between two or more values in a way that allows the inference that that intruder is level.

Unconfirmed rate track. An altitude track for which the pattern of the last few altitude reports received from the intruder does not allow the track to be classified in any other way.

Transition. An altitude report for a track that is different from the last credible altitude report for that track.

Trend. A trend exists for the altitude rate if the two most recent altitude level transitions were in the same direction.

4.1.3.3.1.1 On any cycle of tracking, each track is attributed one and only one track classification.

4.1.3.3.1.2 Any track classification is maintained until conditions for another track classification are satisfied.

4.1.3.3.2 The ACAS II tracks the altitudes of intruders. Tracking is based on automatic pressure altitude reports from their transponders, using altitude reports quantized as received. For every intruder on every cycle the tracker provides altitude and altitude rate estimates.

Note 1.— The function that associates Mode C altitude data with tracks is specified in Chapter 4, 4.3.2.1. The altitude tracker specified below assumes that this function has been performed prior to application of the tracker.

Note 2.— The tracker design described in 4.1.3.3.6 is based on altitude reports quantized to 100 ft increments. This does not preclude the use of alternative designs of equal or better performance. This applies in particular to the possible use of a tracker design capable of accommodating altitude reports quantized to increments of less than 100 ft.

Note 3.— The altitude tracker described in 4.1.3.3.6 assumes an input data rate of one altitude measurement per second (per track).

4.1.3.3.3 *Altitude rate confidence.* For every intruder on every cycle, the tracker provides an indication of either "high" or "low" confidence in the altitude rate estimate (4.1.3.3.6.9 and 4.1.3.3.6.10).

4.1.3.3.4 *Altitude rate reasonableness.* The tracker provides a "best estimate" altitude rate and upper and lower bounds for this altitude rate consistent with the received sequence of reports.

4.1.3.3.5 *Altitude rate estimation*

4.1.3.3.5.1 *Finely quantized reports.* When altitude reports quantized to finer increments than 100 ft are available these may be used to provide an altitude rate estimate with better accuracy than that provided by a tracker conforming with the requirements of 4.1.3.3.6.

4.1.3.3.5.2 *Obsolete transitions.* When a track is classified as level, all earlier transitions and any current trend are disregarded.

4.1.3.3.6 *100 ft quantization reports.* For altitude reports quantized to 100 ft increments, the performance of the altitude tracker is, in all respects, equal to or better than that of a reference tracker setting the altitude rate estimate to have an appropriate sign and the magnitude as described in this paragraph.

4.1.3.3.6.1 *Tracker variables.* The reference tracker uses the following variables:

$\dot{z}$ altitude rate estimate, m/s (ft/s);

$\dot{Z}_{gu}$ see 4.1.3.3.6.5.1;

Δz altitude difference between the current report and the most recent credible report;

T_n 1 s;

Q 30.5 m (100 ft);

t_r time since the most recent credible report, s;

t_p time between the two most recent altitude level transitions or, for multiple transitions within one cycle, the average time between these transitions, s;

t_b estimated level occupancy time after the most recent transition, s;

t_{bm} calculated lower bound on level occupancy time, s;

β computed smoothing coefficient for t_b;

β_l limit for β based on t_b;

b_t number of altitude levels crossed between the two most recent altitude level transitions;

b_z number of altitude levels crossed at the most recent rate;

ε smoothed error estimate of t_b, s;

d_t sign of the most recent altitude transition (= +1 for an increase in altitude; = −1 for a decrease); and

x^* value of any variable x before being updated following an altitude level transition.

4.1.3.3.6.2 *Report credibility.* The altitude report is regarded as being credible if either of the following conditions is satisfied:

a) $\Delta z = 0$

b) $|\Delta z - \dot{z}\, t_r| - Q\, t_r / T_n - \dot{Z}_{gu}\, t_r \leq 0$

4.1.3.3.6.3 *Track classification scheme*

Established rate track. An altitude track is classified as established rate if two or more successive transitions are observed in the same direction and the time interval between the two transitions is sufficiently short that the track classification would not be changed to level track during that interval (see the definition of level track), or if an observed transition is opposite in direction to an existing trend and the time since the previous transition is "unexpectedly small" (4.1.3.3.6.8.1).

Level track. An altitude track is classified as level if reports are received at the same level for longer than T_1 after the time at which the next transition was expected, if one was expected, or for more than T_2 whether or not a transition was expected (4.1.3.3.6.3.1).

New track. An altitude track is classified as new during the period between the time of the first altitude report and the first transition or until T_2 has elapsed (4.1.3.3.6.3.1).

Oscillating track. An altitude track is classified as oscillating if a transition occurs in the opposite direction to that of the immediately preceding transition, only one level has been crossed, the time interval between the two transitions is sufficiently short that the track classification would not be changed to level track during that interval (see the definition of level track) and, if the track was classified as established rate, the time since that transition is not "unexpectedly small" (4.1.3.3.6.8.1).

Unconfirmed rate track. An altitude track is classified as unconfirmed rate if a transition occurs for a new or for a level track or if a transition in the opposite direction to the previous transition occurs and more than one level has been crossed for an established, oscillating or unconfirmed rate track.

4.1.3.3.6.3.1 The following values are used:

T_1 = 4.0 s
T_2 = 20 s

4.1.3.3.6.3.2 If a track is already classified as unconfirmed rate and a transition occurs in the opposite direction to the previous one and more than one level has been crossed, the altitude rate is determined as if the track had just become classified as unconfirmed rate (4.1.3.3.6.5).

4.1.3.3.6.4 The magnitude of the rate is set to zero if the track is new, level or oscillating.

4.1.3.3.6.4.1 The quantities ε and b_z are set to zero and t_b to 100 s.

4.1.3.3.6.5 The magnitude of the rate is set to $\dot{Z}_{gu}$ when a track first becomes unconfirmed rate and then decayed each cycle from the value determined the previous cycle until another transition is observed.

4.1.3.3.6.5.1 The value of $\dot{Z}_{gu}$ is 2.4 m/s (480 ft/min) and the decay constant is 0.9.

4.1.3.3.6.5.2 The quantities ε and b_z are set to zero and t_b to $Q/|\dot{z}|$.

4.1.3.3.6.6 For established rate tracks the magnitude of the rate is set to the quantization interval divided by the estimated level occupancy time. The level occupancy time is estimated on receipt of transitions in the direction of the trend and held constant until the next transition either occurs or becomes overdue (4.1.3.3.6.7).

4.1.3.3.6.6.1 When a track is first established, the quantities ε, b_z and t_b are set as follows:

$$\varepsilon = 0,\ b_z = 1,\ \text{and}\ t_b = \text{maximum}\ (t_p,\ 1.4\ s)$$

4.1.3.3.6.6.2 Unless the transition is early or late (4.1.3.3.6.6.3), the quantities ε, b_z and t_b are calculated by recursive averaging following the third and subsequent transitions as follows:

$$\varepsilon' = 0.8\varepsilon^{*} + (t_p - t_b^{*})$$

$$\beta_1 = \frac{(t_b^{*} - T_n)^2}{[(t_b^{*})^2 + 64T_n^2]} \text{ and}$$

$$b_t = b_t^{*} + b_t \text{ and}$$

$$\beta = \text{maximum } (\frac{b_t}{b_t}, \beta_1) \text{ and}$$

$$\varepsilon = \varepsilon'$$

for $|\varepsilon'| \leq 1.35$ (or 2.85 if the most recent transition was observed following one or more missing reports);

$$b_t = 3 \text{ and}$$

$$\beta = 0.5 \text{ and}$$

$$\varepsilon = 0.3\varepsilon' \text{ otherwise;}$$

and in both cases: $t_b = t_b^{*} + \beta(t_p - t_b^{*})$.

4.1.3.3.6.6.3 *Early or late transitions*

If $|t_p - t_b^{*}| > 1.5$s (or 3.0s if the most recent transition was observed following one or more missing reports) or b_t lies outside the range $(t_t/t_b^{*} + 1.1) \geq b_t \geq (t_t/t_b^{*} - 1.1)$, then the quantities ε, b_t and t_b are set as follows:

$$b_t = 1$$
$$\varepsilon = 0$$
$$t_{bm} = \text{minimum } ((0.7t_p + 0.3t_b^{*}), 1.4\text{s})$$
$$t_b = \text{maximum } (t_p, t_{bm}).$$

The rate is calculated as: $\dot{z} = d_tQ/t_b$.

4.1.3.3.6.7 *Overdue transition.* The magnitude of the rate is decayed on each cycle from the value obtained on the previous cycle if reports are received at the same level for at least T_3 after the time of the next expected transition (or T_4 if the most recent transition was observed following one or more missing reports). The value of t_b is not changed in these circumstances.

4.1.3.3.6.7.1 The following values are used:

T_3 = 1.5 s
T_4 = 3.0 s

The following formula for rate decay is used:

$$\dot{z} = d_tQ/[t_b + (0.3t_b + 0.5T_n)\ (0.7 + (t_l - t_b)/T_n)^2]$$

where t_l = time since the most recent transition, *s*.

4.1.3.3.6.7.2 The quantity b_t is set to maximum $(2, b_t^{*} - 1)$.

4.1.3.3.6.8 *Transitions due to jitter.* The magnitude of the rate is set to the value obtained on the previous cycle if a transition is observed opposite in direction to that of the trend, the immediately preceding transition followed the trend, only one level has been crossed and the time since the immediately preceding transition is "unexpectedly small". Such a transition is subsequently treated as missing except for the requirements of 4.1.3.3.4 and 4.1.3.3.6.10 e).

4.1.3.3.6.8.1 The time since the immediately preceding transition is declared "unexpectedly small" when $t_p \leq 0.24\ t_b^{*}$.

4.1.3.3.6.8.2 The quantities ε, b_t and t_b are not changed.

4.1.3.3.6.9 *Track high confidence declaration.* "High" confidence in the tracked rate is declared when the current altitude report is credible and one or more of the following conditions are met:

a) a new track has been observed for longer than T_5 (4.1.3.3.6.9.1) without an altitude transition; or

b) an unconfirmed rate track has been observed for longer than T_6 (4.1.3.3.6.9.1) without an altitude transition; or

c) a track is classified as level; or

d) a track is first classified as established rate; or

e) for an established rate track when a transition has occurred the ratio of the observed transition time to the expected transition time (before being updated) falls between $\Re_1$ and $\Re_2$ (4.1.3.3.6.9.1); or the absolute value of the difference between these times is less than T_8; or the time between the most recently observed and the previous transition is longer than T_8 (4.1.3.3.6.9.1); or

f) for an established rate track when a transition has occurred, the previous report was missing, $|t_p - t_b^{*}| \geq T_7$, $t_p/t_b^{*} \geq 1$ and $-t_p - T_9 \leq (t_b - t_p)b_t \leq T_9$; or

g) a track is classified as oscillating; or

h) confidence was previously set to "high" upon processing of the last credible altitude report and conditions a) to e) of 4.1.3.3.6.10 for "low" confidence declaration are not satisfied.

4.1.3.3.6.9.1 The following values are used:

T_5 = 9 s
T_6 = 9 s
T_7 = 1.1 s

T_8 = 8.5 s
T_9 = 1.25 s
$\Re_1$ = 2/3
$\Re_2$ = 3/2

4.1.3.3.6.10 *Track low confidence declaration.* "Low" confidence in the tracked rate is declared when one or more of the following conditions is satisfied:

a) for a new track until condition a) in 4.1.3.3.6.9 is satisfied; or

b) for an unconfirmed rate track until condition b) in 4.1.3.3.6.9 is satisfied; or

c) when an observed transition time for an established rate track does not satisfy condition e) or condition f) in 4.1.3.3.6.9; or

d) when an expected transition is more than T_{10} (4.1.3.3.6.10.1) late; or

e) for an established rate track when the condition in 4.1.3.3.6.8 is satisfied; or

f) confidence was previously "low" and the conditions for "high" confidence declaration are not satisfied (4.1.3.3.6.9).

4.1.3.3.6.10.1 The value T_{10} = 0.25 s is used.

4.1.3.3.7 *Missing altitude reports.* When altitude reports are missing:

a) the previous value of the altitude rate estimate is maintained; and

b) confidence in the tracked rate is declared "low" when altitude reports are missing for two or more successive cycles.

4.2 Traffic advisories (TAs)

4.2.1 TA GENERATION

A TA is generated for an intruder reporting Mode C altitude when the application of both a range test (4.2.3) and an altitude test (4.2.4) gives a positive result for each in the same cycle of operation.

Note.— A TA may be generated for an intruder equipped with a non altitude-reporting transponder when the result of applying a range test (4.2.3) is positive.

4.2.2 TA WARNING TIME

For intruders reporting altitude, the range test for TAs gives a nominal warning time as follows:

S	*2*	*3*	*4*	*5*	*6*	*7*
TA warning time	T+10	T+10	T+10	T+15	T+15	T+13

where S = sensitivity level

4.2.2.1 The values for T for sensitivity levels 3 to 7 are those given in 4.3.3.4.1. The value for T for sensitivity level 2 is 10 s.

4.2.3 TA RANGE TEST

The range test for TAs has the same form as that used for threat detection (4.3.3). The values used for D_m for sensitivity levels 3 to 7 are those given in 4.3.3.2.1 incremented by $g(T_w - T)^2/6$ where T_w is the desired TA warning time. The base value for D_m for sensitivity level 2 is 0.19 km (0.10 NM).

4.2.4 TA ALTITUDE TEST

The altitude test gives a positive result if one of the following sets of conditions is satisfied:

a) current altitude separation is "small"; or

b) the aircraft are converging in altitude and the time to co-altitude is "small".

These terms and conditions are defined in 4.3.4.1, 4.3.4.2, 4.3.4.3 and 4.3.4.5. The time threshold for time to co-altitude is the TA warning time (4.2.2) and the values used for Z_t are as follows:

z_o FL	below 300	above 300
Z_t m	260	370
(Z_t ft	850	1 200)

4.3 Threat definition

4.3.1 THREAT DETECTION CHARACTERISTICS

4.3.1.1 *Intruder characteristics.* As a minimum, the characteristics of an intruder that are used to define a threat are:

a) tracked altitude: z_i

b) tracked rate of change of altitude: $\dot{z}_i$

c) tracked slant range: r

d) tracked rate of change of slant range: $\dot{r}$

e) sensitivity level of intruder's ACAS: S_i

For an intruder not equipped with ACAS II or ACAS III, S_i is set to 1.

4.3.1.2 *Own aircraft characteristics.* As a minimum, the following characteristics of own aircraft are used in threat definition:

a) altitude: z_o

b) rate of change of altitude: $\dot{z}_o$

c) sensitivity level of own ACAS (Chapter 4, 4.3.4.3): S_o.

4.3.1.3 *Altitude-band SLC command.* ACAS II selects the SLC command based altitude band as indicated in Table A-1.

4.3.1.3.1 The value of Z_u is not less than 1 000 ft.

4.3.2 *Criteria for threat declaration.* An intruder becomes a threat if and only if both the following apply on the same cycle:

a) the range test gives a positive result; and

b) the altitude test gives a positive result.

4.3.2.1 *Established threat.* The threat status of an established threat is maintained on successive cycles if, as a minimum, the range test gives a positive result.

4.3.3 RANGE TEST

4.3.3.1 *RANGE TEST TERMS' DESCRIPTION*

Linear miss distance (m_a). The minimum value that range will take on the assumption that both the intruder and own aircraft proceed from their current positions with unaccelerated motions.

Linear time to closest approach (t_a). The time it would take to reach closest approach if both the intruder and own aircraft proceed from their current positions with unaccelerated motions.

4.3.3.2 *Range convergence.* Aircraft are considered converging in range if the estimated range rate is less than $\dot{R}_t$. In this case the range rate estimate used in the range test is the minimum of the estimated range rate and $-\dot{R}_t$.

4.3.3.2.1 The value 3 m/s (6 kt) is used for $\dot{R}_t$.

4.3.3.3 *Range divergence.* Aircraft that are not considered converging in range are considered diverging in range. Range divergence is considered "slow" if the product of the estimated range multiplied by the estimated range rate is less than $\dot{P}_m$.

4.3.3.3.1 The following values are used for $\dot{P}_m$:

S	*3*	*4 to 6*	*7*
$\dot{P}_m$ km^2/s	0.0069	0.0096	0.0137
($\dot{P}_m$ NM^2/s	0.0020	0.0028	0.0040)

4.3.3.4 *Range test criteria.* The range test gives a positive result when either of the following conditions is satisfied:

a) both

1) the aircraft are converging in range; and

2) the range and range rate estimates indicate that the encounter could be such that the linear miss distance is less than or equal to D_m and the linear time to closest approach less than T; or

b) the aircraft are diverging in range but the range is less than D_m and the range divergence is "slow";

and for all other conditions the result of the range test is negative.

Table A-1

Nominal altitude band	*SLC command code*	*Altitude threshold at which sensitivity level value changes*	*Hysteresis values*
0 to Z_u AGL	2	Z_u AGL	± 100 ft
Z_u to 2 350 ft AGL	3	2 350 ft AGL	± 200 ft
2 350 ft AGL to FL 50	4	FL 50	± 500 ft
FL 50 to FL 100	5	FL 100	± 500 ft
FL 100 to FL 200	6	FL 200	± 500 ft
above FL 200	7		

Note.— The following inequality provides a practical test complying with criterion a) 2) above:

$(r - D_m^2/r)/|\dot{r}'| < T$

where $\dot{r}' = \text{minimum}\ (\dot{r}, -\dot{R}_t)$.

4.3.3.4.1 The values of the parameters T and D_m are as follows:

S	3	4	5	6	7
T s	15	20	25	30	35
D_m km	0.37	0.65	1.0	1.5	2.0
(D_m NM	0.20	0.35	0.55	0.80	1.1)

4.3.4 ALTITUDE TEST

4.3.4.1 *ALTITUDE TEST TERMS' DESCRIPTION*

Altitude divergence rate ($\dot{a}$). The rate of change of a.

Current altitude separation (a). The modulus of the current tracked altitude separation between own aircraft and the intruder.

Times to closest approach (τ_u, τ_m). The estimated time which will be taken to reach minimum range. τ_u is the maximum value (assuming rectilinear relative motion and zero miss distance) and τ_m is the minimum value (assuming rectilinear relative motion and the maximum miss distance of interest, D_m).

Time to co-altitude (τ_v). The estimated time which will be taken to reach co-altitude.

Vertical miss distance (v_m). An estimated lower bound for the projected altitude separation at the estimated time of closest approach.

4.3.4.2 *Current altitude separation.* Current altitude separation is declared "small" if $a < Z_t$. Z_t is not greater than Z_m (4.3.4.4.2) and not less than A_t (4.4.3).

4.3.4.3 *ALTITUDE CONVERGENCE*

4.3.4.3.1 $\dot{a}$ is calculated as follows:

$\dot{a} = \dot{z}_o - \dot{z}_i$ for $z_o - z_i \geq 0$

$\dot{a} = \dot{z}_i - \dot{z}_o$ for $z_o - z_i < 0$

4.3.4.3.2 The aircraft are declared converging in altitude if $\dot{a} < -\dot{Z}_c$.

4.3.4.3.3 The value of $\dot{Z}_c$ is positive and not greater than 0.3 m/s (60 ft/min).

4.3.4.4 *VERTICAL MISS DISTANCE*

4.3.4.4.1 When the aircraft are converging in range ($\dot{r} \leq 0$), time to closest approach and vertical miss distance are calculated as follows:

$\dot{r}' = \text{minimum}\ (\dot{r}, -\dot{R}_t)$

$\tau_u = \text{minimum}\ (|r/\dot{r}'|, T)$

$\tau_m = |(r - D_m^2/r)/\dot{r}'|$ for $r \geq D_m$
$= 0$ for $r < D_m$

$v_{m1} = (z_o - z_i) + (\dot{z}_o - \dot{z}_i)\tau_u$

$v_{m2} = (z_o - z_i) + (\dot{z}_o - \dot{z}_i)\tau_m$

$v_m = 0$ for $v_{m1}v_{m2} \leq 0$, otherwise
$v_m = \text{minimum}\ (v_{m1}, v_{m2})$ for $v_{m1} > 0$
$= \text{maximum}\ (v_{m1}, v_{m2})$ for $v_{m1} < 0$

4.3.4.4.2 Vertical miss distance is declared "small" if $|v_m| < Z_m$. The maximum values for Z_m are given by:

z_o *FL*	*below 200*	*200 to 300*	*above 300*
Z_m m	183	213	244
(Z_m ft	600	700	800)

4.3.4.5 *TIME TO CO-ALTITUDE*

4.3.4.5.1 The time to co-altitude for $\dot{a}$ less than $-\dot{Z}_c$ is calculated as follows:

$$\tau_v = -a/\dot{a}$$

Note.— τ_v is not used if the aircraft are not converging in altitude and range.

4.3.4.5.2 τ_v is declared "small" if $\tau_v < T_v$ for encounters in which the magnitude of own aircraft's vertical rate is not more than 600 ft/min or own aircraft's vertical rate has the same sign as but smaller magnitude than that of the intruder. For all other encounters τ_v is declared "small" if $\tau_v < T$. The values of the parameters T_v are as follows:

S	3	4	5	6	7
T_v s	15	18	20	22	30

4.3.4.6 *Altitude test criteria.* For any realistic traffic pattern, the altitude test gives a positive result at a rate no greater than that produced by an altitude test which gives a positive result when any of the following sets of conditions is satisfied:

a) the aircraft are converging in range, the current altitude separation is "small" and the vertical miss distance is "small"; or

b) the aircraft are converging in range and altitude, both time to co-altitude and vertical miss distance are "small"; or

c) the aircraft are diverging in range and the current altitude separation is "small";

and for all other conditions the result of the altitude test are negative.

4.4 Generation of RAs

4.4.1 RA types are defined in Chapter 4, 4.1.

4.4.2 DELAY IN RA GENERATION

Note.— An RA will be generated for all threats except in the circumstances described here or for co-ordination purposes.

ACAS II does not generate an RA in respect of a new threat when any of the following conditions are satisfied:

a) the altitude separation test (4.4.2.1) gives a negative result; or

b) confidence in the tracked altitude rate of the intruder is "low" and no resolution manoeuvre would provide a predicted separation of at least A_t (4.4.2.2), whether the threat had an altitude rate equal to the upper altitude rate bound, to the lower altitude rate bound, or to any altitude rate between these bounds (4.1.3.3.4); or

c) there is "low" confidence in the threat's tracked altitude rate, the current altitude separation is greater than 46 m (150 ft), and the RA generated would be altitude crossing.

4.4.2.1 *ALTITUDE SEPARATION TEST*

4.4.2.1.1 The altitude rate of own ACAS II aircraft is declared "small" if $|\dot{z}_o| \leq \dot{Z}_t$.

4.4.2.1.2 The value 3.0 m/s (600 ft/min) is used for $\dot{Z}_t$.

4.4.2.1.3 The delay in threat declaration is declared "acceptable" if it is less than 3.0 s.

4.4.2.1.4 *Test conditions.* The altitude separation test gives a negative result if all of the following conditions are satisfied:

a) own altitude rate is "small" (4.4.2.1.1);

b) the RA that would be generated in respect of the new threat would be altitude crossing; and

c) either:

1) the current altitude separation exceeds A_c; or

2) all of the following conditions are satisfied:

i) current altitude separation is greater than 91 m (300 ft);

ii) the threat is equipped with ACAS;

iii) a valid RAC has not been received from the equipped threat; and

iv) the delay in threat declaration is "acceptable" (4.4.2.1.3);

otherwise the result of the altitude separation test is positive.

4.4.2.1.5 The value of 183 m (600 ft) is used for A_c.

4.4.2.2 The following values are used for A_t:

z_o	A_t m	(A_t ft)
less than FL 100	61	(200)
FL 100 to FL 200	73	(240)
FL 201 to FL 300	122	(400)
greater than FL 300	146	(480)

4.4.2.2.1 Hysteresis is applied to the switching thresholds for A_t.

4.4.3 *Required altitude separation.* The RA (Chapter 4, 4.3.5) is such that it is predicted to provide an altitude separation of at least A_l at closest approach except in the circumstances described in 4.4.3.2.

4.4.3.1 The following values are used for the parameter A_l:

z_o	A_l m	(A_l ft)
less than FL 50	91	(300)
FL 50 to FL 100	107	(350)
FL 100 to FL 200	122	(400)
FL 201 to FL 300	183	(600)
greater than FL 300	213	(700)

4.4.3.1.1 Hysteresis is applied to the switching thresholds for A_l.

4.4.3.2 *Inadequate vertical separation.* If the restrictions on RAs (Chapter 4, 4.3.5 and 4.4.4 below) preclude the generation of an RA predicted to provide an altitude separation at closest approach of at least A_l, the RA is that predicted to provide the largest altitude separation at closest approach consistent with the other provisions in this chapter.

4.4.3.3 *Critical interval.* Predictions for closest approach are for the period of time during which a collision could occur.

4.4.3.3.1 The critical interval is that time between τ_{mt} and τ_{ut} where:

$\dot{r}' = \text{minimum } (\dot{r}, -\dot{R}_l)$

$\tau_{ut} = \text{minimum } (\tau^*_{ut}, |r/\dot{r}'|, T_e)$

$\tau_{mt} = \text{maximum } (T_{min}, \text{minimum } (\tau^*_{mt}, |(r - D_m^2/r)/\dot{r}'|))$

for $r \geq D_m$

$= T_{min}$ for $r < D_m$

where τ^*_{ut} and τ^*_{mt} are both equal to T_e for a threat that has newly passed the range test (4.3.3) and are the values of τ_{ut} and τ_{mt}, respectively, on the previous cycle otherwise.

4.4.3.3.1.1 T_e is greater than T. T_{min} is greater than zero and less than T_e. The following parameter values are used:

S	*3*	*4*	*5*	*6*	*7*
T_e, s	25	30	30	35	40

T_{min} = 10 s

4.4.3.4 *The threat trajectory.* The RA is designed to provide altitude separations sufficient to avoid collisions with threats that:

a) continue with their current altitude rates; or

b) are climbing or descending when they first become threats and reduce their altitude rates or manoeuvre to level flight.

Table A-2. RA strength options

Constraint	*Type*	$\dot{Z}_g$
Upward sense RA		
Increased climb	Positive	$> \dot{Z}_{clm}$
Climb	Positive	$\dot{Z}_{clm}$
Do not descend	VSL	0
Do not descend faster than 2.5 m/s	VSL	−2.5 m/s (−500 ft/min)
Do not descend faster than 5.1 m/s	VSL	−5.1 m/s (−1 000 ft/min)
Do not descend faster than 10 m/s	VSL	−10 m/s (−2 000 ft/min)
Downward sense RA		
Increased descend	Positive	$< \dot{Z}_{des}$
Descend	Positive	$\dot{Z}_{des}$
Do not climb	VSL	0
Do not climb faster than 2.5 m/s	VSL	+2.5 m/s (+500 ft/min)
Do not climb faster than 5.1 m/s	VSL	+5.1 m/s (+1 000 ft/min)
Do not climb faster than 10 m/s	VSL	+10 m/s (+2 000 ft/min)

4.4.3.4.1 Predicted altitude separation is based on the assumption that the threat will maintain its current altitude rate.

4.4.3.5 *Own aircraft trajectory.* Predicted altitude separation at closest approach is based on the following assumptions concerning the response of the ACAS II aircraft to the RA:

a) for preventive RAs, the altitude rate of own aircraft will remain within the limits specified by the RA;

b) for corrective RAs, the trajectory of own aircraft will consist of unaccelerated flight at the current rate for $T_p + T_s$, followed by a constant acceleration ($\ddot{Z}_g$) in the vertical plane to achieve the selected altitude rate ($\dot{Z}_g$) and thereafter unaccelerated motion at this rate.

Note.— The predicted time to closest approach might be so short that the selected altitude rate, $\dot{Z}_g$ cannot be achieved.

4.4.3.5.1 The parameter T_p, which represents pilot reaction time, takes the value 5 s for the initial RA strength or 2.5 s for any subsequent RA strength.

4.4.3.5.2 The value of the parameter T_s is chosen so that it models the system delay from receipt of the relevant SSR reply to the presentation of the RA to the pilot (Chapter 4, 4.3.5.10).

4.4.3.5.3 The parameter $\ddot{Z}_g$ takes the value 0.35g for a reversed sense RA or 0.25g otherwise.

4.4.3.5.4 If the selected altitude rate, Z_g, exceeds the performance capabilities of the aircraft, a value suitable for the aircraft is substituted.

4.4.4 RESTRICTIONS ON RAS

4.4.4.1 *Range of available RA strengths.* ACAS II has a capability to provide at least the vertical RA strength options of Table A-2 in resolving encounters.

4.4.4.1.1 *Increased rate RAs.* If the range of RA strength options considered by a particular ACAS II is restricted to those in Table A-2 and the predicted separation at closest approach for the existing RA is inadequate but would be increased by an increase in own altitude rate, ACAS II increases the selected altitude rate beyond $\dot{Z}_{clm}$ or $\dot{Z}_{des}$, as appropriate.

4.4.4.1.1.1 Increases in the selected altitude rate to 13 m/s (2 500 ft/min) are generated when all the following conditions are satisfied:

a) a positive RA with the same sense is currently displayed and has been displayed for more than one cycle; and either

1) if the threat is equipped or the current RA is not altitude crossing, confidence in the threat's tracked altitude rate is "high" (4.1.3.3.6.9), and the current RA strength is predicted to provide an altitude separation at closest approach of less than 61 m (200 ft); or

2) the threat is not equipped and the current RA is altitude crossing, and 10 s or less remain until closest approach and the threat's altitude at closest approach is currently predicted to be less than 61 m (200 ft) above or below the current altitude of own aircraft in the case of a descend or a climb RA respectively;

b) the time remaining to closest approach is less than T_{ir} and greater than 4 s;

c) own aircraft is more than 1 450 ft AGL, or the sense is upward and increase climb RAs are not inhibited by aircraft performance limits, in order to avoid interaction with the ground proximity warning system; and

d) the value of τ_u (4.3.4.4.1) was not already rising by the time the range to the threat was 3.2 km (1.7 NM).

The following values are used for T_{ir}.

S	*3*	*4*	*5*	*6*	*7*
T_{ir}, *S*	13	18	20	24	26

Note.— Condition 2) of a) above allows the use of an increased rate RA against a levelling-off, unequipped threat in an altitude-crossing encounter which does not qualify for a sense reversal (4.4.4.3.1). This situation can arise because the threat is levelling off with a low deceleration such that its predicted altitude at the point of closest approach follows the ACAS II aircraft's current altitude on each succeeding cycle. An increased rate RA could generate additional altitude separation.

4.4.4.1.2 The default values for $\dot{Z}_{clm}$ and $\dot{Z}_{des}$ are 7.6 m/s (1 500 ft/min) and −7.6 m/s (−1 500 ft/min), respectively. If 7.6 m/s (1 500 ft/min) exceeds the aircraft's climb capability, a suitable value may be substituted to enable the generation of climb RAs. If the actual rate of climb or descent exceeds the default rate, the actual rate is substituted.

Note.— Climbs may be inhibited in response to discrete indications e.g. that the aircraft is at its ceiling. However, it is possible that certain aircraft will have such limited climb capability that RAs to climb at 7.6 m/s (1 500 ft/min) have to be permanently inhibited to comply with Chapter 4, 4.3.5.4.

4.4.4.1.3 *RA retention.* Subject to the requirement that a descend RA is not generated at low altitude (Chapter 4, 4.3.5.4.1), the RA is not modified (Chapter 4, 4.3.5.6) if any of the following apply:

a) the range test has given a negative result but the intruder remains a threat (4.3.5.1.1); or

b) less than 2.5 s remain until closest approach; or

c) the intruder is diverging in range but the RA has not yet been cancelled (4.3.5.1.1).

4.4.4.1.4 *Weakening RAs.* Subject to the requirement that a descend RA is not generated at low altitude (Chapter 4, 4.3.5.4.1), an RA is not weakened (Chapter 4, 4.3.5.7) if any of the following conditions apply:

a) it is positive and current altitude separation is less than A_l; or

b) it (any strength) has been displayed for less than 10 s or, for a reversed sense RA, 5 s; or

c) there is "low" confidence in the threat's tracked altitude rate.

Note.— This limitation on weakening RAs does not apply to the declaration of an aircraft to be not a threat (Chapter 4, 4.3.5.1.1).

4.4.4.1.5 Increased rate RAs (4.4.4.1.1) are not weakened if less than 10 s have elapsed from the time at which the threat last qualified for an increased rate RA.

4.4.4.2 *Initial bias against altitude crossing.* A newly generated RA is non-crossing provided:

a) a non-crossing RA is predicted to provide an altitude separation of at least A_{nc} at closest approach; and

b) the current altitude separation is greater than A_{nb}.

4.4.4.2.1 A_{nc} has a value in the range $A_l/2$ to A_l.

4.4.4.2.2 The value of A_{nb} is 91 m (300 ft).

4.4.4.3 *Sense reversal for an established threat.* Sense reversals against unequipped threats are generated when the following conditions apply:

a) the threat is not equipped;

b) more than 4 s remain before closest approach;

c) the value of τ_u (4.3.4.4.1) was not already rising by the time the range to the threat was 3.2 km (1.7 NM); and

d) either:

1) i) the current RA is altitude crossing;

ii) current altitude separation is at least 61 m (200 ft), or 30 m (100 ft) if more than 10 s remain before closest approach;

iii) either

— at the time the RA was generated the threat was predicted to cross the initial altitude of own aircraft, but currently the threat's altitude at closest approach is predicted to be above or below the current altitude of own aircraft in the case of a climb or descend RA, respectively; or

— at the time the RA was generated the threat was not predicted to cross the initial altitude of own aircraft, but current estimates of the separations predicted to be achievable for climb and descend RAs at closest approach show that greater separation will be obtained for a reversed sense RA; and

iv) by the time of reaching closest approach, own aircraft will, with reversed sense, be able to exceed the maximum bound on the threat's altitude at closest approach (projected using the maximum altitude rate bound (4.1.3.3.4)); or

2) i) the current RA is not altitude crossing; and

ii) the threat has crossed own aircraft's altitude by at least 30 m (100 ft) in the direction of the RA sense.

Note.— The sense of an RA for an established threat cannot be reversed except for co-ordination purposes or because the predicted separation at closest approach for the existing sense is inadequate (Chapter 4, 4.3.5.5).

4.4.4.3.1 Climb RAs occurring as a result of reversals of downward-sense RAs are issued regardless of manoeuvre limitation indications.

— END —

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AIR TRAFFIC SERVICES

AIR TRAFFIC CONTROL SERVICE
FLIGHT INFORMATION SERVICE
ALERTING SERVICE

ANNEX 11

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

TENTH EDITION — JULY 1994

This edition incorporates all amendments adopted by the Council prior to 19 March 1994 and supersedes, on 10 November 1994, all previous editions of Annex 11.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-35	Incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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APPENDICES

ATTACHMENTS

FOREWORD

Historical background

In October 1945, the Rules of the Air and Air Traffic Control (RAC) Division at its first session made recommendations for Standards, Practices and Procedures for Air Traffic Control. These were reviewed by the then Air Navigation Committee and approved by the Council on 25 February 1946. They were published as "Recommendations for Standards, Practices and Procedures — *Air Traffic Control*" in the second part of Doc 2010, published in February 1946.

The RAC Division, at its second session in December 1946 - January 1947, reviewed Doc 2010 and proposed Standards and Recommended Practices for Air Traffic Control. It did not appear possible, however, to finalize those Standards prior to basic principles being established by the RAC Division for the organization of the relevant services.

These were established by the RAC Division at its third session in April - May 1948 and a draft Annex was thereafter submitted to States. This was adopted by the Council on 18 May 1950, pursuant to Article 37 of the Convention on International Civil Aviation (Chicago, 1944), and designated as Annex 11 to the Convention with the title "International Standards and Recommended Practices — *Air Traffic Services*". It became effective on 1 October 1950. This new title — *Air Traffic Services* — was preferred to the title *Air Traffic Control*, in order to make it clear that air traffic control service was a part of the services covered by Annex 11, together with flight information service and alerting service.

Table A shows the origin of subsequent amendments, together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

The Standards and Recommended Practices in this document, together with the Standards in Annex 2, govern the application of the "Procedures for Air Navigation Services — *Rules of the Air and Air Traffic Services*" and the "Regional Supplementary Procedures — *Rules of the Air and Air Traffic Services*", in which latter document will be found subsidiary procedures of regional application.

Annex 11 pertains to the establishment of airspace, units and services necessary to promote a safe, orderly and expeditious flow of air traffic. A clear distinction is made between air traffic control service, flight information service and alerting service. Its purpose, together with Annex 2, is to ensure that flying on international air routes is carried out under uniform conditions designed to improve the safety and efficiency of air operation.

The Standards and Recommended Practices in Annex 11 apply in those parts of the airspace under the jurisdiction of a Contracting State wherein air traffic services are provided and also wherever a Contracting State accepts the responsibility of providing air traffic services over the high seas or in airspace of undetermined sovereignty. A Contracting State accepting such responsibility may apply the Standards and Recommended Practices in a manner consistent with that adopted for airspace under its jurisdiction.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

Attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. Information relating to the establishment and withdrawal of, and changes to, facilities, services and procedures affecting aircraft operations provided according to the Standards specified in this Annex should be notified and take effect in accordance with Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1. — *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interests of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2. — *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

It is to be noted that in the English text the following practice has been adhered to when writing the specifications: Standards employ the operative verb "shall", while Recommended Practices employ the operative verb "should"

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document which is identified by a number includes all subdivisions of that portion.

Table A. Amendments to Annex 11

Amendment(s)	*Source(s)*	*Subject(s)*	*Adopted/approved* *Effective* *Applicable*
1st Edition	Rules of the Air and Air Traffic Control (RAC) Division, Third Session (1948)	International Standards and Recommended Practices — *Air Traffic Services.*	18 May 1950 1 October 1950 1 June 1951
1 to 6 (2nd Edition)	Rules of the Air and Air Traffic Control (RAC) Division, Fourth Session (1950)	Aerodrome traffic; transfer of control; contents of clearance; distress phase; requirements for communications; upper flight information regions and upper control areas; vertical separation.	27 November 1951 1 April 1952 1 September 1952
7	Air Navigation Commission	Deletion of guidance material on the dissemination of information on ATS facilities.	22 February 1956 — —
8 (3rd Edition)	Second Air Navigation Conference (1955)	Definitions; establishment of authority; designations of airspace; separation of aircraft; requirements for communications; requirements for meteorological information; determination and establishment of controlled airspaces; diagrams of communications.	11 May 1956 15 September 1956 1 December 1956
9 (4th Edition)	Rules of the Air, Air Traffic Services and Search and Rescue (RAC/SAR) Divisions (1958)	Definitions; objectives of air traffic services; designations of airspace and controlled aerodromes; specifications for airspace; air traffic control service; alerting service; requirements for communications; determination and establishment of controlled airspaces, naming of reporting points; automation of air traffic control.	8 December 1959 1 May 1960 1 August 1960
10	Panel for Co-ordinating Procedures Respecting the Supply of Information for Air Operations (1959)	SIGMET information; delegation and application of flight information service; requirements for meteorological information.	2 December 1960 1 April 1961 1 July 1961
11	Air Navigation Commission	Deletion of guidance material illustrating the depiction on charts of air traffic services information.	26 June 1961 — —
12	Air Navigation Commission	Guidance material relating to the selection of designators for routes within controlled airspace.	15 December 1961 — —
13	Air Navigation Commission	Notification of rescue co-ordination centres during uncertainty, alert and distress phases.	13 April 1962 1 August 1962 1 November 1962
14	Air Navigation Commission	Requirements for other aircraft in the vicinity of an aircraft in a state of emergency to be informed of the nature of emergency.	19 June 1964 1 November 1964 1 February 1965

Amendment(s)	*Source(s)*	*Subject(s)*	*Adopted/approved Effective Applicable*
15 (5th Edition)	Rules of the Air, Air Traffic Services/ Operations (RAC/OPS) Divisional Meeting (1963); Air Navigation Commission	Application of vertical separation for flights above FL 290; provision of air traffic control service to VFR flights; delineation of airspace; vertical limits of flight information regions; ATS routes and reporting point designators; co-ordination with operators; methods of separation; requirements for communications; guidance material on the determination and establishment of controlled airspace.	17 March 1965 29 March 1966 25 August 1966
16	Air Traffic Control Automation Panel (ATCAP), Fifth Meeting (1966)	Transfer of responsibility for control; control of air traffic flow.	7 June 1967 5 October 1967 8 February 1968
17	Fifth Air Navigation Conference (1967)	Air traffic services reporting office and its communication requirements; clearances and separation; scope of the flight information service; communications for control of vehicles at aerodromes; ATS requirements for meteorological information; information on aerodrome conditions and operational status of navigation aids.	23 January 1969 23 May 1969 18 September 1969
18 (6th Edition)	Sixth Air Navigation Conference (1969); Air Navigation Commission	Definitions; terminology for designating controlled airspace; vertical limits of ATS airspaces; minimum flight altitudes; establishment and application of separation minima; clearances and separation; standard departure and arrival routes; establishment and identification of reporting points and reporting lines; provision of flight information service to IFR flights over water areas; establishment of air-ground communications for ATS purposes.	25 May 1970 25 September 1970 4 February 1971
19	Air Navigation Commission	Authority over aircraft over the high seas; SIGMET information.	15 November 1972 15 March 1973 16 August 1973
20	Seventh Air Navigation Conference (1972)	Definitions; area navigation (RNAV); designators for ATS routes and reporting points.	23 March 1973 30 July 1973 23 May 1974
21	Council action in pursuance of Assembly Resolutions A17-10 and A18-10	Practices to be followed by ATS units in the event that an aircraft is subjected to unlawful interference.	7 December 1973 7 April 1974 23 May 1974
22	Technical Panel on Supersonic Transport Operations (SSTP), Fourth Meeting (1973); Air Navigation Commission	Clearance for transonic acceleration and deceleration of supersonic flights; co-operation between military authorities and air traffic services and requirements for communications.	4 February 1975 4 June 1975 9 October 1975
23	Air Navigation Commission	Use of SSR code 7500 in the event of unlawful interference; requirements for communications between ATS units and meteorological offices.	12 December 1975 12 April 1976 12 August 1976
24	Air Navigation Commission	Definitions; time-keeping accuracy.	7 April 1976 7 August 1976 30 December 1976
25 (7th Edition)	Ninth Air Navigation Conference (1976)	Definitions; VOR change-over points; identification of ATS routes; establishment and identification of significant points; flight information service; ATS requirements for information.	7 December 1977 7 April 1978 10 August 1978

Amendment(s)	Source(s)	Subject(s)	Adopted/approved Effective Applicable
26	Air Navigation Commission	Designation of standard departure and arrival routes.	3 December 1979 3 April 1980 27 November 1980
27	Air Navigation Commission	Co-ordination of activities constituting a potential hazard to flights of civil aircraft; unmanned free balloons.	4 March 1981 4 July 1981 26 November 1981
28	Air Navigation Commission	Requirements for communications between ATS units and military units.	1 April 1981 1 August 1981 26 November 1981
29	Operational Flight Information Service (OFIS) Panel, Second Meeting (1980); Review of the General Concept of Separation Panel (RGCSP), Fourth Meeting (1980); Air Navigation Commission	Provision of integrated AIS, ATS, MET and other pertinent operational information to aircraft in flight; composite separation; automatic recording of radar data; traffic information broadcasts by aircraft.	2 April 1982 2 August 1982 25 November 1982
30	ATS Data Acquisition, Processing and Transfer (ADAPT) Panel, Third Meeting (1981); AGA Divisional Meeting (1981); Air Navigation Commission	ATS requirements for communications; marking of surface wind indicators; surface movement guidance and control systems; units of measurement; definitions.	16 March 1983 29 July 1983 24 November 1983
31	Council; Air Navigation Commission	Civil-military co-ordination; in-flight contingencies involving strayed or unidentified aircraft and/or interception of civil aircraft; requirements for communications; traffic information broadcasts by aircraft.	12 March 1986 27 July 1986 20 November 1986
32 (8th Edition)	Review of the General Concept of Separation Panel (RGCSP), Fifth Meeting (1985); Air Navigation Commission	Definitions; Co-ordinated Universal Time (UTC); volcanic ash warnings; establishment of ATS routes defined by VOR; deletion of Attachments A, B, C, D, F and G.	18 March 1987 27 July 1987 19 November 1987
33 (9th Edition)	Secretariat; Visual Flight Rules Operations Panel, Third Meeting (1986); Air Navigation Commission; amendments consequential to the adoption of amendments to Annex 6	Operation of aircraft in mixed VFR/IFR; ATS requirements for NOTAM action; surface movement guidance and control; and ATS responsibilities regarding acts of unlawful interference.	12 March 1990 30 July 1990 14 November 1991
34	Secondary Surveillance Radar Improvements and Collision Avoidance Systems Panel, Fourth Meeting (SICASP/4) (1989)	Definitions; provision of air traffic services irrespective of airborne collision avoidance system (ACAS) operation.	26 February 1993 26 July 1993 11 November 1993
35 (10th Edition)	Review of the General Concept of Separation Panel (RGCSP), Sixth Meeting (1988), Seventh Meeting (1990), Eighth Meeting (1993); Automatic Dependent Surveillance Panel (ADSP), Second Meeting (1992); Air Navigation Commission	Definitions; reduced vertical separation minimum of 300 m (1 000 ft) vertical separation minimum above FL 290; integration of helicopter traffic with conventional aeroplane traffic; establishment of ATS routes defined by VOR and establishment of ATS routes for use by RNAV-equipped aircraft; required navigation performance; automatic dependent surveillance; provisions relating to the World Geodetic System — 1984 (WGS-84) geodetic datum; transmission of information to aircraft on radioactive material and toxic chemical "clouds".	18 March 1994 25 July 1994 10 November 1994

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

Note.— Throughout the text of this document the term "service" is used as an abstract noun to designate functions, or service rendered; the term "unit" is used to designate a collective body performing a service.

When the following terms are used in the Standards and Recommended Practices for Air Traffic Services they have the following meanings:

Accepting unit. Air traffic control unit next to take control of an aircraft.

Advisory airspace. An airspace of defined dimensions, or designated route, within which air traffic advisory service is available.

Advisory route. A designated route along which air traffic advisory service is available.

Aerodrome. A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome control service. Air traffic control service for aerodrome traffic.

Aerodrome control tower. A unit established to provide air traffic control service to aerodrome traffic.

Aerodrome traffic. All traffic on the manoeuvring area of an aerodrome and all aircraft flying in the vicinity of an aerodrome.

Note.— An aircraft is in the vicinity of an aerodrome when it is in, entering or leaving an aerodrome traffic circuit.

Aeronautical fixed service (AFS). A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.

Aeronautical Information Publication. A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

Aeronautical mobile service. A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate; emergency position-indicating radio beacon stations may also participate in this service on designated distress and emergency frequencies.

Aeronautical station. A land station in the aeronautical mobile service. In certain instances, an aeronautical station may be located, for example, on board ship or on a platform at sea.

Aeronautical telecommunication station. A station in the aeronautical telecommunication service.

Airborne collision avoidance system (ACAS). An aircraft system based on secondary surveillance radar (SSR) transponder signals which operates independently of ground-based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR transponders.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Air-ground communication. Two-way communication between aircraft and stations or locations on the surface of the earth.

Air-taxiing. Movement of a helicopter/VTOL above the surface of an aerodrome, normally in ground effect and at a ground speed normally less than 37 km/h (20 kt).

Note.— The actual height may vary, and some helicopters may require air-taxiing above 8 m (25 ft) AGL to reduce ground effect turbulence or provide clearance for cargo slingloads.

Air traffic. All aircraft in flight or operating on the manoeuvring area of an aerodrome.

Air traffic advisory service. A service provided within advisory airspace to ensure separation, in so far as practical, between aircraft which are operating on IFR flight plans.

Air traffic control clearance. Authorization for aircraft to proceed under conditions specified by an air traffic control unit.

Note 1.— For convenience, the term "air traffic control clearance" is frequently abbreviated to "clearance" when used in appropriate contexts.

Note 2.— The abbreviated term "clearance" may be prefixed by "taxi", "take-off" "departure", "en route", "approach" or "landing" to indicate the particular portion of flight to which the air traffic control clearance relates.

Air traffic control service. A service provided for the purpose of:

a) preventing collisions:

1) between aircraft, and

2) on the manoeuvring area between aircraft and obstructions; and

b) expediting and maintaining an orderly flow of air traffic.

Air traffic control unit. A generic term meaning variously, area control centre, approach control office or aerodrome control tower.

Air traffic service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Air traffic services airspaces. Airspaces of defined dimensions, alphabetically designated, within which specific types of flights may operate and for which air traffic services and rules of operation are specified.

Note.— ATS airspaces are classified as Class A to G as shown in Appendix 4.

Air traffic services reporting office. A unit established for the purpose of receiving reports concerning air traffic services and flight plans submitted before departure.

Note.— An air traffic services reporting office may be established as a separate unit or combined with an existing unit, such as another air traffic services unit, or a unit of the aeronautical information service.

Air traffic services unit. A generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office.

Airway. A control area or portion thereof established in the form of a corridor equipped with radio navigation aids.

ALERFA. The code word used to designate an alert phase.

Alerting service. A service provided to notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required.

Alert phase. A situation wherein apprehension exists as to the safety of an aircraft and its occupants.

Alternate aerodrome. An aerodrome to which an aircraft may proceed when it becomes either impossible or inadvisable to proceed to or to land at the aerodrome of intended landing. Alternate aerodromes include the following:

Take-off alternate. An alternate aerodrome at which an aircraft can land should this become necessary shortly after take-off and it is not possible to use the aerodrome of departure.

En-route alternate. An aerodrome at which an aircraft would be able to land after experiencing an abnormal or emergency condition while en route.

Destination alternate. An alternate aerodrome to which an aircraft may proceed should it become impossible or inadvisable to land at the aerodrome of intended landing.

Note.— The aerodrome from which a flight departs may also be an en-route or a destination alternate aerodrome for that flight.

Altitude. The vertical distance of a level, a point or an object considered as a point, measured from mean sea level.

Approach control office. A unit established to provide air traffic control service to controlled flights arriving at, or departing from, one or more aerodromes.

Approach control service. Air traffic control service for arriving or departing controlled flights.

Appropriate ATS authority. The relevant authority designated by the State responsible for providing air traffic services in the airspace concerned.

Apron. A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

Apron management service. A service provided to regulate the activities and the movement of aircraft and vehicles on an apron.

Area control centre. A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

Area control service. Air traffic control service for controlled flights in control areas.

Area navigation (RNAV). A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Area navigation route. An ATS route established for the use of aircraft capable of employing area navigation.

ATS route. A specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services.

Note.— The term "ATS route" is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route, etc.

Automatic dependent surveillance (ADS). A surveillance technique in which aircraft automatically provide, via a data link, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position and additional data as appropriate.

Base turn. A turn executed by the aircraft during the initial approach between the end of the outbound track and the beginning of the intermediate or final approach track. The tracks are not reciprocal.

Note.— Base turns may be designated as being made either in level flight or while descending, according to the circumstances of each individual procedure.

Change-over point. The point at which an aircraft navigating on an ATS route segment defined by reference to very high frequency omnidirectional radio ranges is expected to transfer its primary navigational reference from the facility behind the aircraft to the next facility ahead of the aircraft.

Note.— Change-over points are established to provide the optimum balance in respect of signal strength and quality between facilities at all levels to be used and to ensure a common source of azimuth guidance for all aircraft operating along the same portion of a route segment.

Clearance limit. The point to which an aircraft is granted an air traffic control clearance.

Conference communications. Communication facilities whereby direct speech conversation may be conducted between three or more locations simultaneously.

Control area. A controlled airspace extending upwards from a specified limit above the earth.

Controlled aerodrome. An aerodrome at which air traffic control service is provided to aerodrome traffic.

Note.— The term "controlled aerodrome" indicates that air traffic control service is provided to aerodrome traffic but does not necessarily imply that a control zone exists.

Controlled airspace. An airspace of defined dimensions within which air traffic control service is provided to IFR flights and to VFR flights in accordance with the airspace classification.

Note.— Controlled airspace is a generic term which covers ATS airspace Classes A, B, C, D and E as shown in Appendix 4.

Controlled flight. Any flight which is subject to an air traffic control clearance.

Control zone. A controlled airspace extending upwards from the surface of the earth to a specified upper limit.

Cruising level. A level maintained during a significant portion of a flight.

DETRESFA. The code word used to designate a distress phase.

Distress phase. A situation wherein there is reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger or require immediate assistance.

Emergency phase. A generic term meaning, as the case may be, uncertainty phase, alert phase or distress phase.

Final approach. That part of an instrument approach procedure which commences at the specified final approach fix or point, or where such a fix or point is not specified,

a) at the end of the last procedure turn, base turn or inbound turn of a racetrack procedure, if specified; or

b) at the point of interception of the last track specified in the approach procedure; and

ends at a point in the vicinity of an aerodrome from which:

1) a landing can be made; or

2) a missed approach procedure is initiated.

Flight information centre. A unit established to provide flight information service and alerting service.

Flight information region. An airspace of defined dimensions within which flight information service and alerting service are provided.

Flight information service. A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Flight level. A surface of constant atmospheric pressure which is related to a specific pressure datum, 1 013.2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals.

Note 1.— A pressure type altimeter calibrated in accordance with the Standard Atmosphere:

a) when set to a QNH altimeter setting, will indicate altitude;

b) when set to a QFE altimeter setting, will indicate height above the QFE reference datum;

c) when set to a pressure of 1 013.2 hectopascals (hPa) may be used to indicate flight levels.

Note 2.— The terms "height" and "altitude" used in Note 1 above indicate altimetric rather than geometric heights and altitudes.

Flight plan. Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Note.— Specifications for flight plans are contained in Annex 2. When the expression "flight plan form" is used it denotes the model flight plan form at Appendix 2 to the PANS-RAC.

Forecast. A statement of expected meteorological conditions for a specified time or period, and for a specified area or portion of airspace.

Height. The vertical distance of a level, a point or an object considered as a point, measured from a specified datum.

IFR. The symbol used to designate the instrument flight rules.

IFR flight. A flight conducted in accordance with the instrument flight rules.

IMC. The symbol used to designate instrument meteorological conditions.

INCERFA. The code word used to designate an uncertainty phase.

Instrument meteorological conditions (IMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.

Note.— The specified minima for visual meteorological conditions are contained in Annex 2.

International NOTAM office. An office designated by a State for the exchange of NOTAM internationally.

Level. A generic term relating to the vertical position of an aircraft in flight and meaning variously, height, altitude or flight level.

Manoeuvring area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Meteorological office. An office designated to provide meteorological service for international air navigation.

Movement area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

NOTAM. A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

Operator. A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Printed communications. Communications which automatically provide a permanent printed record at each terminal of a circuit of all messages which pass over such circuit.

Reporting point. A specified geographical location in relation to which the position of an aircraft can be reported.

Required navigation performance (RNP). A statement of the navigation performance accuracy necessary for operation within a defined airspace.

Rescue Co-ordination Centre. A unit responsible for promoting efficient organization of search and rescue service and for co-ordinating the conduct of search and rescue operations within a search and rescue region.

RNP type. A containment value expressed as a distance in nautical miles from the intended position within which flights would be for at least 95 per cent of the total flying time.

Example.— RNP 4 represents a navigation accuracy of plus or minus 7.4 km (4 NM) on a 95 per cent containment basis.

Runway. A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Runway Visual Range (RVR). The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

SIGMET information. Information issued by a meteorological watch office concerning the occurrence or expected occurrence of specified en-route weather phenomena which may affect the safety of aircraft operations.

Significant point. A specified geographical location used in defining an ATS route or the flight path of an aircraft and for other navigation and ATS purposes.

Special VFR flight. A VFR flight cleared by air traffic control to operate within a control zone in meteorological conditions below VMC.

Taxiing. Movement of an aircraft on the surface of an aerodrome under its own power, excluding take-off and landing.

Terminal control area. A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

Track. The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic or grid).

Traffic avoidance advice. Advice provided by an air traffic services unit specifying manoeuvres to assist a pilot to avoid a collision.

Traffic information. Information issued by an air traffic services unit to alert a pilot to other known or observed air traffic which may be in proximity to the position or intended route of flight and to help the pilot avoid a collision.

Transfer of control point. A defined point located along the flight path of an aircraft, at which the responsibility for providing air traffic control service to the aircraft is transferred from one control unit or control position to the next.

Transferring unit. Air traffic control unit in the process of transferring the responsibility for providing air traffic control service to an aircraft to the next air traffic control unit along the route of flight.

Uncertainty phase. A situation wherein uncertainty exists as to the safety of an aircraft and its occupants.

VFR. The symbol used to designate the visual flight rules.

VFR flight. A flight conducted in accordance with the visual flight rules.

Visual meteorological conditions (VMC). Meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, equal to or better than specified minima.

Note.— The specified minima are contained in Annex 2.

VMC. The symbol used to designate visual meteorological conditions.

Way-point. A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation.

CHAPTER 2. GENERAL

2.1 Establishment of authority

2.1.1 Contracting States shall determine, in accordance with the provisions of this Annex and for the territories over which they have jurisdiction, those portions of the airspace and those aerodromes where air traffic services will be provided. They shall thereafter arrange for such services to be established and provided in accordance with the provisions of this Annex, except that, by mutual agreement, a State may delegate to another State the responsibility for establishing and providing air traffic services in flight information regions, control areas or control zones extending over the territories of the former.

Note.— If one State delegates to another State the responsibility for the provision of air traffic services over its territory, it does so without derogation of its national sovereignty. Similarly, the providing State's responsibility is limited to technical and operational considerations and does not extend beyond those pertaining to the safety and expedition of aircraft using the concerned airspace. Furthermore, the providing State in providing air traffic services within the territory of the delegating State will do so in accordance with the requirements of the latter which is expected to establish such facilities and services for the use of the providing State as are jointly agreed to be necessary. It is further expected that the delegating State would not withdraw or modify such facilities and services without prior consultation with the providing State. Both the delegating and providing States may terminate the agreement between them at any time.

2.1.2 Those portions of the airspace over the high seas or in airspace of undetermined sovereignty where air traffic services will be provided shall be determined on the basis of regional air navigation agreements. A Contracting State having accepted the responsibility to provide air traffic services in such portions of airspace shall thereafter arrange for the services to be established and provided in accordance with the provisions of this Annex.

Note 1.— The phrase "regional air navigation agreements" refers to the agreements approved by the Council of ICAO normally on the advice of Regional Air Navigation Meetings.

Note 2.— The Council, when approving the Foreword to this Annex, indicated that a Contracting State accepting the responsibility for providing air traffic services over the high seas or in airspace of undetermined sovereignty may apply the Standards and Recommended Practices in a manner consistent with that adopted for airspace under its jurisdiction.

2.1.3 When it has been determined that air traffic services will be provided, the States concerned shall designate the authority responsible for providing such services.

Note 1.— The authority responsible for establishing and providing the services may be a State or a suitable Agency.

Note 2.— Situations which arise in respect of the establishment and provision of air traffic services to either part or whole of an international flight are as follows:

Situation 1: *A route, or portion of a route, contained within airspace under the sovereignty of a State establishing and providing its own air traffic services.*

Situation 2: *A route, or portion of a route, contained within airspace under the sovereignty of a State which has, by mutual agreement, delegated to another State, responsibility for the establishment and provision of air traffic services.*

Situation 3: *A portion of a route contained within airspace over the high seas or in airspace of undetermined sovereignty for which a State has accepted the responsibility for the establishment and provision of air traffic services.*

For the purpose of this Annex, the State which designates the authority responsible for establishing and providing the air traffic services is:

in Situation 1: *the State having sovereignty over the relevant portion of the airspace;*

in Situation 2: *the State to whom responsibility for the establishment and provision of air traffic services has been delegated;*

in Situation 3: *the State which has accepted the responsibility for the establishment and provision of air traffic services.*

2.1.4 Where air traffic services are established, information shall be published as necessary to permit the utilization of such services.

2.2 Objectives of the air traffic services

The objectives of the air traffic services shall be to:

a) prevent collisions between aircraft;

b) prevent collisions between aircraft on the manoeuvring area and obstructions on that area;

c) expedite and maintain an orderly flow of air traffic;

d) provide advice and information useful for the safe and efficient conduct of flights;

e) notify appropriate organizations regarding aircraft in need of search and rescue aid, and assist such organizations as required.

2.3 Divisions of the air traffic services

The air traffic services shall comprise three services identified as follows.

2.3.1 The *air traffic control service*, to accomplish objectives a), b) and c) of 2.2, this service being divided in three parts as follows:

a) *Area control service:* the provision of air traffic control service for controlled flights, except for those parts of such flights described in sub-paragraphs b) and c) below, in order to accomplish objectives a) and c) of 2.2;

b) *Approach control service:* the provision of air traffic control service for those parts of controlled flights associated with arrival or departure, in order to accomplish objectives a) and c) of 2.2;

c) *Aerodrome control service:* the provision of air traffic control service for aerodrome traffic, except for those parts of flights described in sub-paragraph b) above, in order to accomplish objectives a), b) and c) of 2.2.

2.3.2 The *flight information service*, to accomplish objective d) of 2.2.

2.3.3 The *alerting service*, to accomplish objective e) of 2.2.

2.4 Determination of the need for air traffic services

2.4.1 The need for the provision of air traffic services shall be determined by consideration of the following:

a) the types of air traffic involved;

b) the density of air traffic;

c) the meteorological conditions;

d) such other factors as may be relevant.

Note.— Due to the number of elements involved, it has not been possible to develop specific data to determine the need for air traffic services in a given area or at a given location. For example:

a) a mixture of different types of air traffic with aircraft of varying speeds (conventional jet, etc.) might necessitate the provision of air traffic services whereas a relatively greater density of traffic where only one type of operation is involved would not;

b) meteorological conditions might have considerable effect in areas where there is a constant flow of air traffic (e.g. scheduled traffic), whereas similar or worse meteorological conditions might be relatively unimportant in an area where air traffic would be discontinued in such conditions (e.g. local VFR flights);

c) open stretches of water, mountainous, uninhabited or desert areas might necessitate the provision of air traffic services even though the amount of frequency of operations is extremely light.

2.4.2 The carriage of airborne collision avoidance systems (ACAS) by aircraft in a given area shall not be a factor in determining the need for air traffic services in that area.

2.5 Designation of the portions of the airspace and controlled aerodromes where air traffic services will be provided

2.5.1 When it has been determined that air traffic services will be provided in particular portions of the airspace or at particular aerodromes, then those portions of the airspace or those aerodromes shall be designated in relation to the air traffic services that are to be provided.

2.5.2 The designation of the particular portions of the airspace or the particular aerodromes shall be as follows:

2.5.2.1 *Flight information regions.* Those portions of the airspace where it is determined that flight information service and alerting service will be provided shall be designated as flight information regions.

2.5.2.2 *Control areas and control zones*

2.5.2.2.1 Those portions of the airspace where it is determined that air traffic control service will be provided to IFR flights shall be designated as control areas or control zones.

Note.— The distinction between control areas and control zones is made in 2.9.

2.5.2.2.1.1 Those portions of controlled airspace wherein it is determined that air traffic control service will also be provided to VFR flights shall be designated as Classes B, C, or D airspace.

2.5.2.2.2 Where designated within a flight information region, control areas and control zones shall form part of that flight information region.

2.5.2.3 *Controlled aerodromes.* Those aerodromes where it is determined that air traffic control service will be provided to aerodrome traffic shall be designated as controlled aerodromes.

2.6 Classification of airspaces

2.6.1 ATS airspaces shall be classified and designated in accordance with the following:

Class A. IFR flights only are permitted, all flights are subject to air traffic control service and are separated from each other.

Class B. IFR and VFR flights are permitted, all flights are subject to air traffic control service and are separated from each other.

Class C. IFR and VFR flights are permitted, all flights are subject to air traffic control service and IFR flights are separated from other IFR flights and from VFR flights. VFR flights are separated from IFR flights and receive traffic information in respect of other VFR flights.

Class D. IFR and VFR flights are permitted and all flights are subject to air traffic control service, IFR flights are separated from other IFR flights and receive traffic information in respect of VFR flights, VFR flights receive traffic information in respect of all other flights.

Class E. IFR and VFR flights are permitted. IFR flights are subject to air traffic control service and are separated from other IFR flights. All flights receive traffic information as far as is practical.

Class F. IFR and VFR flights are permitted, all participating IFR flights receive an air traffic advisory service and all flights receive flight information service if requested.

Class G. IFR and VFR flights are permitted and receive flight information service if requested.

2.6.2 States shall select those airspace classes appropriate to their needs.

2.6.3 The requirements for flights within each class of airspace shall be as shown in the table in Appendix 4.

Note.— Where the proposed ATS airspaces adjoin vertically, i.e. one above the other, flights at a common level would comply with requirements of, and be given services applicable to, the less restrictive class of airspace. In applying these criteria, Class B airspace shall therefore be considered less restrictive than Class A airspace; Class C airspace less restrictive than Class B airspace, etc.

2.7 Required navigation performance (RNP)

2.7.1 RNP types shall be prescribed by States. When applicable, RNP types shall be prescribed on the basis of regional air navigation agreements.

2.7.2 **Recommendation.—** *RNP types RNP 4, RNP 12.6 and RNP 20 should be implemented from 1995 and, in addition, RNP 1 should be implemented from 1998.*

2.7.3 The prescribed RNP type shall be appropriate to the level of communications, navigation and air traffic services provided in the airspace concerned.

Note.— Applicable RNP types and associated procedures are published in the Manual on Required Navigation Performance (RNP) *(Doc 9613).*

2.8 Establishment and designation of the units providing air traffic services

The air traffic services shall be provided by units established and designated as follows:

2.8.1 Flight information centres shall be established to provide flight information service and alerting service within flight information regions, unless the responsibility of providing such services within a flight information region is assigned to an air traffic control unit having adequate facilities for the discharge of such responsibility.

Note.— This does not preclude delegating to other units the function of providing certain elements of the flight information service.

2.8.2 Air traffic control units shall be established to provide air traffic control service, flight information service and alerting service within control areas, control zones and at controlled aerodromes.

Note.— The services to be provided by various air traffic control units are indicated in 3.2.

2.9 Specifications for flight information regions, control areas and control zones

2.9.1 **Recommendation.—** *The delineation of airspace, wherein air traffic services are to be provided, should be related to the nature of the route structure and the need for efficient service rather than to national boundaries.*

Note 1.— Conclusions of agreements to permit the delineation of airspace lying across national boundaries is advisable when such action will facilitate the provision of air traffic services (see 2.1.1). Agreements which permit delineation of airspace boundaries by straight lines will, for example, be most convenient where data processing techniques are used by air traffic services units.

Note 2.— Where delineation of airspace is made by reference to national boundaries there is a need for suitably sited transfer points to be mutually agreed upon.

2.9.2 Flight information regions

2.9.2.1 Flight information regions shall be delineated to cover the whole of the air route structure to be served by such regions.

2.9.2.2 A flight information region shall include all airspace within its lateral limits, except as limited by an upper flight information region.

2.9.2.3 Where a flight information region is limited by an upper flight information region, the lower limit specified for the upper flight information region shall constitute the upper vertical limit of the flight information region and shall coincide with a VFR cruising level of the tables in Appendix 3 to Annex 2.

Note.— In cases where an upper flight information region is established the procedures applicable therein need not be identical with those applicable in the underlying flight information region.

2.9.3 Control areas

2.9.3.1 Control areas including, *inter alia*, airways and terminal control areas shall be delineated so as to encompass sufficient airspace to contain the flight paths of those IFR flights or portions thereof to which it is desired to provide the applicable parts of the air traffic control service, taking into account the capabilities of the navigation aids normally used in that area.

Note.— In a control area other than one formed by a system of airways, a system of routes may be established to facilitate the provision of air traffic control.

2.9.3.2 A lower limit of a control area shall be established at a height above the ground or water of not less than 200 m (700 ft).

Note.— This does not imply that the lower limit has to be established uniformly in a given control area (see Figure A-5 of the Air Traffic Services Planning Manual *(Doc 9426), Part I, Section 2, Chapter 3).*

2.9.3.2.1 **Recommendation.—** *The lower limit of a control area should, when practicable and desirable in order to allow freedom of action for VFR flights below the control area, be established at a greater height than the minimum specified in 2.9.3.2.*

2.9.3.2.2 **Recommendation.—** *When the lower limit of a control area is above 900 m (3 000 ft) MSL it should coincide with a VFR cruising level of the tables in Appendix 3 to Annex 2.*

Note.— This implies that the selected VFR cruising level be such that expected local atmospheric pressure variations do not result in a lowering of this limit to a height of less than 200 m (700 ft) above ground or water.

2.9.3.3 An upper limit of a control area shall be established when either:

a) air traffic control service will not be provided above such upper limit; or

b) the control area is situated below an upper control area, in which case the upper limit shall coincide with the lower limit of the upper control area.

When established, such upper limit shall coincide with a VFR cruising level of the tables in Appendix 3 to Annex 2.

2.9.4 Flight information regions or control areas in the upper airspace

Recommendation.— *Where it is desirable to limit the number of flight information regions or control areas through which high flying aircraft would otherwise have to operate, a flight information region or control area, as appropriate, should be delineated to include the upper airspace within the lateral limits of a number of lower flight information regions or control areas.*

2.9.5 Control zones

2.9.5.1 The lateral limits of control zones shall encompass at least those portions of the airspace, which are not within control areas, containing the paths of IFR flights arriving at and departing from aerodromes to be used under instrument meteorological conditions.

Note.— Aircraft holding in the vicinity of aerodromes are considered as arriving aircraft.

2.9.5.2 The lateral limits of a control zone shall extend to at least 9.3 km (5 NM) from the centre of the aerodrome or aerodromes concerned in the directions from which approaches may be made.

Note.— A control zone may include two or more aerodromes situated close together.

2.9.5.3 If a control zone is located within the lateral limits of a control area, it shall extend upwards from the surface of the earth to at least the lower limit of the control area.

Note.— An upper limit higher than the lower limit of the overlying control area may be established when desired.

2.9.5.4 **Recommendation.—** *If a control zone is located outside of the lateral limits of a control area, an upper limit should be established.*

2.9.5.5 **Recommendation.—** *If it is desired to establish the upper limit of a control zone at a level higher than the lower limit of the control area established above it, or if the control zone is located outside of the lateral limits of a control area, its upper limit should be established at a level which can easily be identified by pilots. When this limit is above 900 m (3 000 ft) MSL it should coincide with a VFR cruising level of the tables in Appendix 3 to Annex 2.*

Note.— This implies that, if used, the selected VFR cruising level be such that expected local atmospheric pressure variations do not result in a lowering of this limit to a height of less than 200 m (700 ft) above ground or water.

2.10 Identification of air traffic services units and airspaces

2.10.1 **Recommendation.—** *An area control centre or flight information centre should be identified by the name of a nearby town or city or geographic feature.*

2.10.2 **Recommendation.—** *An aerodrome control tower or approach control office should be identified by the name of the aerodrome at which it is located.*

2.10.3 **Recommendation.—** *A control zone, control area or flight information region should be identified by the name of the unit having jurisdiction over such airspace.*

2.11 Establishment and identification of ATS routes

2.11.1 ATS routes shall be identified by designators.

2.11.2 **Recommendation.—** *Designators for ATS routes other than standard departure and arrival routes should be selected in accordance with the principles set forth in Appendix 1.*

2.11.3 **Recommendation.—** *Standard departure and arrival routes and associated procedures should be identified in accordance with the principles set forth in Appendix 3.*

2.11.4 **Recommendation.—** *When warranted by density, complexity or nature of the traffic, special routes should be established for use by low-level traffic, including helicopters operating to and from helidecks on the high seas. When determining the lateral spacing between such routes, account should be taken of the navigational means available and the navigation equipment carried on board helicopters.*

Note.— Guidance material relating to the establishment of ATS routes is contained in the Air Traffic Services Planning Manual *(Doc 9426).*

2.12 Establishment of change-over points

2.12.1 **Recommendation.—** *Change-over points should be established on ATS route segments defined by reference to very high frequency omnidirectional radio ranges where this will assist accurate navigation along the route segments. The establishment of change-over points should be limited to route segments of 110 km (60 NM) or more, except where the complexity of ATS routes, the density of navigation aids or other technical and operational reasons warrant the establishment of change-over points on shorter route segments.*

2.12.2 **Recommendation.—** *Unless otherwise established in relation to the performance of the navigation aids or frequency protection criteria, the change-over point on a route segment should be the mid-point between the facilities in the case of a straight route segment or the intersection of radials in the case of a route segment which changes direction between the facilities.*

Note.— Guidance on the establishment of change-over points is contained in Attachment A.

2.13 Establishment and identification of significant points

2.13.1 Significant points shall be established for the purpose of defining an ATS route and/or in relation to the requirements of air traffic services for information regarding the progress of aircraft in flight.

2.13.2 Significant points shall be identified by designators.

2.13.3 **Recommendation.—** *Significant points should be established and identified in accordance with the principles set forth in Appendix 2.*

2.14 Establishment and identification of standard routes for taxiing aircraft

2.14.1 **Recommendation.—** *Where necessary, standard routes for taxiing aircraft should be established on an aerodrome between runways, aprons and maintenance areas. Such routes should be direct, simple and where practicable, designed to avoid traffic conflicts.*

2.14.2 **Recommendation.—** *Standard routes for taxiing aircraft should be identified by designators distinctively different from those of the runways and ATS routes.*

2.15 Co-ordination between the operator and air traffic services

2.15.1 Air traffic services units, in carrying out their objectives, shall have due regard for the requirements of the operators consequent on their obligations as specified in Annex 6, and, if so required by the operators, shall make available to them or their designated representatives such information as may be available to enable them or their designated representatives to carry out their responsibilities.

2.15.2 When so requested by an operator, messages (including position reports) received by air traffic services units and relating to the operation of the aircraft for which operational control service is provided by that operator shall, so far as practicable, be made available immediately to the operator or a designated representative in accordance with locally agreed procedures.

2.16 Co-ordination between military authorities and air traffic services

2.16.1 Air traffic services authorities shall establish and maintain close co-operation with military authorities responsible for activities that may affect flights of civil aircraft.

2.16.2 Co-ordination of activities potentially hazardous to civil aircraft shall be effected in accordance with 2.17.

2.16.3 Arrangements shall be made to permit information relevant to the safe and expeditious conduct of flights of civil aircraft to be promptly exchanged between air traffic services units and appropriate military units.

2.16.3.1 Air traffic services units shall, either routinely or on request, in accordance with locally agreed procedures, provide appropriate military units with pertinent flight plan and other data concerning flights of civil aircraft. In order to eliminate or reduce the need for interceptions, air traffic services authorities shall designate any areas or routes where the requirements of Annex 2 concerning flight plans, two-way communications and position reporting apply to all flights to ensure that all pertinent data is available in appropriate air traffic services units specifically for the purpose of facilitating identification of civil aircraft.

2.16.3.2 Special procedures shall be established in order to ensure that:

a) air traffic services units are notified if a military unit observes that an aircraft which is, or might be, a civil aircraft is approaching, or has entered, any area in which interception might become necessary;

b) all possible efforts are made to confirm the identity of the aircraft and to provide it with the navigational guidance necessary to avoid the need for interception.

2.17 Co-ordination of activities potentially hazardous to civil aircraft

2.17.1 The arrangements for activities potentially hazardous to civil aircraft, whether over the territory of a State or over the high seas, shall be co-ordinated with the appropriate air traffic services authorities. The co-ordination shall be effected early enough to permit timely promulgation of information regarding the activities in accordance with the provisions of Annex 15.

2.17.1.1 **Recommendation.—** *If the appropriate ATS authority is not that of the State where the organization planning the activities is located, initial co-ordination should be effected through the ATS authority responsible for the airspace over the State where the organization is located.*

2.17.2 The objective of the co-ordination shall be to achieve the best arrangements which will avoid hazards to civil aircraft and minimize interference with the normal operations of such aircraft.

2.17.2.1 **Recommendation.—** *In determining these arrangements the following should be applied:*

a) the locations or areas, times and durations for the activities should be selected to avoid closure or realignment of established ATS routes, blocking of the most economic flight levels, or delays of scheduled aircraft operations, unless no other options exist;

b) the size of the airspace designated for the conduct of the activities should be kept as small as possible;

c) direct communication between the appropriate ATS authority or air traffic services unit and the organization or unit conducting the activities should be provided for use in the event that civil aircraft emergencies or other unforeseen circumstances require discontinuation of the activities.

2.17.3 The appropriate ATS authorities shall be responsible for initiating the promulgation of information regarding the activities.

2.17.4 **Recommendation.—** *If activities potentially hazardous to civil aircraft take place on a regular or continuing basis, special committees should be established as required to ensure that the requirements of all parties concerned are adequately co-ordinated.*

2.18 Geographical coordinates

2.18.1 Geographical coordinates shall be determined and reported in terms of the World Geodetic System — 1984 (WGS-84) geodetic datum.

2.18.2 Geographical coordinate determination and reporting shall be in accordance with the principles set forth in Appendix 5.

2.19 Co-ordination between meteorological and air traffic services authorities

To ensure that aircraft receive the most up-to-date meteorological information for aircraft operations, arrangements shall be made, where necessary, between meteorological and air traffic services authorities for air traffic services personnel:

a) in addition to using indicating instruments, to report, if observed by air traffic services personnel or communicated by aircraft, such other meteorological elements as may be agreed upon;

b) to report as soon as possible to the associated meteorological office meteorological phenomena of operational significance, if observed by air traffic services personnel or communicated by aircraft, which have not been included in the aerodrome meteorological report;

c) to report as soon as possible to the associated meteorological office pertinent information concerning pre-eruption volcanic activity, volcanic eruptions and information concerning volcanic ash cloud.

Note.— See 4.2.3 regarding transmission of special air-reports.

2.20 Co-ordination between aeronautical information services and air traffic services authorities

To ensure that aeronautical information services units obtain information to enable them to provide up-to-date pre-flight information and to meet the need for in-flight information, arrangements shall be made between aeronautical information services and air traffic services authorities for air traffic services personnel to report to the responsible aeronautical information services unit, with a minimum of delay:

a) information on aerodrome conditions;

b) the operational status of associated facilities, services and navigation aids within their area of responsibility;

c) the occurrence of volcanic activity observed by air traffic services personnel or reported by aircraft; and

d) any other information considered to be of operational significance.

Note 1.— Specifications for the issue of a NOTAM are contained in Annex 15, Chapter 5.

Note 2.— Reports of volcanic activity comprise the information detailed in Annex 3, Chapter 4.

2.21 Minimum flight altitudes

Minimum flight altitudes shall be determined and promulgated by each Contracting State for each ATS route over its territory. The minimum flight altitudes determined shall be at least 300 m (1 000 ft) above the highest obstacle located within the area concerned.

Note.— The requirements for publication by States of minimum flight altitudes and of the criteria used to determine them are contained in Annex 15, Appendix 1.

2.22 Service to aircraft in the event of an emergency

2.22.1 An aircraft known or believed to be in a state of emergency, including being subjected to unlawful interference, shall be given maximum consideration, assistance and priority over other aircraft as may be necessitated by the circumstances.

Note.— To indicate that it is in a state of emergency, an aircraft equipped with an SSR transponder might operate the equipment as follows:

a) on Mode A, Code 7700; or

b) on Mode A, Code 7500, to indicate specifically that it is being subjected to unlawful interference.

2.22.2 When an occurrence of unlawful interference with an aircraft takes place or is suspected, ATS units shall attend promptly to requests by the aircraft. Information pertinent to the safe conduct of the flight shall continue to be transmitted and necessary action shall be taken to expedite the conduct of all phases of the flight, specially the safe landing of the aircraft.

2.23 In-flight contingencies

2.23.1 Strayed or unidentified aircraft

Note 1.— The terms "strayed aircraft" and "unidentified aircraft" in this paragraph have the following meanings:

Strayed aircraft. *An aircraft which has deviated significantly from its intended track or which reports that it is lost.*

Unidentified aircraft. *An aircraft which has been observed or reported to be operating in a given area but whose identity has not been established.*

Note 2.— An aircraft may be considered, at the same time, as a "strayed aircraft" by one unit and as an "unidentified aircraft" by another unit.

2.23.1.1 As soon as an air traffic services unit becomes aware of a strayed aircraft it shall take all necessary steps as outlined in 2.23.1.1.1 and 2.23.1.1.2 to assist the aircraft and to safeguard its flight.

Note.— Navigational assistance by an air traffic services unit is particularly important if the unit becomes aware of an aircraft straying, or about to stray, into an area where there is a risk of interception or other hazard to its safety.

2.23.1.1.1 If the aircraft's position is not known, the air traffic services unit shall:

a) attempt to establish two-way communication with the aircraft, unless such communication already exists;

b) use all available means to determine its position;

c) inform other ATS units into whose area the aircraft may have strayed or may stray, taking into account all the factors which may have affected the navigation of the aircraft in the circumstances;

d) inform, in accordance with locally agreed procedures, appropriate military units and provide them with pertinent flight plan and other data concerning strayed aircraft;

e) request from the units referred to in c) and d) and from other aircraft in flight every assistance in establishing communication with the aircraft and determining its position.

Note.— The requirements in d) and e) apply also to ATS units informed in accordance with c).

2.23.1.1.2 When the aircraft's position is established, the air traffic services unit shall:

a) advise the aircraft of its position and corrective action to be taken; and

b) provide, as necessary, other ATS units and appropriate military units with relevant information concerning the strayed aircraft and any advice given to that aircraft.

2.23.1.2 As soon as an air traffic services unit becomes aware of an unidentified aircraft in its area, it shall endeavour to establish the identity of the aircraft whenever this is necessary for the provision of air traffic services or required by the appropriate military authorities in accordance with locally agreed procedures. To this end, the air traffic services unit shall take such of the following steps as are appropriate in the circumstances:

a) attempt to establish two-way communication with the aircraft;

b) inquire of other air traffic services units within the flight information region about the flight and request their assistance in establishing two-way communication with the aircraft;

c) inquire of air traffic services units serving the adjacent flight information regions about the flight and request their assistance in establishing two-way communication with the aircraft;

d) attempt to obtain information from other aircraft in the area.

2.23.1.2.1 The air traffic services unit shall, as necessary, inform the appropriate military unit as soon as the identity of the aircraft has been established.

2.23.2 Interception of civil aircraft

2.23.2.1 As soon as an air traffic services unit learns that an aircraft is being intercepted in its area of responsibility, it shall take such of the following steps as are appropriate in the circumstances:

a) attempt to establish two-way communication with the intercepted aircraft on any available frequency, including the emergency frequency 121.5 MHz, unless such communication already exists;

b) inform the pilot of the intercepted aircraft of the interception;

c) establish contact with the intercept control unit maintaining two-way communication with the intercepting aircraft and provide it with available information concerning the aircraft;

d) relay messages between the intercepting aircraft or the intercept control unit and the intercepted aircraft, as necessary;

e) in close co-ordination with the intercept control unit take all necessary steps to ensure the safety of the intercepted aircraft;

f) inform ATS units serving adjacent flight information regions if it appears that the aircraft has strayed from such adjacent flight information regions.

2.23.2.2 As soon as an air traffic services unit learns that an aircraft is being intercepted outside its area of responsibility, it shall take such of the following steps as are appropriate in the circumstances:

a) inform the ATS unit serving the airspace in which the interception is taking place, providing this unit with available information that will assist in identifying the aircraft and requesting it to take action in accordance with 2.23.2.1;

b) relay messages between the intercepted aircraft and the appropriate ATS unit, the intercept control unit or the intercepting aircraft.

2.24 Time in air traffic services

2.24.1 Air traffic services units shall use Co-ordinated Universal Time (UTC) and shall express the time in hours and minutes of the 24-hour day beginning at midnight.

2.24.2 Air traffic services units shall be equipped with clocks indicating the time in hours, minutes and seconds, clearly visible from each operating position in the unit concerned.

2.24.3 Air traffic services unit clocks and other time-recording devices shall be checked as necessary to ensure correct time to within plus or minus 30 seconds of UTC at all times.

2.24.4 The correct time shall be obtained from a standard time station or, if not possible, from another unit which has obtained the correct time from such station.

2.24.5 Aerodrome control towers shall, prior to an aircraft taxiing for take-off, provide the pilot with the correct time, unless arrangements have been made for the pilot to obtain it from other sources. Air traffic services units shall, in addition, provide aircraft with the correct time on request. Time checks shall be given to the nearest half minute.

CHAPTER 3. AIR TRAFFIC CONTROL SERVICE

3.1 Application

Air traffic control service shall be provided:

a) to all IFR flights in Class A, B, C, D and E airspaces;

b) to all VFR flights in Classes B, C and D airspace;

c) to all special VFR flights;

d) to all aerodrome traffic at controlled aerodromes.

3.2 Provision of air traffic control service

The parts of air traffic control service described in 2.3.1 shall be provided by the various units as follows:

a) *Area control service:*

1) by an area control centre; or

2) by the unit providing approach control service in a control zone or in a control area of limited extent which is designated primarily for the provision of approach control service and where no area control centre is established.

b) *Approach control service:*

1) by an aerodrome control tower or area control centre when it is necessary or desirable to combine under the responsibility of one unit the functions of the approach control service with those of the aerodrome control service or the area control service;

2) by an approach control office when it is necessary or desirable to establish a separate unit.

c) *Aerodrome control service:* by an aerodrome control tower.

Note.— The task of providing specified services on the apron, e.g. apron management service, may be assigned to an aerodrome control tower or to a separate unit.

3.3 Operation of air traffic control service

3.3.1 In order to provide air traffic control service, an air traffic control unit shall:

a) be provided with information on the intended movement of each aircraft, or variations therefrom, and with current information on the actual progress of each aircraft;

b) determine from the information received, the relative positions of known aircraft to each other;

c) issue clearances and information for the purpose of preventing collision between aircraft under its control and of expediting and maintaining an orderly flow of traffic;

d) co-ordinate clearances as necessary with other units:

1) whenever an aircraft might otherwise conflict with traffic operated under the control of such other units;

2) before transferring control of an aircraft to such other units.

3.3.2 Information on aircraft movements, together with a record of air traffic control clearances issued to such aircraft, shall be so displayed as to permit ready analysis in order to maintain an efficient flow of air traffic with adequate separation between aircraft.

3.3.3 Clearances issued by air traffic control units shall provide separation:

a) between all flights in Class A and B airspaces;

b) between IFR flights in Class C, D, and E airspaces;

c) between IFR flights and VFR flights in Class C airspace;

d) between IFR flights and special VFR flights;

e) between special VFR flights when so prescribed by the appropriate ATS authority,

except that, when requested by an aircraft and if so prescribed by the appropriate ATS authority for the cases listed under a), b) and c) above, a flight may be cleared without separation being so provided in respect of a specific portion of the flight conducted in visual meteorological conditions.

3.3.4 Separation by an air traffic control unit shall be obtained by at least one of the following:

a) vertical separation, obtained by assigning different levels selected from:

1) the tables of cruising levels in Appendix 3 of Annex 2, or

2) a modified table of cruising levels, when so prescribed in accordance with Appendix 3 of Annex 2 for flight above FL 410,

except that the correlation of levels to track as prescribed therein shall not apply whenever otherwise indicated in appropriate aeronautical information publications or air traffic control clearances;

Note.— Guidance material relating to vertical separation is contained in the Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive *(Doc 9574).*

b) horizontal separation, obtained by providing:

1) longitudinal separation, by maintaining an interval between aircraft operating along the same, converging or reciprocal tracks, expressed in time or distance; or

2) lateral separation, by maintaining aircraft on different routes or in different geographical areas;

c) composite separation, consisting of a combination of vertical separation and one of the other forms of separation contained in b) above, using minima for each which may be lower than, but not less than half of, those used for each of the combined elements when applied individually. Composite separation shall only be applied on the basis of regional air navigation agreements.

Note.— Guidance material relating to the implementation of composite lateral/vertical separation is contained in the Air Traffic Services Planning Manual *(Doc 9426).*

3.4 Separation minima

3.4.1 The selection of separation minima for application within a given portion of airspace shall be as follows:

a) the separation minima shall be selected from those prescribed by the provisions of the PANS-RAC and the *Regional Supplementary Procedures* as applicable under the prevailing circumstances except that, where types of aids are used or circumstances prevail which are not covered by current ICAO provisions, other separation minima shall be established as necessary by:

1) the appropriate ATS authority, following consultation with operators, for routes or portions of routes contained within the sovereign airspace of a State;

2) regional air navigation agreement for routes or portions of routes contained within airspace over the high seas or over areas of undetermined sovereignty.

Note.— Details of current separation minima prescribed by ICAO are contained in the PANS-RAC (Doc 4444) and Part 1 of the Regional Supplementary Procedures *(Doc 7030).*

b) the selection of separation minima shall be made in consultation between the appropriate ATS authorities responsible for the provision of air traffic services in neighbouring airspace when:

1) traffic will pass from one into the other of the neighbouring airspaces;

2) routes are closer to the common boundary of the neighbouring airspaces than the separation minima applicable in the circumstances.

Note.— The purpose of this provision is to ensure, in the first case, compatibility on both sides of the line of transfer of traffic, and, in the other case, adequate separation between aircraft operating on both sides of the common boundary.

3.4.2 Details of the selected separation minima and of their areas of application shall be notified:

a) to the ATS units concerned; and

b) to pilots and operators through aeronautical information publications, where separation is based on the use by aircraft of specified navigation aids or specified navigation techniques.

3.5 Responsibility for control

3.5.1 Responsibility for control of individual flights

A controlled flight shall be under the control of only one air traffic control unit at any given time.

3.5.2 Responsibility for control within a given block of airspace

Responsibility for the control of all aircraft operating within a given block of airspace shall be vested in a single air traffic control unit. However, control of an aircraft or groups of aircraft may be delegated to other air traffic control units provided that co-ordination between all air traffic control units concerned is assured.

3.6 Transfer of responsibility for control

Note.— Relevant paragraphs of this section are not applicable when two or more parts of the air traffic control service are provided by one unit, since, in such case, no transfer of responsibility is necessary, in respect of the provision of such parts of the service.

3.6.1 Place or time of transfer

The responsibility for the control of an aircraft shall be transferred from one air traffic control unit to another as follows:

3.6.1.1 *Between two units providing area control service.* The responsibility for the control of an aircraft shall be transferred from a unit providing area control service in a control area to the unit providing area control service in an adjacent control area at the time of crossing the common control area boundary as estimated by the area control centre having control of the aircraft or at such other point or time as has been agreed between the two units.

3.6.1.2 *Between a unit providing area control service and a unit providing approach control service.* The responsibility for the control of an aircraft shall be transferred from a unit providing area control service to a unit providing approach control service, and vice versa, at a point or time agreed between the two units.

3.6.1.3 *Between a unit providing approach control service and a unit providing aerodrome control service*

3.6.1.3.1 *Arriving aircraft.* The responsibility for the control of an aircraft approaching to land shall be transferred from the unit providing approach control service to the unit providing aerodrome control service, when the aircraft:

a) is in the vicinity of the aerodrome, and:

   1) it is considered that it will be able to complete its approach and landing in visual reference to the ground, or

   2) it has reached uninterrupted visual meteorological conditions, or

b) has landed;

whichever is the earliest.

Note:— Even though there is an approach control office, control of certain flights may be transferred directly from an area control centre to an aerodrome control tower and vice versa, by prior arrangement between the units concerned for the relevant part of approach control service to be provided by the area control centre or the aerodrome control tower, as applicable.

3.6.1.3.2 *Departing aircraft.* The responsibility for control of a departing aircraft shall be transferred from the unit providing aerodrome control service to the unit providing approach control service:

a) *when visual meteorological conditions prevail in the vicinity of the aerodrome:*

   1) prior to the time the aircraft leaves the vicinity of the aerodrome, or

   2) prior to the aircraft entering instrument meteorological conditions,

whichever is the earlier;

b) *when instrument meteorological conditions prevail at the aerodrome:*

   1) immediately before the aircraft enters the runway in use for take-off, or

   2) immediately after the aircraft is airborne, if local procedures render such action preferable.

Note.— See Note following 3.6.1.3.1.

3.6.2 Co-ordination of transfer

3.6.2.1 Responsibility for control of an aircraft shall not be transferred from one air traffic control unit to another without the consent of the accepting control unit, which shall be obtained in accordance with 3.6.2.2, 3.6.2.2.1, 3.6.2.2.2 and 3.6.2.3.

3.6.2.2 The transferring control unit shall communicate to the accepting control unit the appropriate parts of the current flight plan and any control information pertinent to the transfer requested.

3.6.2.2.1 Where transfer of control is to be effected using radar data, the control information pertinent to the transfer shall include information regarding the position and, if required, the track and speed of the aircraft, as observed by radar immediately prior to the transfer.

3.6.2.2.2 Where transfer of control is to be effected using ADS data, the control information pertinent to the transfer shall include the four-dimensional position and other information as necessary.

3.6.2.3 The accepting control unit shall:

a) indicate its ability to accept control of the aircraft on the terms specified by the transferring control unit, unless by prior agreement between the two units concerned, the absence of any such indication is understood to signify acceptance of the terms specified, or indicate any necessary changes thereto; and

b) specify any other information or clearance for a subsequent portion of the flight, which it requires the aircraft to have at the time of transfer.

3.6.2.4 The accepting control unit shall notify the transferring control unit when it has established two-way voice and/or data link communications with and assumed control of the aircraft concerned, unless otherwise specified by agreement between the two control units concerned.

3.7 Air traffic control clearances

Air traffic control clearances shall be based solely on the requirements for providing air traffic control service.

3.7.1 Contents of clearances

3.7.1.1 An air traffic control clearance shall indicate:

a) aircraft identification as shown in the flight plan;

b) clearance limit;

c) route of flight;

d) level(s) of flight for the entire route or part thereof and changes of levels if required;

Note.— If the clearance for the levels covers only part of the route, it is important for the air traffic control unit to specify a point to which the part of the clearance regarding levels applies whenever necessary to ensure compliance with 3.6.5.2.2 a) of Annex 2.

e) any necessary instructions or information on other matters such as approach or departure manoeuvres, communications and the time of expiry of the clearance.

Note.— The time of expiry of the clearance indicates the time after which the clearance will be automatically cancelled if the flight has not been commenced.

3.7.1.2 **Recommendation.—** *Standard departure and arrival routes and associated procedures should be established when necessary to facilitate:*

a) the safe, orderly and expeditious flow of air traffic;

b) the description of the route and procedure in air traffic control clearances.

Note.— Material relating to the establishment of standard departure and arrival routes and associated procedures is contained in the Air Traffic Services Planning Manual *(Doc 9426). The design criteria are contained in PANS-OPS, Volume II (Doc 8168).*

3.7.2 Clearances for transonic flight

3.7.2.1 The air traffic control clearance relating to the transonic acceleration phase of a supersonic flight shall extend at least to the end of that phase.

3.7.2.2 **Recommendation.—** *The air traffic control clearance relating to the deceleration and descent of an aircraft from supersonic cruise to subsonic flight should provide for uninterrupted descent, at least during the transonic phase.*

3.7.3 Co-ordination of clearances

An air traffic control clearance shall be co-ordinated between air traffic control units to cover the entire route of an aircraft or a specified portion thereof as follows.

3.7.3.1 An aircraft shall be cleared for the entire route to the aerodrome of first intended landing:

a) when it has been possible, prior to departure, to co-ordinate the clearance between all the units under whose control the aircraft will come; or

b) when there is reasonable assurance that prior co-ordination will be effected between those units under whose control the aircraft will subsequently come.

Note.— Where a clearance is issued covering the initial part of the flight solely as a means of expediting departing traffic, the succeeding en-route clearance will be as specified above even though the aerodrome of first intended landing is under the jurisdiction of an area control centre other than the one issuing the en-route clearance.

3.7.3.2 When co-ordination as in 3.7.3.1 has not been achieved or is not anticipated, the aircraft shall be cleared only to that point where co-ordination is reasonably assured; prior to reaching such point, or at such point, the aircraft shall receive further clearance, holding instructions being issued as appropriate.

3.7.3.3 When an aircraft intends to depart from an aerodrome within a control area to enter another control area within a period of thirty minutes, or such other specific period of time as has been agreed between the area control centres concerned, co-ordination with the subsequent area control centre shall be effected prior to issuance of the departure clearance.

3.7.3.4 When an aircraft intends to leave a control area for flight outside controlled airspace, and will subsequently re-enter the same or another control area, a clearance from point of departure to the aerodrome of first intended landing may be issued. Such clearance or revisions thereto shall apply only to those portions of the flight conducted within controlled airspace.

3.7.4 Control of air traffic flow

When it becomes apparent to an air traffic control unit that traffic additional to that already accepted cannot be accommodated within a given period of time at a particular location or in a particular area, or can only be accommodated at a given rate, that unit shall advise other air traffic control units and operators known or believed to be concerned and pilots-in-command of aircraft destined to that location or area that additional flights are likely to be subjected to excessive delay, or, if applicable, that specified restrictions are to be applied to any additional traffic for a specified period of time for the purpose of avoiding excessive delay to aircraft in flight.

3.8 Control of persons and vehicles at aerodromes

3.8.1 The movement of persons or vehicles including towed aircraft on the manoeuvring area of an aerodrome shall be controlled by the aerodrome control tower as necessary to avoid hazard to them or to aircraft landing, taxiing or taking off.

3.8.2 In conditions where low visibility procedures are in operation:

a) persons and vehicles operating on the manoeuvring area of an aerodrome shall be restricted to the essential minimum and particular regard shall be given to the requirements to protect the ILS sensitive area(s) when Category II or Category III precision instrument operations are in progress;

b) subject to the provisions in 3.8.3, the minimum separation between vehicles and taxiing aircraft shall be as prescribed by the appropriate ATS authority taking into account the aids available.

Note.— The period of application of low visibility procedures is determined in accordance with local instructions. Guidance on low visibility operations on an aerodrome is contained in the Manual of Surface Movement Guidance and Control Systems (SMGCS) *(Doc 9476).*

3.8.3 Emergency vehicles proceeding to the assistance of an aircraft in distress shall be afforded priority over all other surface movement traffic.

3.8.4 Subject to the provisions in 3.8.3, vehicles on the manoeuvring area shall be required to comply with the following rules:

a) vehicles and vehicles towing aircraft shall give way to aircraft which are landing, taking off or taxiing;

b) vehicles shall give way to other vehicles towing aircraft;

c) vehicles shall give way to other vehicles in accordance with local instructions;

d) notwithstanding the provisions of a), b) and c), vehicles and vehicles towing aircraft shall comply with instructions issued by the aerodrome control tower.

3.9 Use of surface movement radar (SMR)

Note.— Surface movement radar (SMR) has proven to be useful in assisting with the monitoring of aircraft and vehicles on the manoeuvring area. See Annex 14, Volume I, Chapter 8 for the requirements concerning the provision of SMR and the Air Traffic Services Planning Manual *(Doc 9426) for guidance on the use of SMR.*

CHAPTER 4. FLIGHT INFORMATION SERVICE

4.1 Application

4.1.1 Flight information service shall be provided to all aircraft which are likely to be affected by the information and which are:

a) provided with air traffic control service; or

b) otherwise known to the relevant air traffic services units.

Note.— Flight information service does not relieve the pilot-in-command of an aircraft of any responsibilities and the pilot-in-command has to make the final decision regarding any suggested alteration of flight plan.

4.1.2 Where air traffic services units provide both flight information service and air traffic control service, the provision of air traffic control service shall have precedence over the provision of flight information service whenever the provision of air traffic control service so requires.

Note.— It is recognized that in certain circumstances aircraft on final approach, landing, take-off and climb may require to receive without delay essential information other than that pertaining to the provision of air traffic control service.

4.2 Scope of flight information service

4.2.1 Flight information service shall include the provision of pertinent:

a) SIGMET information;

b) information concerning pre-eruption volcanic activity, volcanic eruptions and volcanic ash clouds;

c) information concerning the release into the atmosphere of radioactive materials or toxic chemicals;

d) information on changes in the serviceability of navigation aids;

e) information on changes in condition of aerodromes and associated facilities, including information on the state of the aerodrome movement areas when they are affected by snow, ice or significant depth of water;

f) information on unmanned free balloons;

and of any other information likely to affect safety.

4.2.2 Flight information service provided to flights shall include, in addition to that outlined in 4.2.1, the provision of information concerning:

a) weather conditions reported or forecast at departure, destination and alternate aerodromes;

b) collision hazards, to aircraft operating in airspace Classes C, D, E, F and G;

c) for flight over water areas, in so far as practicable and when requested by a pilot, any available information such as radio call sign, position, true track, speed, etc., of surface vessels in the area.

Note 1.— The information in b), including only known aircraft the presence of which might constitute a collision hazard to the aircraft informed, will sometimes be incomplete and air traffic services cannot assume responsibility for its issuance at all times or for its accuracy.

Note 2.— When there is a need to supplement collision hazard information provided in compliance with b), or in case of temporary disruption of flight information service, traffic information broadcasts by aircraft may be applied in designated airspaces. Guidance on traffic information broadcasts by aircraft and related operating procedures is contained in Attachment C.

4.2.3 **Recommendation.—** *ATS units should transmit, as soon as practicable, special air-reports to other aircraft concerned, to the associated meteorological office, and to other ATS units concerned. Transmissions to aircraft should be continued for a period to be determined by agreement between the meteorological and air traffic services authorities concerned.*

4.2.4 Flight information service provided to VFR flights shall include, in addition to that outlined in 4.2.1, the provision of available information concerning traffic and weather conditions along the route of flight that are likely to make operation under the visual flight rules impracticable.

4.3 Operational flight information service broadcasts

4.3.1 Application

4.3.1.1 The meteorological information and operational information concerning navigation aids and aerodromes included in the flight information service shall, whenever available, be provided in an operationally integrated form.

4.3.1.2 **Recommendation.—** *Where integrated operational flight information messages are to be transmitted to aircraft, they should be transmitted with the content and, where specified, in the sequence indicated, for the various phases of flight.*

4.3.1.3 **Recommendation.—** *Operational flight information service broadcasts, when provided, should consist of messages containing integrated information regarding selected operational and meteorological elements appropriate to the various phases of flight. These broadcasts should be of three major types, i.e. HF, VHF and ATIS.*

4.3.2 HF operational flight information service (OFIS) broadcasts

4.3.2.1 **Recommendation.—** *HF operational flight information service (OFIS) broadcasts should be provided when it has been determined by regional air navigation agreement that a requirement exists.*

4.3.2.2 **Recommendation.—** *Whenever such broadcasts are provided:*

a) the information should be in accordance with 4.3.2.5, as applicable, subject to regional air navigation agreement;

b) the aerodromes for which reports and forecasts are to be included should be as determined by regional air navigation agreement;

c) the time-sequencing of stations participating in the broadcast should be as determined by regional air navigation agreement;

d) the broadcast message should not exceed the length of time allocated for it by regional air navigation agreement, care being taken that the readability is not impaired by the speed of the transmission;

e) each aeordrome message should be identified by the name of the aerodrome to which the information applies;

f) when information has not been received in time for a broadcast, the latest available information should be included together with the time of that observation;

g) the full broadcast message should be repeated if this is feasible within the remainder of the time allotted to the broadcasting station;

h) the broadcast information should be updated immediately a significant change occurs; and

i) the HF OFIS message should be prepared and disseminated by the most appropriate unit(s) as designated by each State.

4.3.2.3 **Recommendation.—** *Pending the development and adoption of a more suitable form of speech for universal use in aeronautical radiotelephony communications, HF OFIS broadcasts concerning aerodromes designated for use by international air services should be available in the English language.*

4.3.2.4 **Recommendation.—** *Where HF OFIS broadcasts are available in more than one language, a discrete channel should be used for each language.*

4.3.2.5 **Recommendation.—** *HF operational flight information service broadcast messages should contain the following information in the sequence indicated or as determined by regional air navigation agreement:*

a) En-route weather information

Information on significant en-route weather phenomena should be in the form of available SIGMET as prescribed in Annex 3.

b) Aerodrome information including:

1) name of aerodrome;

2) time of observation;

3) essential operational information;

4) surface wind direction and speed; if appropriate, maximum wind speed;

5) visibility and, when applicable, runway visual range (RVR);

6) present weather;

7) cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater; cumulonimbus; if the sky is obscured, vertical visibility when available; and

8) aerodrome forecast.

4.3.3 VHF operational flight information service (OFIS) broadcasts

4.3.3.1 **Recommendation.—** *VHF operational flight information service broadcasts should be provided as determined by regional air navigation agreement.*

4.3.3.2 **Recommendation.—** *Whenever such broadcasts are provided:*

a) the aerodromes for which reports and forecasts are to be included should be as determined by regional air navigation agreement;

b) each aerodrome message should be identified by the name of the aerodrome to which the information applies;

c) when information has not been received in time for a broadcast, the latest available information should be included together with the time of that observation;

d) the broadcasts should be continuous and repetitive;

e) the broadcast message should, whenever practicable, not exceed five minutes, care being taken that the readability is not impaired by the speed of the transmission;

f) the broadcast message should be updated on a scheduled basis as determined by regional air navigation agreement. In addition it should be expeditiously updated immediately a significant change occurs; and

g) the VHF OFIS message should be prepared and disseminated by the most appropriate unit(s) as designated by each State.

4.3.3.3 **Recommendation.—** *Pending the development and adoption of a more suitable form of speech for universal use in aeronautical radiotelephony communications, VHF OFIS broadcasts concerning aerodromes designated for use by international air services should be available in the English language.*

4.3.3.4 **Recommendation.—** *Where VHF OFIS broadcasts are available in more than one language, a discrete channel should be used for each language.*

4.3.3.5 **Recommendation.—** *VHF operational flight information service broadcast messages should contain the following information in the sequence indicated:*

a) name of aerodrome;

b) time of observation;

c) landing runway;

d) significant runway surface conditions and, if appropriate, braking action;

e) changes in the operational state of the navigation aids, if appropriate;

f) holding delay, if appropriate;

g) surface wind direction and speed; if appropriate, maximum wind speed;

h) visibility and, when applicable, runway visual range (RVR);

i) present weather;

j) cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater; cumulonimbus; if the sky is obscured, vertical visibility, when available;

**k) air temperature;*

**l) dew point temperature;*

**m) QNH altimeter setting;*

n) trend-type landing forecast, when available; and

o) notice of current SIGMET messages.

4.3.4 Automatic terminal information service (ATIS)

4.3.4.1 Automatic terminal information service (ATIS) broadcasts shall be provided at aerodromes where there is a requirement to reduce the communication load on the ATS VHF air-ground communication channels. When provided, they shall comprise:

a) one broadcast serving arriving aircraft; or

b) one broadcast serving departing aircraft; or

c) one broadcast serving both arriving and departing aircraft; or

d) two broadcasts serving arriving and departing aircraft respectively at those aerodromes where the length of a broadcast serving both arriving and departing aircraft would be excessively long.

4.3.4.2 A discrete VHF frequency shall, whenever practicable, be used for ATIS broadcasts. If a discrete frequency is not available, the transmission may be made on the voice channel(s) of the most appropriate terminal navigation aid(s), preferably a VOR, provided the range and readability are adequate and the identification of the navigation aid is sequenced with the broadcast so that the latter is not obliterated.

4.3.4.3 ATIS broadcast shall not be transmitted on the voice channel of an ILS.

* *As determined on the basis of regional air navigation agreement.*

4.3.4.4 Whenever ATIS is provided:

a) the broadcast information shall relate to a single aerodrome;

b) the broadcast shall be continuous and repetitive;

c) the broadcast information shall be updated immediately a significant change occurs;

d) the preparation and dissemination of the ATIS message shall be the responsibility of the air traffic services;

e) the information contained in the current broadcast shall immediately be made known to the ATS unit(s) concerned with the provision to aircraft of information relating to approach, landing and take-off, whenever the message has not been prepared by that (those) unit(s);

f) individual ATIS messages shall be identified by a designator in the form of a letter of the ICAO spelling alphabet. Designators assigned to consecutive ATIS messages shall be in alphabetical order;

g) aircraft shall acknowledge receipt of the broadcast information upon establishing communication with the ATS unit providing approach control service or aerodrome control service, as appropriate; and

h) the appropriate ATS unit shall, when replying to the message in g) above or, in the case of arriving aircraft, at such other time as may be prescribed by the appropriate ATS authority, provide the aircraft with the current altimeter setting.

4.3.4.5 **Recommendation.—** *Pending the development and adoption of a more suitable form of speech for universal use in aeronautical radiotelephony communications, ATIS broadcasts provided at aerodromes designated for use by international air services should be available in the English language.*

4.3.4.6 **Recommendation.—** *Where ATIS broadcasts are available in more than one language, a discrete channel should be used for each language.*

4.3.4.7 When rapidly changing meteorological conditions make it inadvisable to include a weather report in the ATIS broadcast, the ATIS messages in 4.3.4.1 above shall indicate that the relevant weather information will be given on initial contact with the appropriate ATS unit.

4.3.4.8 Information contained in a current ATIS broadcast, the receipt of which has been acknowledged by the aircraft concerned, need not be included in a directed transmission to the aircraft, with the exception of the altimeter setting, which shall be provided in accordance with 4.3.4.4 h).

4.3.4.9 If an aircraft acknowledges receipt of an ATIS broadcast that is no longer current, any element of information that needs updating shall be transmitted to the aircraft without delay.

4.3.4.10 *ATIS broadcast messages*

4.3.4.10.1 **Recommendation.—** *The ATIS broadcast message should, whenever practicable, not exceed 30 seconds, care being taken that the readability of the ATIS message is not impaired by the speed of the transmission or by the identification signal of a navigation aid used for transmission of ATIS.*

4.3.4.10.2 **Recommendation.—** *Contents of ATIS broadcasts should be kept as brief as possible. Information additional to that specified in 4.3.5 to 4.3.7, for example information already available in aeronautical information publications (AIPs) and NOTAMs, should only be included when justified in exceptional circumstances.*

4.3.5 ATIS broadcasts for arriving and departing aircraft

ATIS broadcast messages containing both arrival and departure information shall contain the following elements of information in the order listed:

a) name of aerodrome;

b) designator;

c) time of observation, if appropriate;

d) type of approach to be expected;

e) the runway(s) in use; status of arresting system constituting a potential hazard, if any;

f) significant runway surface conditions and, if appropriate, braking action;

g) holding delay, if appropriate;

h) transition level, if applicable;

i) other essential operational information;

j) surface wind direction and speed, including significant variations;

k) visibility and, when applicable, runway visual range (RVR);

l) present weather;

m) cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater; cumulonimbus; if the sky is obscured, vertical visibility when available;

n) air temperature;

*o) dew point temperature;

p) altimeter setting(s);

q) any available information on significant meteorological phenomena in the approach, take-off and climb-out areas;

r) trend-type landing forecast, when available; and

s) specific ATIS instructions.

4.3.6 ATIS broadcasts for arriving aircraft

ATIS broadcast messages containing arrival information only shall contain the following elements of information in the order listed:

a) name of aerodrome;

b) designator;

c) time of observation, if appropriate;

d) type of approach to be expected;

e) main landing runway; status of arresting system constituting a potential hazard, if any;

f) significant runway surface conditions and, if appropriate, braking action;

g) holding delay, if appropriate;

h) transition level, if applicable;

i) other essential operational information;

j) surface wind direction and speed, including significant variations;

k) visibility and, when applicable, runway visual range (RVR);

l) present weather;

m) cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater; cumulonimbus; if the sky is obscured, vertical visibility when available;

n) air temperature;

*o) dew point temperature;

p) altimeter setting(s);

q) any available information on significant meteorological phenomena in the approach area;

r) trend-type landing forecast, when available; and

s) specific ATIS instructions.

4.3.7 ATIS broadcasts for departing aircraft

ATIS broadcast messages containing departure information only shall contain the following elements of information in the order listed:

a) name of aerodrome;

b) designator;

c) time of observation, if appropriate;

d) runway(s) to be used for take-off; status of arresting system constituting a potential hazard, if any;

e) significant surface conditions of runway(s) to be used for take-off and, if appropriate, braking action;

f) other essential operational information;

g) surface wind direction and speed, including significant variations;

h) visibility and, when applicable, runway visual range (RVR);

i) cloud below 1 500 m (5 000 ft) or below the highest minimum sector altitude, whichever is greater; cumulonimbus; if the sky is obscured, vertical visibility when available;

j) air temperature representative of the runway(s);

k) altimeter setting(s);

l) any available information on significant meteorological phenomena in the take-off and climb-out areas; and

m) specific ATIS instructions.

4.3.8 Use of the OFIS messages in directed request/reply transmissions

When requested by the pilot the applicable OFIS message(s) shall be transmitted by the appropriate ATS unit.

* As determined on the basis of regional air navigation agreement.

10/11/94

CHAPTER 5. ALERTING SERVICE

5.1 Application

5.1.1 Alerting service shall be provided:

a) for all aircraft provided with air traffic control service;

b) in so far as practicable, to all other aircraft having filed a flight plan or otherwise known to the air traffic services; and

c) to any aircraft known or believed to be the subject of unlawful interference.

5.1.2 Flight information centres or area control centres shall serve as the central point for collecting all information relevant to a state of emergency of an aircraft operating within the flight information region or control area concerned and for forwarding such information to the appropriate rescue co-ordination centre.

5.1.3 In the event of a state of emergency arising to an aircraft while it is under the control of an aerodrome control tower or approach control office, such unit shall notify immediately the flight information centre or area control centre responsible which shall in turn notify the rescue co-ordination centre, except that notification of the area control centre, flight information centre, or rescue co-ordination centre shall not be required when the nature of the emergency is such that the notification would be superfluous.

5.1.3.1 Nevertheless, whenever the urgency of the situation so requires, the aerodrome control tower or approach control office responsible shall first alert and take other necessary steps to set in motion all appropriate local rescue and emergency organizations which can give the immediate assistance required.

5.2 Notification of rescue co-ordination centres

5.2.1 Without prejudice to any other circumstances that may render such notification advisable, air traffic services units shall, except as prescribed in 5.5.1, notify rescue co-ordination centres immediately an aircraft is considered to be in a state of emergency in accordance with the following:

a) *Uncertainty phase* when:

1) no communication has been received from an aircraft within a period of thirty minutes after the time a communication should have been received, or from the time an unsuccessful attempt to establish communication with such aircraft was first made, whichever is the earlier, or when

2) an aircraft fails to arrive within thirty minutes of the estimated time of arrival last notified to or estimated by air traffic services units, whichever is the later,

except when no doubt exists as to the safety of the aircraft and its occupants.

b) *Alert phase* when:

1) following the uncertainty phase, subsequent attempts to establish communication with the aircraft or inquiries to other relevant sources have failed to reveal any news of the aircraft, or when

2) an aircraft has been cleared to land and fails to land within five minutes of the estimated time of landing and communication has not been re-established with the aircraft, or when

3) information has been received which indicates that the operating efficiency of the aircraft has been impaired, but not to the extent that a forced landing is likely,

except when evidence exists that would allay apprehension as to the safety of the aircraft and its occupants, or when

4) an aircraft is known or believed to be the subject of unlawful interference.

c) *Distress phase* when:

1) following the alert phase further unsuccessful attempts to establish communication with the aircraft and more widespread unsuccessful inquiries point to the probability that the aircraft is in distress, or when

2) the fuel on board is considered to be exhausted, or to be insufficient to enable the aircraft to reach safety, or when

3) information is received which indicates that the operating efficiency of the aircraft has been impaired to the extent that a forced landing is likely, or when

4) information is received or it is reasonably certain that the aircraft is about to make or has made a forced landing,

except when there is reasonable certainty that the aircraft and its occupants are not threatened by grave and imminent danger and do not require immediate assistance.

5.2.2 The notification shall contain such of the following information as is available in the order listed:

a) INCERFA, ALERFA or DETRESFA, as appropriate to the phase of the emergency;

b) agency and person calling;

c) nature of the emergency;

d) significant information from the flight plan;

e) unit which made last contact, time and frequency used;

f) last position report and how determined;

g) colour and distinctive marks of aircraft;

h) any action taken by reporting office;

i) other pertinent remarks.

5.2.2.1 **Recommendation.**— *Such part of the information specified in 5.2.2, which is not available at the time notification is made to a rescue co-ordination centre, should be sought by an air traffic services unit prior to the declaration of a distress phase, if there is reasonable certainty that this phase will eventuate.*

5.2.3 Further to the notification in 5.2.1, the rescue co-ordination centre shall, without delay, be furnished with:

a) any useful additional information, especially on the development of the state of emergency through subsequent phases; or

b) information that the emergency situation no longer exists.

Note.— The cancellation of action initiated by the rescue co-ordination centre is the responsibility of that centre.

5.3 Use of communication facilities

Air traffic services units shall, as necessary, use all available communication facilities to endeavour to establish and maintain communication with an aircraft in a state of emergency, and to request news of the aircraft.

5.4 Plotting aircraft in a state of emergency

When a state of emergency is considered to exist, the flight of the aircraft involved shall be plotted on a chart in order to determine the probable future position of the aircraft and its maximum range of action from its last known position. The flights of other aircraft known to be operating in the vicinity of the aircraft involved shall also be plotted in order to determine their probable future positions and maximum endurance.

5.5 Information to the operator

5.5.1 When an area control or a flight information centre decides that an aircraft is in the uncertainty or the alert phase, it shall, when practicable, advise the operator prior to notifying the rescue co-ordination centre.

Note.— If an aircraft is in the distress phase, the rescue co-ordination centre has to be notified immediately in accordance with 5.2.1.

5.5.2 All information notified to the rescue co-ordination centre by an area control or flight information centre shall, whenever practicable, also be communicated, without delay, to the operator.

5.6 Information to aircraft operating in the vicinity of an aircraft in a state of emergency

5.6.1 When it has been established by an air traffic services unit that an aircraft is in a state of emergency, other aircraft known to be in the vicinity of the aircraft involved shall, except as provided in 5.6.2, be informed of the nature of the emergency as soon as practicable.

5.6.2 When an air traffic services unit knows or believes that an aircraft is being subjected to unlawful interference, no reference shall be made in ATS air-ground communications to the nature of the emergency unless it has first been referred to in communications from the aircraft involved and it is certain that such reference will not aggravate the situation.

CHAPTER 6. AIR TRAFFIC SERVICES REQUIREMENTS FOR COMMUNICATIONS

6.1 Aeronautical mobile service (air-ground communications)

6.1.1 General

6.1.1.1 Radiotelephony and/or digital data interchange techniques shall be used in air-ground communications for air traffic services purposes.

Note.— Requirements for ATS units to be provided with and to maintain guard on the emergency channel 121.5 MHz are specified in Annex 10, Volume I, Part II.

6.1.1.2 When direct pilot-controller two-way radiotelephony or digital data interchange is used for the provision of air traffic control service, recording facilities shall be provided on all such air-ground communication channels.

6.1.2 For flight information service

6.1.2.1 Air-ground communication facilities shall enable two-way communications to take place between a unit providing flight information service and appropriately equipped aircraft flying anywhere within the flight information region.

6.1.2.2 **Recommendation.—** *Whenever practicable, air-ground communication facilities for flight information service should permit direct, rapid, continuous and static-free two-way communications.*

6.1.3 For area control service

6.1.3.1 Air-ground communication facilities shall enable two-way communications to take place between a unit providing area control service and appropriately equipped aircraft flying anywhere within the control area(s).

6.1.3.2 **Recommendation.—** *Whenever practicable, air-ground communication facilities for area control service should permit direct, rapid, continuous and static-free two-way communications.*

6.1.3.3 **Recommendation.—** *Where high frequency or general purpose extended range very high frequency air-ground communication channels are used for area control service and are worked by air-ground communicators, suitable arrangements should be made to permit direct pilot-controller communications, as and when required.*

6.1.4 For approach control service

6.1.4.1 Air-ground communication facilities shall enable direct, rapid, continuous and static-free two-way communications to take place between the unit providing approach control service and appropriately equipped aircraft under its control.

6.1.4.2 Where the unit providing approach control service functions as a separate unit, air-ground communications shall be conducted over communication channels provided for its exclusive use.

6.1.5 For aerodrome control service

6.1.5.1 Air-ground communication facilities shall enable direct, rapid, continuous and static-free two-way communications to take place between an aerodrome control tower and appropriately equipped aircraft operating at any distance within 45 km (25 NM) of the aerodrome concerned.

6.1.5.2 **Recommendation.—** *Where conditions warrant, separate communication channels should be provided for the control of traffic operating on the manoeuvring area.*

6.2 Aeronautical fixed service (ground-ground communications)

6.2.1 General

6.2.1.1 Direct-speech communications and/or digital data interchange techniques shall be used in ground-ground communications for air traffic services purposes.

Note.— Indication by time of the speed with which the communication should be established is provided as a guide to communication services, particularly to determine the types of communication channels required, e.g. that "instantaneous" is intended to refer to communications which effectively provide for immediate access between controllers; "fifteen seconds" to accept switchboard operation and "five minutes" to mean methods involving retransmission.

6.2.2 Communications within a flight information region

6.2.2.1 *Communications between air traffic services units*

6.2.2.1.1 A flight information centre shall have facilities for communications with the following units providing a service within its area of responsibility:

a) the area control centre, unless collocated;

b) approach control offices;

c) aerodrome control towers.

6.2.2.1.2 An area control centre, in addition to being connected to the flight information centre as prescribed in 6.2.2.1.1, shall have facilities for communications with the following units providing a service within its area of responsibility:

a) approach control offices;

b) aerodrome control towers;

c) air traffic services reporting offices, when separately established.

6.2.2.1.3 An approach control office, in addition to being connected to the flight information centre and the area control centre as prescribed in 6.2.2.1.1 and 6.2.2.1.2, shall have facilities for communications with the associated aerodrome control tower(s) and, when separately established, the associated air traffic services reporting office(s).

6.2.2.1.4 An aerodrome control tower, in addition to being connected to the flight information centre, the area control centre and the approach control office as prescribed in 6.2.2.1.1, 6.2.2.1.2 and 6.2.2.1.3, shall have facilities for communications with the associated air traffic services reporting office, when separately established.

6.2.2.2 *Communications between air traffic services units and other units*

6.2.2.2.1 A flight information centre and an area control centre shall have facilities for communications with the following units providing a service within their respective area of responsibility:

a) appropriate military units;

b) the meteorological office serving the centre;

c) the aeronautical telecommunications station serving the centre;

d) appropriate operator's offices;

e) the rescue co-ordination centre or, in the absence of such centre, any other appropriate emergency service;

f) the international NOTAM office serving the centre.

6.2.2.2.2 An approach control office and an aerodrome control tower shall have facilities for communications with the following units providing a service within their respective area of responsibility:

a) appropriate military units;

b) rescue and emergency services (including ambulance, fire, etc.);

c) the meteorological office serving the unit concerned;

d) the aeronautical telecommunications station serving the unit concerned;

e) the unit providing apron management service, when separately established.

6.2.2.2.3 The communication facilities required under 6.2.2.2.1 a) and 6.2.2.2.2 a) shall include provisions for rapid and reliable communications between the air traffic services unit concerned and the military unit(s) responsible for control of interception operations within the area of responsibility of the air traffic services unit.

6.2.2.3 *Description of communication facilities*

6.2.2.3.1 The communication facilities required under 6.2.2.1, 6.2.2.2.1 a) and 6.2.2.2.2 a), b) and c) shall include provisions for:

a) communications by direct speech, whereby for the purpose of transfer of radar control the communications can be established instantaneously and for other purposes the communications can normally be established within fifteen seconds; and

b) printed communications, when a written record is required; the message transit time for such communications being no longer than five minutes.

6.2.2.3.2 **Recommendation.—** *In all cases not covered by 6.2.2.3.1, the communication facilities should include provisions for:*

a) communications by direct speech, whereby the communications can normally be established within fifteen seconds; and

b) printed communications, when a written record is required; the message transit time for such communications being no longer than five minutes.

6.2.2.3.3 **Recommendation.—** *In all cases where automatic transfer of data to and/or from air traffic services computers is required, suitable facilities for automatic recording should be provided.*

6.2.2.3.4 **Recommendation.—** *The communication facilities required in accordance with 6.2.2.1 and 6.2.2.2 should be supplemented, as and where necessary, by facilities for other forms of visual or audio communications, for example, closed circuit television or separate information processing systems.*

6.2.2.3.5 The communication facilities required under 6.2.2.2.2 a), b) and c) shall include provisions for communications by direct speech arranged for conference communications.

6.2.2.3.6 **Recommendation.—** *The communication facilities required under 6.2.2.2.2 d) should include provisions for communications by direct speech arranged for conference communications, whereby the communications can normally be established within fifteen seconds.*

6.2.2.3.7 All facilities for direct-speech communications between air traffic services units and between air traffic services units and appropriate military units shall be provided with automatic recording.

6.2.2.3.8 **Recommendation.—** *All facilities for direct-speech communications required under 6.2.2.2.1 and 6.2.2.2.2 and not otherwise covered by 6.2.2.3.7 should be provided with automatic recording.*

6.2.3 Communications between flight information regions

6.2.3.1 Flight information centres and area control centres shall have facilities for communications with all adjacent flight information centres and area control centres.

6.2.3.1.1 These communication facilities shall in all cases include provisions for messages in a form suitable for retention as a permanent record, and delivery in accordance with transit times specified by regional air navigation agreements.

6.2.3.1.2 Unless otherwise prescribed on the basis of regional air navigation agreements, facilities for communications between area control centres serving contiguous control areas shall, in addition, include provisions for direct-speech communications with automatic recording, whereby for the purpose of transfer of control using radar or ADS data, the communications can be established instantaneously and for other purposes the communications can normally be established within fifteen seconds.

6.2.3.1.3 When so required by agreement between the States concerned in order to eliminate or reduce the need for interceptions in the event of deviations from assigned track, facilities for communications between adjacent flight information centres or area control centres other than those mentioned in 6.2.3.1.2 shall include provisions for direct-speech communications. The communication facilities shall be provided with automatic recording.

6.2.3.1.4 **Recommendation.—** *The communication facilities in 6.2.3.1.3 should permit communications to be established normally within fifteen seconds.*

6.2.3.2 **Recommendation.—** *Adjacent ATS units should be connected in all cases where special circumstances exist.*

Note.— Special circumstances may be due to traffic density, types of aircraft operations and/or the manner in which the airspace is organized and may exist even if the control areas and/or control zones are not contiguous or have not (yet) been established.

6.2.3.3 **Recommendation.—** *Wherever local conditions are such that it is necessary to clear aircraft into an adjacent control area prior to departure, an approach control office and/or aerodrome control tower should be connected with the area control centre serving the adjacent area.*

6.2.3.4 **Recommendation.—** *The communication facilities in 6.2.3.2 and 6.2.3.3 should include provisions for communications by direct speech with automatic recording, whereby for the purpose of transfer of control using radar or ADS data, the communications can be established instantaneously and for other purposes the communications can normally be established within fifteen seconds.*

6.2.3.5 **Recommendation.—** *In all cases where automatic exchange of data between air traffic services computers is required, suitable facilities for automatic recording should be provided.*

6.2.4 Procedures for direct-speech communications

Recommendation.— *Appropriate procedures for direct-speech communications should be developed to permit immediate connexions to be made for very urgent calls concerning the safety of aircraft, and the interruption, if necessary, of less urgent calls in progress at the time.*

6.3 Surface movement control service

6.3.1 Communications for the control of vehicles other than aircraft on manoeuvring areas at controlled aerodromes

6.3.1.1 Two-way radiotelephony communication facilities shall be provided for aerodrome control service for the control of vehicles on the manoeuvring area, except where communication by a system of visual signals is deemed to be adequate.

6.3.1.2 **Recommendation.—** *Where conditions warrant, separate communication channels should be provided for the control of vehicles on the manoeuvring area. Automatic recording facilities should be provided on all such channels.*

6.4 Aeronautical radio navigation service

6.4.1 Automatic recording of surveillance data

6.4.1.1 **Recommendation.—** *Surveillance data from primary and secondary radar equipment or obtained through ADS, used as an aid to air traffic services, should be automatically recorded for use in accident and incident investigations, search and rescue, air traffic control and surveillance systems evaluation and training.*

6.4.1.2 **Recommendation.—** *Automatic recordings should be retained for a period of at least fourteen days. When the recordings are pertinent to accident and incident investigations, they should be retained for longer periods until it is evident that they will no longer be required.*

CHAPTER 7. AIR TRAFFIC SERVICES REQUIREMENTS FOR INFORMATION

7.1 Meteorological information

7.1.1 General

7.1.1.1 Air traffic services units shall be supplied with up-to-date information on existing and forecast meteorological conditions as necessary for the performance of their respective functions. The information shall be supplied in such a form as to require a minimum of interpretation on the part of air traffic services personnel and with a frequency which satisfies the requirements of the air traffic services units concerned.

7.1.1.2 **Recommendation.—** *Meteorological offices should be so situated as to facilitate personal consultation between meteorological personnel and personnel of units providing air traffic services. Where collocation is not practicable, the required consultation should be achieved by other means.*

7.1.1.3 **Recommendation.—** *Air traffic services units should be supplied with available detailed information on the location, vertical extent, direction and rate of movement of meteorological phenomena in the vicinity of the aerodrome, and particularly in the climb-out and approach areas, which could be hazardous to aircraft operations.*

Note.— The meteorological phenomena are listed in Annex 3, Chapter 4, 4.12.1.

7.1.1.4 **Recommendation.—** *When computer-processed upper air data are made available to air traffic services units in digital form for use by air traffic services computers, the contents, format and transmission arrangements should be as agreed between the Meteorological Authority and the appropriate ATS Authority.*

7.1.2 Flight information centres and area control centres

7.1.2.1 Flight information centres and area control centres shall be supplied with SIGMET information, special air-reports, current meteorological reports and forecasts, particular emphasis being given to the occurrence or expected occurrence of weather deterioration as soon as this can be determined. These reports and forecasts shall cover the flight information region or control area and such other areas as may be determined on the basis of regional air navigation agreements.

Note.— For the purpose of this provision, certain changes in weather are construed as weather deterioration, although they are not ordinarily considered as such. An increase in temperature may, for example, adversely affect the operation of certain types of aircraft.

7.1.2.2 Flight information centres and area control centres shall be provided, at suitable intervals, with current pressure data for setting altimeters, for locations specified by the flight information centre or area control centre concerned.

7.1.3 Units providing approach control service

7.1.3.1 Units providing approach control service shall be supplied with current meteorological reports and forecasts for the airspace and the aerodromes with which they are concerned. Special reports and amendments to forecasts shall be communicated to the units providing approach control service as soon as they are necessary in accordance with established criteria, without waiting for the next routine report or forecast. Where multiple anemometers are used, the indicators to which they are related shall be clearly marked to identify the runway and section of the runway monitored by each anemometer.

Note.— See Note following 7.1.2.1.

7.1.3.2 Units providing approach control service shall be provided with current pressure data for setting altimeters, for locations specified by the unit providing approach control service.

7.1.3.3 Units providing approach control service for final approach, landing and take-off shall be equipped with surface wind indicator(s). The indicator(s) shall be related to the same location(s) of observation and be fed from the same anemometer(s) as the corresponding indicator(s) in the aerodrome control tower and in the meteorological station, where such a station exists.

7.1.3.4 **Recommendation.—** *Units providing approach control service for final approach, landing and take-off at aerodromes where runway visual range values are measured by instrumental means should be equipped with indicator(s) permitting read-out of the current runway visual range value(s). The indicator(s) should be related to the same location(s) of observation and be fed from the same runway visual range measuring device(s) as the corresponding indicator(s) in the aerodrome control tower and in the meteorological station, where such a station exists.*

7.1.4 Aerodrome control towers

7.1.4.1 Aerodrome control towers shall be supplied with current meteorological reports and forecasts for the aerodrome with which they are concerned. Special reports and amendments to forecasts shall be communicated to the aerodrome control towers as soon as they are necessary in accordance with established criteria, without waiting for the next routine report or forecast.

Note.— See Note following 7.1.2.1.

7.1.4.2 Aerodrome control towers shall be provided with current pressure data for setting altimeters for the aerodrome concerned.

7.1.4.3 Aerodrome control towers shall be equipped with surface wind indicator(s). The indicator(s) shall be related to the same location(s) of observation and be fed from the same anemometer(s) as the corresponding indicator(s) in the meteorological station, where such a station exists. Where multiple anemometers are used, the indicators to which they are related shall be clearly marked to identify the runway and section of the runway monitored by each anemometer.

7.1.4.4 **Recommendation.—** *Aerodrome control towers at aerodromes where runway visual range values are measured by instrumental means should be equipped with indicator(s) permitting read-out of the current runway visual range value(s). The indicator(s) should be related to the same location(s) of observation and be fed from the same runway visual range measuring device(s) as the corresponding indicator(s) in the meteorological station, where such a station exists.*

7.1.5 Communication stations

Where necessary for flight information purposes, current meteorological reports and forecasts shall be supplied to communication stations. A copy of such information shall be forwarded to the flight information centre or the area control centre.

7.2 Information on aerodrome conditions and the operational status of associated facilities

Aerodrome control towers and units providing approach control service shall be kept currently informed of the operationally significant conditions of the movement area, including the existence of temporary hazards, and the operational status of any associated facilities at the aerodrome(s) with which they are concerned.

7.3 Information on the operational status of navigation aids

7.3.1 ATS units shall be kept currently informed of the operational status of non-visual navigation aids, and those visual aids essential for take-off, departure, approach and landing procedures within their area of responsibility and those visual and non-visual aids essential for surface movement.

7.3.2 **Recommendation.—** *Information on the operational status, and any changes thereto, of visual and non-visual aids as referred to in 7.3.1 should be received by the appropriate ATS unit(s) on a timely basis consistent with the use of the aid(s) involved.*

Note.— Guidance material regarding the provision of information to ATS units in respect to visual and non-visual navigation aids is contained in the Air Traffic Services Planning Manual *(Doc 9426). Specifications for monitoring visual aids are contained in Annex 14, and related guidance material is in the* Aerodrome Design Manual *(Doc 9157), Part 5.- Specifications for monitoring non-visual aids are contained in Annex 10, Volume I.*

7.4 Information on unmanned free balloons

Operators of unmanned free balloons shall keep the appropriate air traffic services units informed of details of flights of unmanned free balloons in accordance with the provisions contained in Annex 2.

7.5 Information concerning volcanic activity

ATS units shall be informed, in accordance with local agreement, of pre-eruption volcanic activity, volcanic eruptions and volcanic ash cloud which could affect airspace used by flights within their area of responsibility.

7.6 Information concerning radioactive materials and toxic chemical "clouds"

ATS units shall be informed, in accordance with local agreement, of the release into the atmosphere of radioactive materials or toxic chemicals which could affect airspace used by flights within their area of responsibility.

APPENDIX 1. PRINCIPLES GOVERNING THE IDENTIFICATION OF RNP TYPES AND THE IDENTIFICATION OF ATS ROUTES OTHER THAN STANDARD DEPARTURE AND ARRIVAL ROUTES

(Chapter 2, Sections 2.7 and 2.11 refer)

Note.— See Appendix 3 concerning the identification of standard departure and arrival routes and associated procedures. Guidance material on the establishment of these routes and procedures is contained in the Air Traffic Services Planning Manual *(Doc 9426).*

1. Designators for ATS routes and RNP types

1.1 The purpose of a system of route designators and required navigation performance (RNP) type(s) applicable to specified ATS route segment(s), route(s) or area is to allow both pilots and ATS, taking into account automation requirements:

a) to make unambiguous reference to any ATS route without the need to resort to the use of geographical coordinates or other means in order to describe it;

b) to relate an ATS route to a specific vertical structure of the airspace, as applicable;

c) to indicate a required level of navigation performance accuracy, when operating along an ATS route or within a specified area; and

d) to indicate that a route is used primarily or exclusively by certain types of aircraft.

Note 1.— Prior to the global introduction of RNP, all references in the Appendix to RNP also apply to area navigation (RNAV) routes, where navigation performance accuracy requirements have been specified.

Note 2.— Specifications governing the publication of RNP types are given in Annex 4, Chapter 7, and Annex 15, Appendix 1.

Note 3.— In relation to this appendix and for flight planning purposes, a prescribed RNP type is not considered an integral part of the ATS route designator.

1.2 In order to meet this purpose, the designation system should:

a) permit the identification of any ATS route in a simple and unique manner;

b) avoid redundancy;

c) be usable by both ground and airborne automation systems;

d) permit utmost brevity in operational use; and

e) provide sufficient possibility of extension to cater for any future requirements without the need for fundamental changes.

1.3 Controlled, advisory and uncontrolled ATS routes, with the exception of standard arrival and departure routes, should therefore be identified as specified hereafter.

2. Composition of designator

2.1 The ATS route designator should consist of a basic designator supplemented, if necessary by:

a) one prefix as prescribed in 2.3; and

b) one additional letter as prescribed in 2.4.

2.1.1 The number of characters required to compose the designator should, whenever possible, be kept to a maximum of five and should, in no case, exceed six characters.

2.2 The basic designator should consist of one letter of the alphabet followed by a number from 1 to 999.

2.2.1 Selection of the letter should be made from those listed hereunder:

a) A, B, G, R for routes which form part of the regional networks of ATS routes and are not area navigation routes;

b) L, M, N, P for area navigation routes which form part of the regional networks of ATS routes;

c) H, J, V, W for routes which do not form part of the regional networks of ATS routes and are not area navigation routes;

d) Q, T, Y, Z for area navigation routes which do not form part of the regional networks of ATS routes.

2.3 Where applicable, one supplementary letter should be added as a prefix to the basic designator in accordance with the following:

a) K to indicate a low level route established for use primarily by helicopters;

b) U to indicate that the route or portion thereof is established in the upper airspace;

c) S to indicate a route established exclusively for use by supersonic aircraft during acceleration, deceleration and while in supersonic flight.

2.4 When prescribed by the appropriate ATS authority or on the basis of regional air navigation agreement, a supplementary letter may be added after the basic designator of the ATS route in question in order to indicate the type of service provided or the turn performance required on the route in question in accordance with the following:

a) for RNP 1 routes at and above FL 200, the letter Y to indicate that all turns on the route between 30 and 90 degrees shall be made within the allowable RNP tolerance of a tangential arc between the straight leg segments defined with a radius of 22.5 NM (e.g. A123Y[1]);

b) for RNP 1 routes at and below FL 190, the letter Z to indicate that all turns on the route between 30 and 90 degrees shall be made within the allowable RNP tolerance of a tangential arc between the straight leg segments defined with a radius of 15 NM (e.g. G246Z[1]);

c) the letter D to indicate that on the route or portion thereof advisory service only is provided;

d) the letter F to indicate that on the route or portion thereof flight information service only is provided.

Note 1.— Due to limitations in the display equipment on board aircraft, the supplementary letters "D", "F", "Y" or "Z" may not be displayed to the pilot.

Note 2.— Implementation of a route or a portion thereof as controlled route, advisory route or flight information route is indicated in aeronautical charts and aeronautical information publications in accordance with the provisions in Annexes 4 and 15.

Note 3.— The conditions under which States may specify the controlled turn performance referred to in subparagraphs a) and b) above, are discussed in the Manual on Required Navigation Performance (RNP) *(Doc 9613).*

3. Assignment of basic designators

3.1 Basic ATS route designators should be assigned in accordance with the following principles.

3.1.1 The same basic designator should be assigned to a main trunk route throughout its entire length, irrespective of terminal control areas, States or regions traversed.

Note.— This is of particular importance where automated ATS data processing and computerized airborne navigation equipment is used.

3.1.2 Where two or more trunk routes have a common segment, the segment in question should be assigned each of the designators of the routes concerned, except where this would present difficulties in the provision of air traffic service, in which case, by common agreement, one designator only should be assigned.

3.1.3 A basic designator assigned to one route should not be assigned to any other route.

3.1.4 States' requirements for designators should be notified to the Regional Offices of ICAO for co-ordination.

4. Use of designators in communications

4.1 In printed communications the designator should be expressed at all times by not less than two and not more than six characters.

4.2 In voice communications, the basic letter of a designator should be spoken in accordance with the ICAO spelling alphabet.

4.3 Where the prefixes K, U or S specified in 2.3 above are used, they should, in voice communications, be spoken as follows:

K — KOPTER
U — UPPER
S — SUPERSONIC

The word "kopter" should be pronounced as in the word "helicopter" and the words "upper" and "supersonic" as in the English language.

4.4 Where the letters "D", "F", "Y" or "Z" specified in 2.4 above are used, the flight crew should not be required to use them in voice communications.

APPENDIX 2. PRINCIPLES GOVERNING THE ESTABLISHMENT AND IDENTIFICATION OF SIGNIFICANT POINTS

(Chapter 2, Section 2.13 refers)

1. Establishment of significant points

1.1 Significant points should, whenever possible, be established with reference to ground-based radio navigation aids, preferably VHF aids.

1.2 Where such ground-based radio navigation aids do not exist, significant points should be established at locations which can be determined by self-contained airborne navigation aids, or, where navigation by visual reference to the ground is to be effected, by visual observation. Specific points may be designated as "transfer of control" points by agreement between adjacent air traffic control units or control positions concerned.

2. Designators for significant points marked by the site of a radio navigation aid

2.1 Plain language name for significant points marked by the site of a radio navigation aid

2.1.1 Whenever practicable, significant points should be named with reference to an identifiable and preferably prominent geographical location.

2.1.2 In selecting a name for the significant point, care should be taken to ensure that the following conditions are met:

a) the name should not create difficulties in pronunciation for pilots or ATS personnel when speaking in the language used in ATS communications. Where the name of a geographical location in the national language selected for designating a significant point gives rise to difficulties in pronunciation, an abbreviated or contracted version of this name, which retains as much of its geographical significance as possible, should be selected;

   Example: FUERSTENFELDBRUCK = FURSTY

b) the name should be easily recognizable in voice communications and should be free of ambiguity with those of other significant points in the same general area. In addition, the name should not create confusion with respect to other communications exchanged between air traffic services and pilots;

c) the name should, if possible, consist of at least six letters and form two syllables and preferably not more than three;

d) the selected name should be the same for both the significant point and the radio navigation aid marking it.

2.2 Composition of coded designators for significant points marked by the site of a radio navigation aid

2.2.1 The coded designator should be the same as the radio identification of the radio navigation aid. It should be so composed, if possible, as to facilitate association with the name of the point in plain language.

2.2.2 Coded designators should not be duplicated within 1 100 km (600 NM) of the location of the radio navigation aid concerned, except as noted hereunder.

Note.— When two radio navigation aids operating in different bands of the frequency spectrum are situated at the same location, their radio identifications are normally the same.

2.3 States' requirements for coded designators should be notified to the Regional Offices of ICAO for co-ordination.

3. Designators for significant points not marked by the site of a radio navigation aid

3.1 Where a significant point is required at a position not marked by the site of a radio navigation aid, the significant point should be designated by a unique five-letter pronounceable "name-code". This name-code designator then serves as the name as well as the coded designator of the significant point.

3.2 This name-code designator should be selected so as to avoid any difficulties in pronunciation by pilots or ATS personnel when speaking in the language used in ATS communications.

Examples: ADOLA, KODAP

3.3 The name-code designator should be easily recognizable in voice communications and should be free of ambiguity with those used for other significant points in the same general area.

3.4 The name-code designator assigned to a significant point should, if possible, not be assigned to any other significant point. If this requirement cannot be met, then a name-code designator should not be repeated within 11 000 km (6 000 NM) of the location of the significant point where it was first used.

3.5 States' requirements for name-code designators should be notified to the Regional Offices of ICAO for co-ordination.

3.6 In areas where no system of fixed routes is established or where the routes followed by aircraft vary depending on operational considerations, significant points should be determined and reported in terms of World Geodetic System — 1984 (WGS-84) geographical coordinates, except that permanently established significant points serving as exit and/or entry points into such areas should be designated in accordance with the applicable provisions in 2 or 3.

4. Use of designators in communications

4.1 Normally the name selected in accordance with 2 or 3 should be used to refer to the significant point in voice communications. If the plain language name for a significant point marked by the site of a radio navigation aid selected in accordance with 2.1 is not used, it should be replaced by the coded designator which, in voice communications, should be spoken in accordance with the ICAO spelling alphabet.

4.2 In printed and coded communications, only the coded designator or the selected name-code should be used to refer to a significant point.

5. Significant points used for reporting purposes

5.1 In order to permit ATS to obtain information regarding the progress of aircraft in flight, selected significant points may need to be designated as reporting points.

5.2 In establishing such points, consideration should be given to the following factors:

a) the type of air traffic services provided;

b) the amount of traffic normally encountered;

c) the accuracy with which aircraft are capable of adhering to the current flight plan;

d) the speed of the aircraft;

e) the separation minima applied;

f) the complexity of the airspace structure;

g) the control method(s) employed;

h) the start or end of significant phases of a flight (climb, descent, change of direction, etc.);

i) transfer of control procedures;

j) safety and search and rescue aspects;

k) the cockpit and air-ground communication workload.

5.3 Reporting points should be established either as "compulsory" or as "on-request".

5.4 In establishing "compulsory" reporting points the following principles should apply:

a) compulsory reporting points should be limited to the minimum necessary for the routine provision of information to air traffic services units on the progress of aircraft in flight, bearing in mind the need to keep cockpit and controller workload and air-ground communications load to a minimum;

b) the availability of a radio navigation aid at a location should not necessarily determine its designation as a compulsory reporting point;

c) compulsory reporting points should not necessarily be established at flight information region or control area boundaries.

5.5 "On-request" reporting points may be established in relation to the requirements of air traffic services for additional position reports when traffic conditions so demand.

5.6 The designation of compulsory and on-request reporting points should be reviewed regularly with a view to keeping the requirements for routine position reporting to the minimum necessary to ensure efficient air traffic services.

5.7 Routine reporting over compulsory reporting points should not systematically be made mandatory for all flights in all circumstances. In applying this principle, particular attention should be given to the following:

a) high-speed, high-flying aircraft should not be required to make routine position reports over all reporting points established as compulsory for low-speed, low-flying aircraft;

b) aircraft transiting through a terminal control area should not be required to make routine position reports as frequently as arriving and departing aircraft.

5.8 In areas where the above principles regarding the establishment of reporting points would not be practicable, a reporting system with reference to meridians of longitude or parallels of latitude expressed in whole degrees may be established.

APPENDIX 3. PRINCIPLES GOVERNING THE IDENTIFICATION OF STANDARD DEPARTURE AND ARRIVAL ROUTES AND ASSOCIATED PROCEDURES

(See Chapter 2, 2.11.3)

Note.— Material relating to the establishment of standard departure and arrival routes and associated procedures is contained in the Air Traffic Services Planning Manual *(Doc 9426).*

1. Designators for standard departure and arrival routes and associated procedures

Note.— In the following text the term "route" is used in the meaning of "route and associated procedures".

1.1 The system of designators should:

a) permit the identification of each route in a simple and unambiguous manner;

b) make a clear distinction between:

— departure routes and arrival routes;

— departure or arrival routes and other ATS routes;

— routes requiring navigation by reference to ground-based radio aids or self-contained airborne aids, and routes requiring navigation by visual reference to the ground;

c) be compatible with ATS and aircraft data processing and display requirements;

d) be of utmost brevity in its operational application;

e) avoid redundancy;

f) provide sufficient possibility for extension to cater for any future requirements without the need for fundamental changes.

1.2 Each route should be identified by a plain language designator and a corresponding coded designator.

1.3 The designators should, in voice communications, be easily recognizable as relating to a standard departure or arrival route, and should not create any difficulties in pronunciation for pilots and ATS personnel.

2. Composition of designators

2.1 Plain language designator

2.1.1 The plain language designator of a standard departure or arrival route should consist of:

a) a basic indicator; followed by

b) a validity indicator; followed by

c) a route indicator, where required; followed by

d) the word "departure" or "arrival"; followed by

e) the word "visual", if the route has been established for use by aircraft operating in accordance with the visual flight rules (VFR).

2.1.2 The basic indicator should be the name or name-code of the significant point where a standard departure route terminates or a standard arrival route begins.

2.1.3 The validity indicator should be a number from 1 to 9.

2.1.4 The route indicator should be one letter of the alphabet. The letters "I" and "O" should not be used.

2.2 Coded designator

The coded designator of a standard departure or arrival route, instrument or visual, should consist of:

a) the coded designator or name-code of the significant point described in 2.1.1 a); followed by

b) the validity indicator in 2.1.1 b); followed by

c) the route indicator in 2.1.1 c), where required.

Note.— Limitations in the display equipment on board aircraft may require shortening of the basic indicator, if that indicator is a five-letter name-code, e.g. KODAP. The manner in which such an indicator is shortened is left to the discretion of operators.

3. Assignment of designators

3.1 Each route should be assigned a separate designator.

3.2 To distinguish between two or more routes which relate to the same significant point (and therefore are assigned the same basic indicator), a separate route indicator as described in 2.1.4 should be assigned to each route.

4. Assignment of validity indicators

4.1 A validity indicator should be assigned to each route to identify the route which is currently in effect.

4.2 The first validity indicator to be assigned should be the number "1".

4.3 Whenever a route is amended, a new validity indicator, consisting of the next higher number, should be assigned. The number "9" should be followed by the number "1".

5. Examples of plain language and coded designators

5.1 *Example 1*: Standard departure route — instrument:

a) Plain language designator: BRECON ONE DEPARTURE

b) Coded designator: BCN 1

5.1.1 *Meaning*: The designator identifies a standard instrument departure route which terminates at the significant point BRECON (basic indicator). BRECON is a radio navigation facility with the identification BCN (basic indicator of the coded designator). The validity indicator ONE (1 in the coded designator) signifies either that the original version of the route is still in effect or that a change has been made from the previous version NINE (9) to the now effective version ONE (1) (see 4.3). The absence of a route indicator (see 2.1.4 and 3.2) signifies that only one route, in this case a departure route, has been established with reference to BRECON.

5.2 *Example 2*: Standard arrival route — instrument:

a) Plain language designator: KODAP TWO ALPHA ARRIVAL

b) Coded designator: KODAP 2 A

5.2.1 *Meaning*: This designator identifies a standard instrument arrival route which begins at the significant point KODAP (basic indicator). KODAP is a significant point not marked by the site of a radio navigation facility and therefore assigned a five-letter name-code in accordance with Annex 11, Appendix 2. The validity indicator TWO (2) signifies that a change has been made from the previous version ONE (1) to the now effective version TWO (2). The route indicator ALPHA (A) identifies one of several routes established with reference to KODAP and is a specific character assigned to this route.

5.3 *Example 3*: Standard departure route — visual:

a) Plain language designator: ADOLA FIVE BRAVO DEPARTURE VISUAL

b) Coded designator: ADOLA 5 B

5.3.1 *Meaning*: This designator identifies a standard departure route for controlled VFR flights which terminates at ADOLA, a significant point not marked by the site of a radio navigation facility. The validity indicator FIVE (5) signifies that a change has been made from the previous version FOUR (4) to the now effective version FIVE (5). The route indicator BRAVO (B) identifies one of several routes established with reference to ADOLA.

6. Use of designators in communications

6.1 In voice communications, only the plain language designator should be used.

Note.— For the purpose of identification of routes, the words "departure", "arrival" and "visual" described in 2.1.1 d) and 2.1.1 e) are considered to be an integral element of the plain language designator.

6.2 In printed or coded communications, only the coded designator should be used.

7. Display of routes and procedures to air traffic control

7.1 A detailed description of each currently effective standard departure and/or arrival route, including the plain language designator and the coded designator, should be displayed at the working positions at which the routes are assigned to aircraft as part of an ATC clearance, or are otherwise of relevance in the provision of air traffic control services.

7.2 Whenever possible, a graphic portrayal of the routes should also be displayed.

APPENDIX 4. ATS AIRSPACE CLASSIFICATIONS

(Chapter 1, Definitions, refers)

Class	Type of flight	Separation provided	Service provided	VMC visibility and distance from cloud minima*	Speed limitation*	Radio communication requirement	Subject to an ATC clearance
A	IFR only	All aircraft	Air traffic control service	Not applicable	Not applicable	Continuous two-way	Yes
B	IFR	All aircraft	Air traffic control service	Not applicable	Not applicable	Continuous two-way	Yes
	VFR	All aircraft	Air traffic control service	8 km at and above 3 050 m (10 000 ft) AMSL 5 km below 3 050 m (10 000 ft) AMSL Clear of clouds	Not applicable	Continuous two-way	Yes
C	IFR	IFR from IFR IFR from VFR	Air traffic control service	Not applicable	Not applicable	Continuous two-way	Yes
	VFR	VFR from IFR	1) Air traffic control service for separation from IFR; 2) VFR/VFR traffic information (and traffic avoidance advice on request)	8 km at and above 3 050 m (10 000 ft) AMSL 5 km below 3 050 m (10 000 ft) AMSL 1 500 m horizontal; 300 m vertical distance from cloud	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
D	IFR	IFR from IFR	Air traffic control service including traffic information about VFR flights (and traffic avoidance advice on request)	Not applicable	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	Traffic information between VFR and IFR flights (and traffic avoidance advice on request)	8 km at and above 3 050 m (10 000 ft) AMSL 5 km below 3 050 m (10 000 ft) AMSL 1 500 m horizontal; 300 m vertical distance from cloud	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
E	IFR	IFR from IFR	Air traffic control service and traffic information about VFR flights as far as practical	Not applicable	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	Traffic information as far as practical	8 km at and above 3 050 m (10 000 ft) AMSL 5 km below 3 050 m (10 000 ft) AMSL 1 500 m horizontal; 300 m vertical distance from cloud	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No
F	IFR	IFR from IFR as far as practical	Air traffic advisory service; flight information service	Not applicable	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	No
	VFR	Nil	Flight information service	8 km at and above 3 050 m (10 000 ft) AMSL 5 km below 3 050 m (10 000 ft) AMSL 1 500 m horizontal; 300 m vertical distance from cloud At and below 900 m AMSL or 300 m above terrain whichever is higher — 5 km **, clear of cloud and in sight of ground or water	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No

Class	Type of flight	Separation provided	Service provided	VMC visibility and distance from cloud minima*	Speed limitation*	Radio communication requirement	Subject to an ATC clearance
G	IFR	Nil	Flight information service	Not applicable	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	No
	VFR	Nil	Flight information service	8 km at and above 3 050 m (10 000 ft) AMSL 5 km below 3 050 m (10 000 ft) AMSL 1 500 m horizontal; 300 m vertical distance from cloud At and below 900 m AMSL or 300 m above terrain whichever is higher — 5 km **, clear of cloud and in sight of ground or water	250 kt IAS below 3 050 m (10 000 ft) AMSL	No	No

* When the height of the transition altitude is lower than 3 050 m (10 000 ft) AMSL, FL 100 should be used in lieu of 10 000 ft.

** When so prescribed by the appropriate ATS authority:

a) lower flight visibilities to 1 500 m may be permitted for flights operating:

1) at speeds that will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision; or

2) in circumstances in which the probability of encounters with other traffic would normally be low, e.g. in areas of low traffic volume and for aerial work at low levels;

b) helicopters may be permitted to operate in less than 1 500 m flight visibility, if manoeuvred at a speed that will give adequate opportunity to observe other traffic or any obstacles in time to avoid collision.

10/11/94

APPENDIX 5. PRINCIPLES GOVERNING THE DETERMINATION AND REPORTING OF GEOGRAPHICAL COORDINATES

1. Geographical coordinates indicating latitude and longitude shall be determined and reported to the aeronautical information services authority in terms of the World Geodetic System — 1984 (WGS-84) geodetic reference datum, identifying those geographical coordinates which have been transformed into WGS-84 coordinates by mathematical means and whose accuracy of original field work does not meet the requirements in 2 below.

2. The order of accuracy of the field work and determinations and calculations derived therefrom shall be such that the resulting operational navigation data for the phases of flight will be within the maximum deviations, with respect to an appropriate reference frame, as indicated herein.

a) flight information region boundaries: two kilometres (one nautical mile);

b) prohibited, restricted and danger area boundaries outside control area/control zone boundaries: two kilometres (one nautical mile);

c) prohibited, restricted and danger area boundaries inside control area/control zone boundaries: one hundred metres;

d) control area and control zone boundaries, position of air navigation aids/fixes and of significant points not marked by the site of air navigation aids for en-route, holding, standard instrument arrival and departure: one hundred metres; and

e) final approach fixes or final approach points for precision approaches and other essential fixes or points comprising instrument approach procedures: three metres.

Note 1.— An appropriate reference frame is that which enables WGS-84 to be realized on a given position and with respect to which all coordinate data are related.

Note 2.— Specifications governing the publication of WGS-84 coordinates are given in Annex 4, Chapter 2 and Annex 15, Chapter 3.

Note 3.— For those fixes and points that are serving a dual purpose, e.g. holding point and missed approach point, the higher accuracy applies.

ATTACHMENT A. MATERIAL RELATING TO A METHOD OF ESTABLISHING ATS ROUTES DEFINED BY VOR

1. Introduction

1.1 The guidance material in this Attachment results from comprehensive studies, carried out in Europe in 1972 and the United States in 1978, which were in general agreement.

Note.— Details of the European studies are contained in ICAO Circular 120 — Methodology for the Derivation of Separation Minima Applied to the Spacing Between Parallel Tracks in ATS Route Structures.

1.2 In applying the guidance material in 3 and 4, it should be recognized that the data on which it is based are generally representative of navigation using VOR meeting the full requirements of Doc 8071 — *Manual on Testing of Radio Navigation Aids*. Any additional factors, such as those due to particular operational requirements, frequency of aircraft passings or information available regarding the actual track-keeping performance of aircraft within a given portion of airspace should be taken into account.

1.3 Attention is also invited to the basic assumptions in 4.2 and to the fact that the values given in 4.1 represent a conservative approach. Before applying these values, account should therefore be taken of any practical experience gained in the airspace under consideration, as well as the possibility of achieving improvements in the over-all navigation performance of aircraft.

1.4 States are encouraged to keep ICAO fully informed of the results of the application of this guidance material.

2. Determination of VOR system performance values

The large variability of the values which are likely to be associated with each of the factors that make up the total VOR system, and the limitation of presently available methods to measure all these effects individually with the required precision, have led to the conclusion that an assessment of the total system error provides a more realistic method for determining the VOR system performance. The material contained in 3 and 4 should be applied only after study of ICAO Circular 120 especially in respect to the environmental conditions.

Note.— Guidance material on over-all VOR system accuracy is also contained in Annex 10, Volume I, Attachment C to Part I.

3. Determination of protected airspace along VOR-defined routes

Note 1.— The material of this section has not been derived by means of the collision-risk/target level of safety method.

Note 2.— The word "containment" as used in this section is intended to indicate that the protected airspace provided will contain the traffic for 95 per cent of the total flying time (i.e. accumulated over all aircraft) for which the traffic operates along the route in question. Where, for example 95 per cent containment is provided, it is implicit that for 5 per cent of the total flying time traffic will be outside *the protected airspace. It is not possible to quantify the maximum distance which such traffic is likely to deviate beyond the protected airspace.*

3.1 For VOR-defined routes where radar is not used to assist aircraft in remaining within the protected airspace, the following guidance is provided. However, when the lateral deviations of aircraft are being controlled with the aid of radar monitoring, the size of the protected airspace required may be reduced, as indicated by practical experience gained in the airspace under consideration.

3.2 As a minimum, protection against activity in airspace adjacent to the routes should provide 95 per cent containment.

3.3 The work described in ICAO Circular 120 indicates that a VOR system performance based on the probability of 95 per cent containment would require the following protected airspace around the centre line of the route to allow for possible deviations:

— VOR routes with 93 km (50 NM) or less between VORs: ± 7.4 km (4 NM)

— VOR routes with up to 278 km (150 NM) between VORs: ± 7.4 km (4 NM) up to 46 km (25 NM) from the VOR then expanding protected airspace up to ± 11.1 km (6 NM) at 139 km (75 NM) from the VOR.

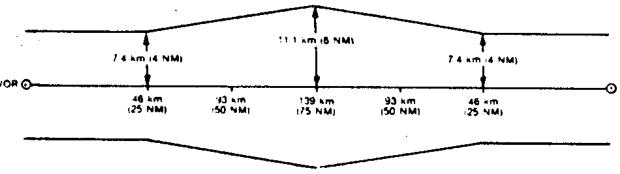

Figure A-1

3.4 If the appropriate ATS authority considers that a better protection is required, e.g. because of the proximity of prohibited, restricted or danger areas, climb or descent paths of military aircraft, etc., it may decide that a higher level of containment should be provided. For delineating the protected airspace the following values should then be used:

— for segments with 93 km (50 NM) or less between VORs, use the values in line A of the table below

— for segments with more than 93 km (50 NM) and less than 278 km (150 NM) between the VORs use the values given in line A of the table up to 46 km (25 NM), then expand linearly to the value given in line B at 139 km (75 NM) from the VOR.

	Percentage containment					
	95	96	97	98	99	99.5
A (km)	± 7.4	± 7.4	± 8.3	± 9.3	± 10.2	± 11.1
(NM)	± 4.0	± 4.0	± 4.5	± 5.0	± 5.5	± 6.0
B (km)	± 11.1	± 11.1	± 12.0	± 12.0	± 13.0	± 15.7
(NM)	± 6.0	± 6.0	± 6.5	± 6.5	± 7.0	± 8.5

For example, the protected area for a route of 222 km (120 NM) between VORs and for which 99.5 per cent containment is required should have the following shape:

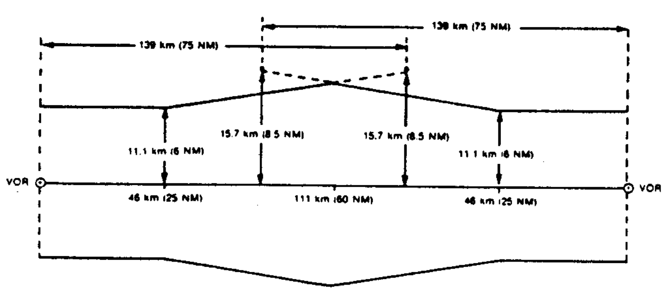

Figure A-2

3.5 If two segments of a VOR-defined ATS route intersect at an angle of more than 25 degrees, additional protected airspace should be provided on the outside of the turn and also on the inside of the turn as necessary. This additional space is to act as a buffer for increased lateral displacement of aircraft, observed in practice, during changes of direction exceeding 25 degrees. The amount of airspace added varies with the angle of intersection. The greater the angle, the greater the additional airspace to be used. Guidance is provided for protected airspace required at turns of no more than 90 degrees. For the exceptional circumstances which require an ATS route with a turn of more than 90 degrees, States should ensure that adequate protected airspace is provided on both the inside and outside of such turns.

3.6 The following examples have been synthesized from the practices of two States which use templates to facilitate the diagramming of airspace for planning purposes. Design of the turning area templates took into account factors such as aircraft speed, bank angle in turns, probable wind velocity, position errors, pilot delays and an intercept angle of at least 30 degrees to achieve the new track, and provides at least 95 per cent containment.

3.7 A template was used to establish the additional airspace required on the outside of turns to contain aircraft executing turns of 30, 45, 60, 75 and 90 degrees. The simplified figures below represent the outer limits of this airspace with the fairing curves removed to allow easy construction. In each case, the additional airspace is shown for aircraft flying in the direction of the large arrow. Where routes are used in both directions, the same additional airspace should be provided on the other outside boundary.

3.8 Figure A-3 illustrates the application of two segments intersecting at a VOR, at an angle of 60 degrees.

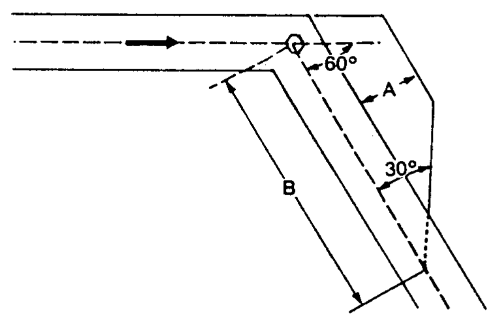

Figure A-3

3.9 Figure A-4 illustrates the application for two segments meeting at a VOR intersection at an angle of 60 degrees beyond the point where boundary splay is required in order to comply with 3.3 and Figure A-1.

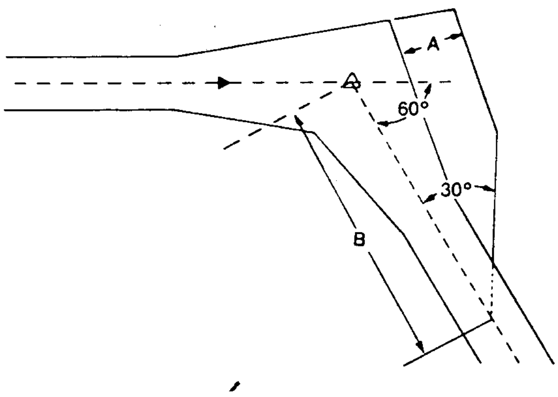

Figure A-4

3.10 The following table outlines the distances to be used in sample cases when providing additional protected airspace for route segments at and below FL 450, intersecting at a VOR or meeting at a VOR intersection not more than 139 km (75 NM) from each VOR.

Note.— Refer to Figures A-3 and A-4 above.

Angle of intersection		*30°*	*45°*	*60°*	*75°*	*90°*
VOR						
*Distance "A"	(km)	5	9	13	17	21
	(NM)	3	5	7	9	11
*Distance "B"	(km)	46	62	73	86	92
	(NM)	25	34	40	46	50
Intersection						
*Distance "A"	(km)	7	11	17	23	29
	(NM)	4	6	9	13	16
*Distance "B"	(km)	66	76	88	103	111
	(NM)	36	41	48	56	60

* Distances are rounded up to the next whole kilometre/nautical mile.

Note.— For behaviour of aircraft at turns, see ICAO Circular 120, 4.4.

3.11 Figure A-5 illustrates a method to construct the required additional protected airspace on the inside of turns for turns of 90 degrees or less:

Locate a point on the airway centre line, equal to the radius of turn plus the along-track tolerance prior to the nominal turning point.

From this point, drop a perpendicular line to intersect the edge of the airway on the inside of the turn.

From this point on the inner edge of the airway, construct a line to intersect the airway centre line beyond the turn at an angle of half of the angle of turn.

The resulting triangle on the inside of the turn depicts the additional airspace which should be protected for the change of direction. For any turn of 90 degrees or less, the extra space on the inside will serve for aircraft approaching the turn from either direction.

Note 1.— Criteria for the calculation of the along-track tolerance are contained in Procedures for Air Navigation Services — Aircraft Operations *(PANS-OPS, Doc 8168), Volume II, Chapter 31.*

Note 2.— Guidance on the calculation of radius of turn is provided in Section 7 below.

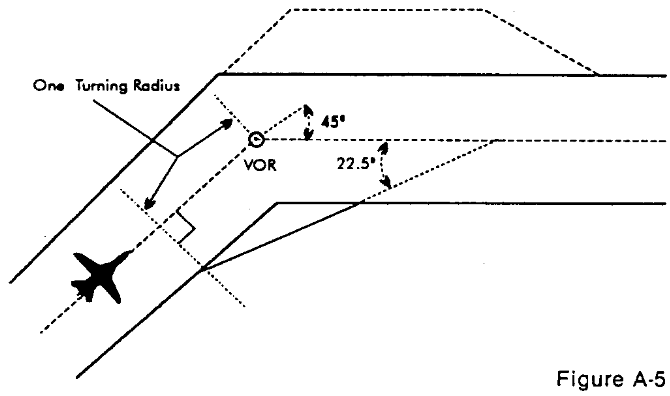

Figure A-5

3.12 For turns at VOR intersections, the principles of construction for extra airspace on the inside of a turn as described in 3.11 can be applied. Depending on the distance of the intersection from one or both VORs, one or both airways may have a splay at the intersection. Depending upon the situation, the extra airspace may be inside, partially inside, or outside of the 95 per cent containment. If the route is used in both directions, the construction should be completed separately for each direction.

3.13 Measured data for routes longer than 278 km (150 NM) between VORs are not yet available. To determine protected airspace beyond 139 km (75 NM) from the VOR, the use of an angular value of the order of 5 degrees as representing the probable system performance would appear satisfactory. The following figure illustrates this application.

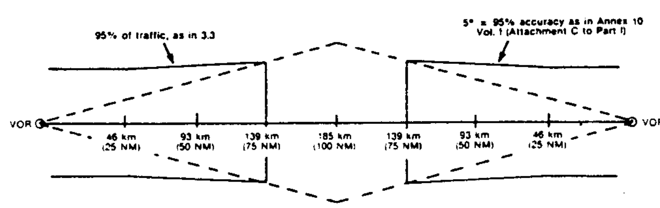

Figure A-6

4. Spacing of parallel routes defined by VORs

Note.— The material of this section has been derived from measured data using the collision-risk/target level of safety method.

4.1 The collision risk calculation, performed with the data of the European study mentioned in 1.1 indicates that, in the type of environment investigated, the distance between route centre lines (S in Figure A-7) for distances between VORs of 278 km (150 NM) or less should normally be a minimum of:

a) 33.3 km (18 NM) for parallel routes where the aircraft on the routes fly in opposite direction; and

b) 30.6 km (16.5 NM) for parallel routes where the aircraft on the two routes fly in the same direction.

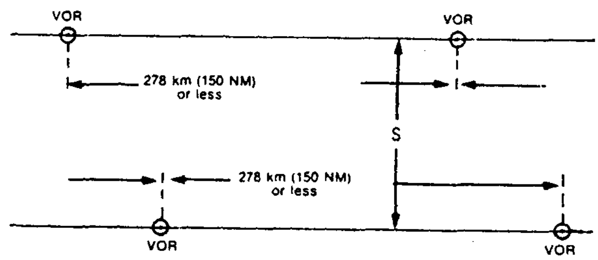

Figure A-7

Note.— Two route segments are considered parallel when:

— *they have about the same orientation, i.e. the angular difference does not exceed 10 degrees;*

— *they are not intersecting, i.e. another form of separation must exist at a defined distance from the intersection;*

— *traffic on each route is independent of traffic on the other route, i.e. it does not lead to restrictions on the other route.*

4.2 This spacing of parallel routes assumes:

a) aircraft may either during climb or descent or during level flight be at the same flight levels on the two routes;

b) traffic densities of 25 000 to 50 000 flights per busy two-month period;

c) VOR transmissions which are regularly flight checked in accordance with ICAO Doc 8071 — *Manual on Testing of Radio Navigation Aids* and have been found to be satisfactory in accordance with the procedures in that document for navigational purposes on the defined routes; and

d) no real-time radar monitoring or control of the lateral deviations is exercised.

4.3 Preliminary work indicates that, in the circumstances escribed in a) to c) below, it may be possible to reduce the inimum distance between routes. However, the figures given ave not been precisely calculated and in each case a detailed udy of the particular circumstances is essential:

a) if the aircraft on adjacent routes are not assigned the same flight levels, the distance between the routes may be reduced; the magnitude of the reduction will depend on the vertical separation between aircraft on the adjacent tracks and on the percentage of climbing and descending traffic, but is not likely to be more than 5.6 km (3 NM);

b) if the traffic characteristics differ significantly from those contained in ICAO Circular 120, the minima contained in 4.1 may require adjustment. For example, for traffic densities of about 10 000 flights per busy two-month period a reduction of 900 to 1 850 m (0.5 to 1.0 NM) may be possible;

c) the relative locations of the VORs defining the two tracks and the distance between the VORs will have an effect on the spacing, but this has not been quantified.

4.4 Application of radar monitoring and control of the lateral deviations of the aircraft may have a large effect on the minimum allowable distance between routes. Studies on the effect of radar monitoring indicate that:

— further work is necessary before a fully satisfactory mathematical model can be developed;

— any reduction of separation is closely related to:

  — traffic (volume, characteristics);
  — radar coverage and processing, availability of an automatic alarm;
  — monitoring continuity;
  — sector work-load; and
  — radiotelephony quality.

According to these studies and taking into account the experience some States have accumulated over many years with parallel route systems under continuous radar control, it can be expected that a reduction to the order of 15 to 18.5 km (8 to 10 NM), but most probably not less than 13 km (7 NM), may be possible as long as radar monitoring workload is not increased substantially by that reduction. Actual operations of such systems using reduced lateral spacing have shown that:

— it is very important to define and publish change-over points (see also 6);

— large turns should be avoided when possible; and

— where large turns cannot be avoided, required turn profiles should be defined for turns larger than 20 degrees.

Even where the probability of total radar failure is very small, procedures to cover that case should be considered.

5. Spacing of adjacent VOR-defined routes that are not parallel

Note 1.— The material of this section is intended to provide guidance for situations where non-intersecting VOR-defined routes are adjacent and have an angular difference exceeding 10 degrees.

Note 2.— The material of this section has not been derived by means of the collision-risk/target level of safety method.

5.1 For adjacent non-intersecting VOR-defined routes that are not parallel, the collision-risk/target level of safety method is not, at its present state of development, fully appropriate. For this reason use should be made of the material in 3.

5.2 The protected airspace between such routes should not be less than that which will provide, without overlap, the 99.5 per cent containment values given in the table in 3.4 (see example in Figure A-8).

5.3 Where there is an angular difference of more than 25 degrees between route segments, additional protected airspace, as indicated in 3.5 to 3.10, should be provided.

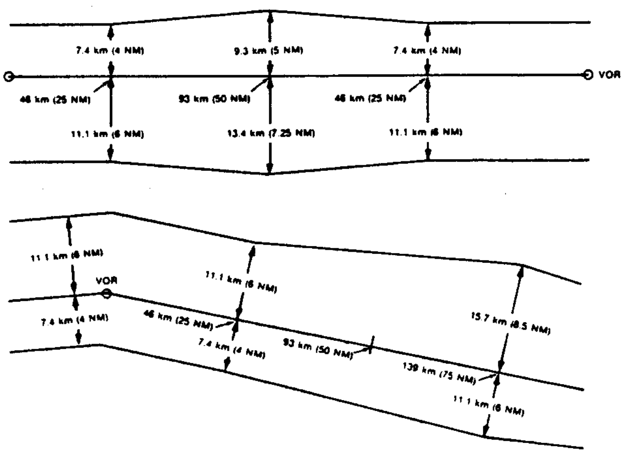

Figure A-8

6. Change-over points for VORs

6.1 When considering the establishment of points for change-over from one VOR to another for primary navigational guidance on VOR-defined ATS routes, States should bear in mind that:

a) the establishment of change-over points should be made on the basis of performance of the VOR stations concerned, including an evaluation of the interference protection criteria. The process should be verified by flight checking (see Doc 8071, Volume I, Part II);

b) where frequency protection is critical, flight inspection should be undertaken at the highest altitudes to which the facility is protected.

6.2 Nothing in 6.1 should be interpreted as placing a restriction on the service ranges of VOR installations meeting the specifications in Annex 10, Volume I, Part I, 3.3.

7. Calculation of radius of turn

7.1 The method used to calculate turn radii and the turn radii indicated below are applicable to aircraft performing a constant radius turn. The material has been derived from the turn performance criteria developed for RNP 1 ATS routes and can be used in the construction of the required additional protected airspace on the inside of turns also for ATS routes other than those defined by VOR.

7.2 Turn performance is dependent on two parameters — ground speed and bank angle. Due to the effect of the wind component changing with the change of heading, the ground speed and hence bank angle will change during a constant radius turn. However, for turns not greater than approximately 90 degrees and for the speed values considered below, the following formula can be used to calculate the achievable constant radius of turn, where the ground speed is the sum of the true airspeed and the wind speed:

$$\text{Radius of turn} = \frac{(\text{Ground speed})^2}{\text{Constant 'G'} * \text{TAN(bank angle)}}$$

7.3 The greater the ground speed, the greater will be the required bank angle. To ensure that the turn radius is representative for all foreseeable conditions, it is necessary to consider extreme parameters. A true airspeed of 1 020 km/h (550 kt) is considered probably the greatest to be encountered in the upper levels. Combined with maximum anticipated wind speeds in the medium and upper flight levels of 370 km/h (200 kt) [99.5 per cent values based on meteorological data], a maximum ground speed of 1 400 km/h (750 kt) should be considered. Maximum bank angle is very much a function of individual aircraft. Aircraft with high wing loadings flying at or near their maximum flight level are highly intolerant of extreme angles. Most transport aircraft are certified to fly no slower than 1.3 times their stall speed for any given configuration. Because the stall speed rises with TAN(bank angle), many operators try not to cruise below 1.4 times the stall speed to protect against gusts or turbulence. For the same reason, many transport aircraft fly at reduced maximum angles of bank in cruise conditions. Hence, it can be assumed that the highest bank angle which can be tolerated by all aircraft types is in the order of 20 degrees.

7.4 By calculation, the radius of turn of an aircraft flying at 1 400 km/h (750 kt) ground speed, with a bank angle of 20 degrees, is 22.51 NM (41.69 km). For purposes of expediency, this has been reduced to 22.5 NM (41.6 km). Following the same logic for the lower airspace, it is considered that up to FL 200 (6 100 m) the maximum figures to be encountered are a true airspeed of 740 km/h (400 kt), with a tailwind of 370 km/h (200 kt). Keeping the maximum bank angle of 20 degrees, and following the same formula, the turn would be defined along a radius of 14.45 NM (26.76 km). For expediency, this figure may be rounded up to 15 NM (27.8 km).

7.5 Given the above, the most logical break point between the two ground speed conditions is between FL 190 (5 800 m) and FL 200 (6 100 m). In order to encompass the range of turn anticipation algorithms used in current flight management systems (FMS) under all foreseeable conditions, the turn radius at FL 200 and above should be defined as 22.5 NM (41.6 km) and at FL 190 and below as 15 NM (27.8 km).

ATTACHMENT B. METHOD OF ESTABLISHING ATS ROUTES FOR USE BY RNAV-EQUIPPED AIRCRAFT

1. Introduction

1.1 This guidance material is the result of studies carried out in Australia, Canada and several European States, the results of which were in general agreement. It also reflects the long existence of RNAV criteria in several States. It must be noted that the values contained herein have not been derived by means of the collision-risk/target level of safety method.

1.2 This guidance material is meant for use on RNAV routes that are established within the coverage area of electronic aids that will provide necessary update and guard against RNAV "blunder" errors.

1.3 This material has been developed for RNP 4. Material for the more stringent RNP types, e.g. RNP 1, is under development.

1.4 States are encouraged to keep ICAO fully informed of the results of their application of the over-all guidance material.

2. Operational applications, RNP 4

2.1 General

2.1.1 Only those aircraft that have been granted airworthiness/operational approval in accordance with Sections 5.4 and 5.5, *Manual on Required Navigation Performance (RNP)* (Doc 9613) are to be afforded air traffic services on RNAV routes developed in accordance with this material.

2.1.2 The use of RNAV equipment should be permitted for navigation along ATS routes defined by VOR. Additionally, RNAV routes may be provided where practicable and when justified by the number of aircraft with RNAV capability. The routes may be:

a) fixed RNAV routes;

b) contingency RNAV routes; and

c) random RNAV routings.

2.1.3 The navigational performance required of such RNAV equipment envisages a level of navigational accuracy for en-route purposes having a navigation performance equal to or better than a track-keeping accuracy of ± 11.1 km (6 NM) for 99.5 per cent of the flight time of all aircraft using RNAV equipment. Navigational performance of this type is expected to be consistent with a track-keeping accuracy of ± 7.4 km (4 NM) for 95 per cent of flight time of all aircraft using RNAV equipment. This level is similar to that currently achieved by aircraft without RNAV capability operating on existing routes defined by VOR or VOR/DME, where the VORs are less than 93 km (50 NM) apart.

2.2 Protected airspace

2.2.1 The minimum protected airspace provided for RNAV ATS routes should be 11.1 km (6 NM) either side of the intended track, within which RNAV-equipped aircraft can be expected to remain for 99.5 per cent of the flight time. Before applying the values stemming from this concept, account should be taken of any practical experience gained in the airspace under consideration as well as the possibility of achieving improvements in the over-all navigation performance of aircraft. In this context, when lateral deviations are being controlled with the aid of radar monitoring, the size of the protected airspace required may be reduced in accordance with the following:

	Percentage containment					
	95	*96*	*97*	*98*	*99*	*99.5*
km	± 7.4	± 7.4	± 8.3	± 9.3	± 10.2	± 11.1
NM	± 4.0	± 4.0	± 4.5	± 5.0	± 5.5	± 6.0

2.2.2 Radar monitoring studies indicate that any potential reduction of the protected airspace is closely related to traffic characteristics, information available to the controller, and sector workload. Finally, it is worth considering that the analysis of RNAV accuracy performed in terms of containment measurements by some European States has shown that flights with RNAV capability were within 5 NM of the route centre line for 99.5 per cent of the time (EUR Doc 001, RNAV/4 refers). If the appropriate ATS authority considers that more protection is required, e.g. because of proximity of prohibited, restricted or danger areas, climb and descent paths of military aircraft, etc., additional buffers should be provided.

2.2.3 Where there is an angular difference of more than 25 degrees between route segments, additional protected airspace, as indicated in Attachment A, 3.5 to 3.12 and Section 7, should be provided.

Note.— Different levels of navigation accuracy may be required by States or regions for operations of RNAV-equipped aircraft. These requirements are not covered by this guidance material and may necessitate changes to protected airspace criteria.

2.3 Spacing between parallel routes
(RNAV/RNAV or RNAV/conventional)

It must be noted that material for RNAV routes has not been derived from the collision-risk/target level of safety method, whereas this information is available for VOR routes. Information on VOR routes is contained in Attachment A, Section 4, and should be used to determine the spacing between RNAV routes.

2.4 Spacing of non-parallel routes
(RNAV/RNAV or RNAV/conventional)

Note 1.— The material in this attachment is intended to provide guidance for situations where non-intersecting routes are adjacent and have an angular difference exceeding 10 degrees.

Note 2.— The material in this attachment has not been derived by means of the collision-risk/target level of safety method.

The protected airspace between such routes should not be less than that which will provide, without overlap, the 99.5 per cent containment values given in 2.2.

ATTACHMENT C. TRAFFIC INFORMATION BROADCASTS BY AIRCRAFT AND RELATED OPERATING PROCEDURES

(See Chapter 4, 4.2.2, Note 2)

Introduction

Traffic information broadcasts by aircraft are intended to permit reports and relevant supplementary information of an advisory nature to be transmitted by pilots on a designated VHF radio telephone (RTF) frequency for the information of pilots of other aircraft in the vicinity.

Traffic Information Broadcasts by Aircraft (TIBA)

1. Introduction and applicability of broadcasts

1.1 TIBAs should be introduced only when necessary and as a temporary measure.

1.2 The broadcast procedures should be applied in designated airspace where:

a) there is a need to supplement collision hazard information provided by air traffic services outside controlled airspace; or

b) there is a temporary disruption of normal air traffic services.

1.3 Such airspaces should be identified by the States responsible for provision of air traffic services within these airspaces, if necessary with the assistance of the appropriate ICAO Regional Office(s), and duly promulgated in aeronautical information publications or NOTAMs, together with the VHF RTF frequency, the message formats and the procedures to be used. Where, in the case of 1.2 a) above, more than one State is involved, the airspace should be designated on the basis of regional air navigation agreement and promulgated in Doc 7030.

1.4 When establishing a designated airspace, dates for the review of its applicability at intervals not exceeding 12 months should be agreed by the appropriate ATS authority(ies).

2. Details of broadcasts

2.1 VHF RTF frequency to be used

2.1.1 The VHF RTF frequency to be used should be determined and promulgated on a regional basis. However, in the case of temporary disruption occurring in controlled airspace, the States responsible may promulgate, as the VHF RTF frequency to be used within the limits of that airspace, a frequency used normally for the provision of air traffic control service within that airspace.

2.1.2 Where VHF is used for air-ground communications with ATS and an aircraft has only two serviceable VHF sets, one should be tuned to the appropriate ATS frequency and the other to the TIBA frequency.

2.2 Listening watch

A listening watch should be maintained on the TIBA frequency 10 minutes before entering the designated airspace until leaving this airspace. For an aircraft taking off from an aerodrome located within the lateral limits of the designated airspace listening watch should start as soon as appropriate after take-off and be maintained until leaving the airspace.

2.3 Time of broadcasts

A broadcast should be made:

a) 10 minutes before entering the designated airspace or, for a pilot taking off from an aerodrome located within the lateral limits of the designated airspace, as soon as appropriate after take-off;

b) 10 minutes prior to crossing a reporting point;

c) 10 minutes prior to crossing or joining an ATS route;

d) at 20-minute intervals between distant reporting points;

e) 2 to 5 minutes, where possible, before a change in flight level;

f) at the time of a change in flight level; and

g) at any other time considered necessary by the pilot.

2.4 Forms of broadcast

2.4.1 The broadcasts other than those indicating changes in flight level, i.e. the broadcasts referred to in 2.3 a), b), c), d) and g), should be in the following form:

ALL STATIONS (necessary to identify a traffic information broadcast)

(call sign)

FLIGHT LEVEL (number) (or CLIMBING* TO FLIGHT LEVEL (number))

(direction)

(ATS route) (or DIRECT FROM (position) TO (position))

POSITION (position**) AT (time)

ESTIMATING (next reporting point, or the point of crossing or joining a designated ATS route) AT (time)

(call sign)

FLIGHT LEVEL (number)

(direction)

Fictitious example:

"ALL STATIONS WINDAR 671 FLIGHT LEVEL 350 NORTHWEST BOUND DIRECT FROM PUNTA SAGA TO PAMPA POSITION 5040 SOUTH 2010 EAST AT 2358 ESTIMATING CROSSING ROUTE LIMA THREE ONE AT 4930 SOUTH 1920 EAST AT 0012 WINDAR 671 FLIGHT LEVEL 350 NORTHWEST BOUND OUT"

2.4.2 Before a change in flight level, the broadcast (referred to in 2.3 e)) should be in the following form:

ALL STATIONS

(call sign)

(direction)

(ATS route) (or DIRECT FROM (position) TO (position))

LEAVING FLIGHT LEVEL (number) FOR FLIGHT LEVEL (number) AT (position and time)

2.4.3 Except as provided in 2.4.4, the broadcast at the time of a change in flight level (referred to in 2.3 f)) should be in the following form:

ALL STATIONS

(call sign)

(direction)

(ATS route) (or DIRECT FROM (position) TO (position))

LEAVING FLIGHT LEVEL (number) NOW FOR FLIGHT LEVEL (number)

followed by:

ALL STATIONS

(call sign)

MAINTAINING FLIGHT LEVEL (number)

2.4.4 Broadcasts reporting a temporary flight level change to avoid an imminent collision risk should be in the following form:

ALL STATIONS

(call sign)

LEAVING FLIGHT LEVEL (number) NOW FOR FLIGHT LEVEL (number)

followed as soon as practicable by:

ALL STATIONS

(call sign)

RETURNING TO FLIGHT LEVEL (number) NOW

2.5 Acknowledgement of the broadcasts

The broadcasts should not be acknowledged unless a potential collision risk is perceived.

3. Related operating procedures

3.1 Changes of cruising level

3.1.1 Cruising level changes should not be made within the designated airspace, unless considered necessary by pilots to avoid traffic conflicts, for weather avoidance or for other valid operational reasons.

* For the broadcast referred to in 2.3 a) in the case of an aircraft taking off from an aerodrome located within the lateral limits of the designated airspace.

** For broadcasts made when the aircraft is not near an ATS significant point, the position should be given as accurately as possible and in any case to the nearest 30 minutes of latitude and longitude.

3.1.2 When cruising level changes are unavoidable, all available aircraft lighting which would improve the visual detection of the aircraft should be displayed while changing levels.

3.2 Collision avoidance

If, on receipt of a traffic information broadcast from another aircraft, a pilot decides that immediate action is necessary to avoid an imminent collision risk, and this cannot be achieved in accordance with the right-of-way provisions of Annex 2, the pilot should:

a) unless an alternative manoeuvre appears more appropriate, immediately descend 150 m (500 ft), or 300 m (1 000 ft) if above FL 290 in an area where a vertical separation minimum of 600 m (2 000 ft) is applied;

b) display all available aircraft lighting which would improve the visual detection of the aircraft;

c) as soon as possible, reply to the broadcast advising action being taken;

d) notify the action taken on the appropriate ATS frequency; and

e) as soon as practicable, resume normal flight level, notifying the action on the appropriate ATS frequency.

3.3 Normal position reporting procedures

Normal position reporting procedures should be continued at all times, regardless of any action taken to initiate or acknowledge a traffic information broadcast.

— END —

10/11/94

SUPPLEMENT TO

ANNEX 11 — AIR TRAFFIC SERVICES

(Tenth Edition)

1. The attached Supplement supersedes all previous Supplements to Annex 11 and includes differences notified by Contracting States up to 10 November 1994.

2. This Supplement should be inserted at the end of Annex 11, Tenth Edition. Additional differences and revised comments received from Contracting States will be issued at intervals as amendments to this Supplement.

SUPPLEMENT TO ANNEX 11 — TENTH EDITION

AIR TRAFFIC SERVICES

Differences between the national regulations and practices of States and the corresponding International Standards contained in Annex 11, as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

NOVEMBER 1994

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT

No.	*Date*	*Entered by*	*No.*	*Date*	*Entered by*

AMENDMENTS TO ANNEX 11 ADOPTED OR APPROVED BY THE COUNCIL SUBSEQUENT TO THE TENTH EDITION ISSUED JULY 1994

No.	*Date of adoption or approval*	*Date applicable*	*No.*	*Date of adoption or approval*	*Date applicable*

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards of Annex 11, Tenth Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
Argentina	3/10/94	1	10/11/94
Canada	4/10/94	1-2	10/11/94
Denmark	4/10/94	1	10/11/94
Finland	6/10/94	1	10/11/94
Germany	28/9/94	1	10/11/94
Jordan	2/6/94	1	10/11/94
Mauritius	21/10/94	1	10/11/94
New Zealand	9/11/94	1	10/11/94
Norway	30/9/94	1	10/11/94
Poland	7/11/94	1	10/11/94
Republic of Korea	26/9/94	1	10/11/94
Russian Federation	14/10/94	1	10/11/94
United Republic of Tanzania	4/7/94	1	10/11/94
United States	7/10/94	1	10/11/94
Uruguay	14/9/94	1	10/11/94
Venezuela	4/11/94	1	10/11/94

2. Contracting States which have notified ICAO that no differences exist

State	*Date of notification*
Austria	22/7/94
Barbados	26/5/94
Belize	12/10/94
Brazil	13/10/94
Cyprus	19/9/94
Egypt	20/9/94
Gabon	16/6/94
Haiti	25/10/94
Micronesia, Federated States of	30/5/94

State	*Date of notification*
Singapore	1/9/94
Switzerland	6/10/94
Tunisia	1/10/94
United Arab Emirates	25/8/94
United Kingdom	5/10/94
United Kingdom (Hong Kong)	5/10/94
Vanuatu	11/8/94
Zambia	31/8/94

3. Contracting States from which no information has been received

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Armenia
Australia
Azerbaijan
Bahamas
Bahrain
Bangladesh
Belarus
Belgium
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
Chile
China
Colombia
Comoros
Congo
Cook Islands
Costa Rica
Côte d'Ivoire
Croatia
Cuba
Czech Republic
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Ecuador
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Fiji
France
Gambia
Georgia
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Honduras
Hungary
Iceland
India
Indonesia
Iran, Islamic Republic of
Iraq
Ireland
Israel
Italy
Jamaica
Japan
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Lithuania
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mexico
Monaco
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nauru
Nepal
Netherlands, Kingdom of the
Nicaragua
Niger
Nigeria
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Portugal
Qatar
Republic of Moldova
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Slovakia
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
Sudan
Suriname
Swaziland
Sweden
Syrian Arab Republic
Tajikistan
Thailand
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Turkey
Turkmenistan
Uganda
Ukraine
Uzbekistan
Viet Nam
Yemen
Zaire
Zimbabwe

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4. Paragraphs with respect to which differences have been notified

Paragraph	*Differences notified by*
Definitions	Canada
	Russian Federation
	United Republic of Tanzania
	United States
	Uruguay
2.6	Denmark
	Finland
	Norway
	Republic of Korea
	Russian Federation
2.6.1	Canada
	Finland
2.6.3	Finland
	Mauritius
2.12	Uruguay
2.18.1	Denmark
2.21	Denmark
2.23	Poland
3.1	Russian Federation
3.3.3	Russian Federation
	United States
3.3.4	Venezuela
3.4.1	New Zealand
3.6.1	Russian Federation
3.6.1.3.1	Denmark
	Uruguay
3.6.1.3.2	Poland
3.7.2	Norway

Paragraph	*Differences notified by*
Chapter 4	Russian Federation
4.2.1	Argentina
4.2.2	Canada
	United States
4.3.5	Canada
	United States
4.3.6	Canada
	United States
4.3.7	Canada
	United States
5.1.1	Norway
5.2.1	Canada
6.1.2.1	Norway
Appendix 1	United States
Appendix 3	Uruguay
Appendix 4	Canada
	Finland
	Germany
	Jordan
	Mauritius
	Norway
	Russian Federation
Appendix 5	United Republic of Tanzania

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ARGENTINA

CHAPTER 4

4.2.1 b) The previous text ["b) information concerning pre-eruption volcanic activity, volcanic eruptions and information concerning volcanic ash clouds for which a SIGMET message or NOTAM has not already been issued"] is being maintained.

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CHAPTER 1

Definitions

Advisory airspace. Advisory airspace refers to Class F Special Use airspace within which an activity occurs of which non-participating pilots should be aware.

Advisory route. Not used in Canada.

Air-taxiing. Canada defines air-taxiing as movement of a helicopter above the surface of an aerodrome, but normally not above 100 ft AGL. The aircraft may proceed via either hover taxi or flight at speeds more than 20 knots.

Air traffic advisory service. Advisory service refers to the provision of flight information service to IFR and VFR aircraft.

Air traffic control clearance. Canada also uses air traffic control instruction defined as a directive issued by an air traffic control unit for air traffic control purposes.

ALERFA. Code word not used.

Altitude. Means the altitude indicated in an altimeter set to the current altimeter setting.

Approach control office and *Approach control service.* Terminal control service is used in lieu of approach control service and associated terms.

Apron management service. Not used in Canada.

DETRESFA. Code word not used.

Flight level. An altimeter set to 29.92 inches of mercury is used.

INCERFA. Code word not used.

CHAPTER 2

2.6.1 In Canada, Class F refers to Special Use airspace identified as restricted or advisory.

CHAPTER 4

4.2.2 b) Collision hazards not provided in Class F.

4.3.5 to 4.3.7 ATIS messages contain the same elements of information but not in the order listed.

CHAPTER 5

5.2.1 a) Uncertainty phase includes:

— a flight plan has been filed and no arrival report has been received by the area control centre within 60 minutes after the estimated arrival time notified to or estimated by the area control centre, whichever is later;

DENMARK

CHAPTER 2

2.6 Certain parts of airspace Class G, designated TIZ, TIA, have requirements for continuous two-way radiocommunication for VFR flights. Speed limitation of 250 kt is applicable below FL 100 in airspace classes concerned.

2.18.1 Not yet implemented.

2.21 Minium flight altitudes for ATS routes have been determined such that an obstruction clearance of at least 300 m (984 ft) has been obtained in accordance with PANS-OPS (Doc 8168). Where minimum flight altitude for ATS routes within Danish territory is not stated, the published lower limit for the route concerned will ensure the necessary obstruction clearance.

CHAPTER 3

3.6.1.3.1 Transfer of control and communications from the unit providing approach control service to the unit providing aerodrome control service shall take place when:

a) the pilot has the aerodrome in sight and intends to complete approach and landing with visual reference to the ground. However, transfer shall not take place until separation is applied between the aircraft concerned and other air traffic being subject to approach control; or

b) the aircraft during instrument approach passes a defined point, established in the approach sector by agreement between the two units; or

c) the aircraft has landed after a radar approach.

FINLAND

CHAPTER 2

2.6 A full description of ATS airspace classification is given in AIP Suomi-Finland, RAC 1-4-3/4 and in tables RAC 3.

2.6.1 Airspace Class G+ has been added:

Class G+. IFR and VFR flights are permitted and receive Aerodrome Flight Information Service. See also table in AIP Suomi-Finland, RAC 1-4-3/4.

The following provisions to different airspace classes have been added:

Classes B through G: VMC visibility and distance from cloud minima in Classes B through G is applicable for both IFR and VFR flights.

Classes C and D: In Classes C and D, traffic avoidance advice is provided only within areas prescribed by The Civil Aviation Administration. See AIP Suomi-Finland, RAC 1-1-9, para 1.3.3.

Class D: In Class D, traffic information for VFR flights is provided about both IFR and VFR flights.

Class G: In Class G, two-way radio communication for IFR flights is required only above an altitude which will be prescribed by the Civil Aviation Administration.

Within terminal control areas, control zones and flight information zones, which change character to Class G outside the operational hours of the appropriate ATS unit, radio communication and position reports are required as prescribed in RAC 1-1-9, para 1.3.2.2.4.

2.6.3, Note *Note.— Where two or more airspaces of different classification overlap each other, the more restrictive class is considered to be dominant. In case of adjoining airspaces, the less restrictive class is considered to be dominant at the respective boundary. In applying these criteria, the airspace classes are given the following succession: A, B, C, D, E, F, G+ and G, where Class A is the most restrictive and Class G the least restrictive.*

Appendix 4 See also comments under 2.6.1 above.

Speed limitation column:

An aircraft shall not exceed the speed 250 kt IAS below flight level 3 050 m (FL 100) when

a) conducting an IFR flight in airspace Classes D, E, F, G+ or G;

b) conducting a VFR flight in airspace Classes C, D, E, F, G+ or G.

An aircraft conducted as VFR flights shall not exceed the speed 140 kt IAS in airspace Classes F, G+ or G below 900 m (3 000 ft) AMSL or 300 m (1 000 ft) above terrain, whichever is higher, when flight visibility is less than 5 km.

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GERMANY

Appendix 4 Class E. VMC visibility and distance from cloud minima. The minimum value has to be 8 km visibility for VFR flights below 3 050 m (10 000 ft) AMSL.

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JORDAN

Appendix 4

Class C *Speed limitation* column:

IAS (250 kts)
Below FL 110.

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MAURITIUS

CHAPTER 2

2.6.3 Class G airspace, IFR flights: Speed limitation not applicable.

Class G Airspace, VFR flights:

1) Continuous two-way communications mandatory for all aircraft operating within Mauritius FIR.

2) Flight visibility lower than 5 km is not prescribed.

Note.—

i) IFR/VFR flights flying from Class C airspace to Class G airspace and vice-versa will be subjected to an ATC clearance when flying within any portion of Class C airspace.

ii) Unless otherwise indicated in ATC clearances, VFR flights are advised to adopt the table of cruising levels for IFR flights as specified in Appendix 3 to Annex 2.

iii) Within Class C and Class G airspace, VFR flights are not authorized to fly above FL 150 (Regional Supplementary Procedures (Doc 7030) refers)..

Appendix 4 See differences under 2.6.3 above.

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NEW ZEALAND

CHAPTER 3

3.4.1 Below FL 290, the 1 000 ft minimum vertical separation may be reduced to 500 ft between an IFR flight and a VFR or SVFR flight which is operating within CTR (Class C or D) and the VFR or SVFR flight is the lower. When the IFR flight is a "Heavy", the minimum shall always be 1 000 ft for reasons of wake turbulence.

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CHAPTER 2

2.6 *Class A.* Class A airspace will change character when authorizations to operate as VFR flights above FL 195 (Annex 2, 4.4 a) refers) affect Class A airspace.

Class D and E. Class D and E airspace will change character in the period between the end of evening civil twilight and the beginning or morning civil twilight as flights, authorized to operate in accordance with the visual flight rules during that period in Class D and E airspace, are separated from IFR flights.

Class D. The services provided to VFR flights in Class D airspace are stated to be "Air traffic control service and traffic information about IFR and VFR flights". "Traffic avoidance advice" is, however, not provided to IFR or VFR flights.

Class G. IFR flights in Class G airspace are not required to establish two-way radio communication with ATS* except that communication shall be established with the appropriate AFIS unit when operating within a traffic information zone (TIZ) or a traffic information area (TIA) (airspace where AFIS is provided).

*See 6.1.2.1 below.

VFR flights operating within TIZ or TIA are required to establish two-way radio communication with the appropriate AFIS unit.

A separate provision regarding communication requirements, etc. when operating within TIZ/TIA is established.

CHAPTER 3

3.7.2 *Note.—* Since supersonic flight over Norwegian territory is generally prohibited, 3.7.2 of Annex 11 will apply only when the supersonic part of the flight concerned will take place outside Norwegian territory, or when permission to conduct supersonic flight over Norwegian territory exceptionally has been granted.

CHAPTER 5

5.1.1 a) In accordance with the Norwegian Rules of the AIR (BSL F, 3.3.1.3.2) any flight, including controlled flights, must file a complete flight plan in order to be provided with alerting service. This does not exclude the provision of such service upon request from any person being connected with operation of the aircraft, or related to persons on board, or if alerting service is considered appropriate by the air traffic services.

CHAPTER 6

6.1.2.1 The provision of Annex 11 will be met in accordance with the following guidelines:

Air-ground communication facilities for flight information service shall enable two-way communications to take place between a unit providing flight information service and appropriately equipped aircraft:

1) flying at or above the minimum safe IFR altitudes established for flight within controlled airspace in the respective flight information region, or

2) operating within areas where the establishment of two-way communications with the appropriate air traffic services unit is mandatory.

Appendix 4 See 2.6 above.

CHAPTER 2

2.23 *Additional provisions.*

Special procedure for the events of not agreed leaving of controlled airspace by civil aircraft operating controlled flight

1) Not agreed leaving of controlled airspace made by civil aircraft means the flight of the aircraft outside the controlled airspace described in ATC clearance.

2) When the aircraft operating the controlled flight leaves the controlled airspace without permission from ATC and is:

— under radar control of civil air traffic control unit, this unit should lead this aircraft into the controlled airspace, on route agreed as necessary with the military air traffic service unit;

— within range of civil radar, appropriate radar air traffic control unit, as far as practicable, should take control of this aircraft and lead it into the controlled airspace, on route agreed as necessary with the military air traffic service unit;

— outside the range of civil radar, appropriate air traffic control unit should relay to the pilot-in-command information of the current position of his aircraft received from military air traffic service unit and give him a clearance, agreed as necessary with the military air traffic service unit, allowing the aircraft to return into controlled airspace.

3) When the pilot-in-command operating a controlled flight will continue flight inconsistently to the received clearance and such action endangers air traffic safety, appropriate military unit may take up the interception procedure to lead the aircraft into the controlled airspace or force it to land on indicated aerodrome.

Procedure for the event of not agreed deviation from intended track by civil operating uncontrolled flight

The term "not agreed deviation of civil aircraft operating uncontrolled flight" means the situation when:

1) aircraft has deviated more than 10 km from its intended track, or

2) aircraft has flown into the danger, prohibited or restricted area, or

3) aircraft has flown into control area

without clearance of appropriate ATS unit.

In event not agreed deviation of aircraft, referred above, the civil air traffic service unit having such possibilities shall lead this aircraft to its intended track in co-ordination with appropriate military air traffic service unit.

When the pilot-in-command will not fulfil instructions of civil ATS unit leading this aircraft on designated track, appropriate military unit may take up the interception procedure to lead the aircraft to its intended track or force it to land on indicated aerodrome.

CHAPTER 3

3.6.1.3.2 Rules in b) are in force independently of the meteorological conditions.

CHAPTER 2

2.6 Classification of airspaces is not applied.

CHAPTER 1

Definitions *Advisory airspace, Advisory route, Air traffic services airspaces.* A control service is provided throughout the whole of the airspace of the Russian Federation.

CHAPTER 2

2.6 This classification is not found.

CHAPTER 3

3.1 and 3.3.3 This classification is not found.

3.6.1 Transfer of control over arriving and departing aircraft between one ATC unit and another takes place at prescribed boundaries without reference to weather conditions or time of day.

The ATC transfer-acceptance points are established as follows:

— between the approach controller and the circuit controller: the holding area second level altitude;

— between the circuit controller with the landing controller: the moment at which the aircraft blip appears on the precision approach radar screens (in the area of the base-leg turn);

— between the circuit controller and the take-off controller the moment at which the aircraft having taken off attains a height of 200 m or an assigned height:

— between the landing controller and the take-off controller: following overflight of the inner marker beacon, the moment at which visual contact is made with the aircraft on final approach;

— between the take-off controller and the taxiing controller: before take-off, the moment at which the aircraft lines up for take-off; after landing, the moment at which the aircraft vacates the runway.

CHAPTER 4 The flight information service is not found.

Appendix 4 This classification is not used.

UNITED REPUBLIC OF TANZANIA

CHAPTER 1

Definitions — *Special VFR flight.* Conditions for special VFR flight also apply at night.

Appendix 5 — All geographical coordinates will be transferred into WGS-84 coordinates by mathematical means and the accuracy of original field work may not meet the requirements in Appendix 5.

UNITED STATES

CHAPTER 1

Definitions — *Airborne collision avoidance system (ACAS).* U.S. glossary uses the term "traffic collision avoidance system (TCAS)".

Air-taxiing. This term is not used. The United States uses the terms "hover taxi" for this manoeuvre above 100 ft above ground level (AGL) and "air taxi" below 100 ft AGL.

CHAPTER 3

3.3.3 — Exception clause. Clearances may be issued to conduct flight in VFR conditions without a pilot request if the clearance would result in noise abatement benefits or when a pilot conducts a practice instrument approach.

CHAPTER 4

4.2.2 — No provision is made for the issuance of collision hazard information to flights operating outside of controlled airspace.

4.3.5 to 4.3.7 — The order in which information is listed in ATIS broadcast messages is not mandated and certain elements are regarded as optional.

Appendix 1

2.2.1 — Routes designated to serve aircraft operating from 18 000 MSL up to and including FL 450 are referred to as "jet routes" and are designated with the letter "J", followed by a number of up to three digits.

URUGUAY

CHAPTER 1

Definitions *Additional definitions:*

Departure instructions. Instructions with which a departing aircraft will have to comply in order to intercept the assigned ATS route.

Clearance limit. The point or time at which a traffic clearance expires.

Traffic clearance. ATC approval of a flight plan with the amendments which it may have introduced.

CHAPTER 2

2.12 Change-over points are not established.

CHAPTER 3

3.6.1.3.1 The responsibility for the control of an aircraft approaching to land shall be transferred from the unit providing approach control service to the unit providing aerodrome control service, when the aircraft is in the vicinity of the aerodrome and:

a) it is established on the final approach segment of a published instrument approach procedure; or

b) during instrument approach it passes a predetermined point established by agreement between the two units; or

c) it is considered that it will be able to complete its approach and landing in visual reference to the ground; or

d) it has reached uninterrupted visual meteorological conditions.

Appendix 3

2.1.1 The plain language designator of a standard departure or arrival route consists of:

2.1.1 a), b) The word "departure" or "arrival"; followed by the word "visual", if the route has been established as exclusively VFR; followed by

c) a basic indicator designated in accordance with 2.1.2; followed by

d) a number assigned consecutively for each route related to the same significant point.

2.1.4 See difference 2.1.1 d) above.

4. Validity indicators are not assigned.

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VENEZUELA

CHAPTER 3

3.3.4 Regarding the modified table of cruising levels introduced in Appendix 3 to Annex 2, Table b) will be applied until the corresponding operational agreements have been reached between adjacent air navigation regions and flight information regions.

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INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

SEARCH AND RESCUE

ANNEX 12

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

SIXTH EDITION—MARCH 1975

This edition incorporates all amendments adopted by the Council prior to 25 November 1974 and supersedes, on 9 October 1975, all previous editions of Annex 12.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Bulletin,* which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA RELATING TO ANNEX 12, SIXTH EDITION

AMENDMENTS				CORRIGENDA			
No.	Date Applicable	Date entered	Entered by	No.	Date Applicable	Date entered	Entered by
1-11	Incorporated in this edition						
12	12/8/76	16/7/79	ICAO				
13	26/11/81	15/6/83	ICAO				
14	15/11/90						
15	11/11/93	11/10/93					

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FOREWORD

Historical Background

In December 1946, the Search and Rescue Division, at its second session, made recommendations for Standards and Recommended Practices for Search and Rescue. These were developed by the Secretariat and the then existent Air Navigation Committee, and were duly submitted to the Council. The proposals were not accepted by the Council in the form in which they were presented and, on 20 April 1948, were referred back to the Air Navigation Committee for further consideration.

A further draft Annex was then developed in the light of experience gained at Regional Air Navigation Meetings and eventually was approved in principle by the Air Navigation Commission and circulated to States for comment. Further development was made by the Air Navigation Commission as a result of States' comments and the resulting proposals were adopted by the Council on 25 May 1950 and designated as Annex 12 to the Convention on International Civil Aviation. The Annex became effective on 1 December 1950 and came into force on 1 March 1951.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

The Standards and Recommended Practices in this document govern the application of the Regional Supplementary Procedures — *Search and Rescue*, contained in Doc 7030, in which document will be found subsidiary procedures of regional application.

Annex 12 is applicable to the establishment, maintenance and operation of search and rescue services in the territories of Contracting States and over the high seas, and to the co-ordination of such services between States.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each Amendment to this Annex.

Attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. Information relating to the establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided according to the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

Status of Annex Components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards and Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

   Standard. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

   Recommended Practice. Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interests of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligation of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of Language

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial Practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation;** *Notes* have been printed in light face italics, the status being indicated by the prefix *Note.*

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

Throughout this document measurements are given in the metric system followed in parentheses by corresponding measurements in the foot-pound system.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A — Amendments to Annex 12

Amendments	*Source(s)*	*Subject(s)*	*Adopted/approved* *Effective* *Applicable*
1st Edition	Search and Rescue Division, Second Session (1946) Air Navigation Commission	International Standards and Recommended Practices — Search and Rescue Services.	25 May 1950 1 December 1950 1 March 1951
1 (2nd Edition)	Search and Rescue Division, Third Session (1951)	Search and rescue organization; communications; appraisals of search and rescue operations; procedures for search and rescue; air-to-ground signals.	31 March 1952 1 September 1952 1 January 1953
2 (3rd Edition)	Second Air Navigation Conference (1955)	Rescue sub-centres; servicing and refuelling rescue units of other Contracting States.	8 May 1956 1 September 1956 1 December 1956
3	Third Air Navigation Conference (1956). Amendment 140 to Annex 6, Chapter 6	Marking of areas of the fuselage suitable for break-in.	13 June 1957 1 October 1957 1 December 1957

Amendments	Source(s)	Subject(s)	Adopted/approved Effective Applicable
4 (4th Edition)	Rules of the Air, Air Traffic Services and Search and Rescue Divisions (1958)	Co-operation between States; information concerning emergencies; procedures for rescue co-ordination centres.	8 December 1959 1 May 1960 1 August 1960
5	Amendment 13 to Annex 11	Notification of rescue co-ordination centres by air traffic services units.	13 April 1962 — 1 November 1962
6	Amendment 4 to Annex 9	Temporary entry of rescue units from other Contracting States.	— — 1 July 1964
7	Amendment 14 to Annex 11, Chapter 5	Alerting of surface vessels and en-route aircraft to assist an aircraft in distress.	19 June 1964 1 November 1964 1 February 1965
8	International Convention for the Safety of Life at Sea. Amendment 15 to Annex 11	Updating of reference; alerting service.	10 December 1965 — 25 August 1966
9 (5th Edition)	Air Navigation Commission review of the Regional Supplementary Procedures	Co-operation between Contracting States; servicing and refuelling of rescue units of other Contracting States; testing search and rescue communications facilities; assistance in search and rescue operations by additional units or services.	25 May 1970 25 September 1970 4 February 1971
10	Air Navigation Commission	Carriage of the International Code of Signals by search and rescue aircraft; equipment of search and rescue aircraft with frequency 2182 kHz; information on position of merchant ships.	11 December 1972 11 April 1973 16 August 1973
11 (6th Edition)	Complete review of the Annex by the Air Navigation Commission	New signal to surface craft; provision of search and rescue service on a 24-hour basis; dissemination of information on position of merchant ships; appraisals of search and rescue operations; improvement of co-operation between neighbouring States; equipment of rescue units; availability of information on air traffic services; location of droppable survival equipment; methods for assisting aircraft in distress and being compelled to ditch to rendezvous with surface craft; methods for assisting search and rescue or other aircraft to rendezvous with aircraft in distress.	25 November 1974 25 March 1975 9 October 1975
12	Amendment 60 to Annex 3	Supplementary communication facilities between meteorological offices and search and rescue units.	8 December 1975 8 April 1976 12 August 1976
13	Air Navigation Commission	Ground-air visual signal code for use by survivors.	15 December 1980 15 April 1981 26 November 1981
14	Air Navigation Commission	Rescue co-ordination centre (RCC) responsibilities regarding preparatory measures in the event an aircraft is subject to unlawful interference.	12 March 1990 30 July 1990 15 November 1990
15	Air Navigation Commission	Definition for search and rescue aircraft; communications requirements for rescue co-ordination centres (RCCs) and equipment of search and rescue (SAR) aircraft; SAR point of contact (SPOC).	12 March 1993 26 July 1993 11 November 1993

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

Note.— Although the Convention on International Civil Aviation allocates to the State of Registry certain functions which that State is entitled to discharge, or obliged to discharge, as the case may be, the Assembly recognized, in Resolution A18-16, that the State of Registry may be unable to fulfil its responsibilities adequately in instances where aircraft are leased, chartered or interchanged — in particular without crew — by an operator of another State and that the Convention may not adequately specify the rights and obligations of the State of an operator in such instances. Accordingly, the Council, without prejudice to the question of whether the Convention may require amendment with respect to the allocation of functions to States, urged that if, in the above-mentioned instances, the State of Registry finds itself unable to discharge adequately the functions allocated to it by the Convention, it delegate to the State of the operator, subject to acceptance by the latter State, those functions of the State of Registry that can more adequately be discharged by the State of the operator. It is understood that the foregoing action will only be a matter of practical convenience and will not affect either the provisions of the Chicago Convention prescribing the duties of the State of Registry or any third State.

CHAPTER 1. — DEFINITIONS

When the following terms are used in the Standards and Recommended Practices for Search and Rescue they have the following meanings:

Alerting post. A unit designated to receive information from the general public regarding aircraft in emergency and to forward the information to the associated rescue co-ordination centre.

Alert phase. A situation wherein apprehension exists as to the safety of an aircraft and its occupants.

Distress phase. A situation wherein there is a reasonable certainty that an aircraft and its occupants are threatened by grave and imminent danger or require immediate assistance.

Ditching. The forced landing of an aircraft on water.

Emergency phase. A generic term meaning, as the case may be, uncertainty phase, alert phase or distress phase.

Operator. A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Radio direction-finding station. A radio station intended to determine only the direction of other stations by means of transmissions from the latter.

Rescue co-ordination centre. A unit responsible for promoting efficient organization of search and rescue service and for co-ordinating the conduct of search and rescue operations within a search and rescue region.

Rescue subcentre. A unit subordinate to a rescue co-ordination centre, established to complement the latter within a specified portion of a search and rescue region.

Rescue unit. A unit composed of trained personnel and provided with equipment suitable for the expeditious conduct of search and rescue.

Search and rescue aircraft. An aircraft provided with specialized equipment suitable for the efficient conduct of search and rescue missions.

Search and rescue region. An area of defined dimensions within which search and rescue service is provided.

Search and rescue services unit. A generic term meaning, as the case may be, rescue co-ordination centre, rescue subcentre or alerting post.

State of Registry. The State on whose register the aircraft is entered.

Uncertainty phase. A situation wherein uncertainty exists as to the safety of an aircraft and its occupants.

CHAPTER 2. — ORGANIZATION

2.1.—Establishment and provision of search and rescue service

2.1.1 Contracting States shall arrange for the establishment and provision of search and rescue services within their territories. Such services shall be provided on a 24-hour basis.

2.1.1.1 Those portions of the high seas or areas of undetermined sovereignty for which search and rescue service will be established shall be determined on the basis of regional air navigation agreements. A Contracting State having accepted the responsibility to provide search and rescue service in such areas shall thereafter arrange for the service to be established and provided in accordance with the provisions of this Annex.

Note.— The phrase "regional air navigation agreements" refers to the agreements approved by the Council of ICAO normally on the advice of Regional Air Navigation Meetings.

2.1.2 In providing assistance to aircraft in distress and to survivors of aircraft accidents, Contracting States shall do so regardless of the nationality of such aircraft or survivors.

2.2.—Establishment of search and rescue regions

2.2.1 Contracting States shall delineate the search and rescue regions within which they will provide search and rescue service. Such regions shall not overlap.

2.2.1.1 **Recommendation.**— *Boundaries of search and rescue regions should, in so far as practicable, be coincident with the boundaries of corresponding flight information regions.*

2.3.—Establishment and designation of search and rescue services units

2.3.1 Contracting States shall establish a rescue co-ordination centre in each search and rescue region.

2.3.2 **Recommendation.**— *Contracting States should establish rescue subcentres whenever this would improve the efficiency of search and rescue services.*

2.3.3 **Recommendation.**— *In areas where public telecommunications facilities would not permit persons observing an aircraft in emergency to notify the rescue co-ordination centre concerned directly and promptly, Contracting States should designate suitable units of public or private services as alerting posts.*

2.4.—Communication for search and rescue services units

2.4.1 Each rescue co-ordination centre shall have means of immediate communication with:

a) the associated air traffic services unit;

b) associated rescue subcentres;

c) appropriate direction-finding and position-fixing stations in the region;

d) where appropriate, coastal radio stations capable of alerting and communicating with surface vessels in the region.

Note.— "Means of immediate communication" are considered to be direct-line telephone or teletype, direct radiotelephone circuit, or, when these cannot be made available, telephone or teletype via a switchboard.

2.4.2 Each rescue co-ordination centre shall have means of rapid and reliable communication with:

a) the headquarters of rescue units in the region;

b) rescue co-ordination centres in adjacent regions;

c) a designated meteorological office or meteorological watch office;

d) rescue units when employed in search and rescue;

e) alerting posts;

f) the COSPAS-SARSAT* Mission Control Centre servicing the search and rescue (SAR) region when the rescue co-ordination centre (RCC) has been designated SAR point of contact (SPOC).

Note.— "Means of rapid and reliable communication" include digital data interchange, telephone, facsimile and radiotelephone.

2.4.3 In addition to the requirement in 2.4.1 b), each rescue subcentre shall have means of rapid and reliable communication with:

a) adjacent rescue subcentres;

b) a meteorological office or meteorological watch office;

* COSPAS — space system for search of vessels in distress
SARSAT — search and rescue satellite-aided tracking

c) rescue units when employed in search and rescue;

d) alerting posts.

Note.— See Note following 2.4.2.

2.4.4 **Recommendation.—** *The means of communication provided in accordance with 2.4.2 c) and 2.4.3 b) should be supplemented, as and where necessary, by other means of visual or audio communication, for example, closed circuit television.*

2.5.—Designation of rescue units

2.5.1 Contracting States shall designate as rescue units elements of public or private services suitably located and equipped for search and rescue in each search and rescue region, and shall define the relative functions of these elements and the respective rescue co-ordination centre.

2.5.1.1 Contracting States shall establish additional rescue units wherever the units designated in accordance with 2.5.1 are insufficient.

Note.— The minimum units and facilities necessary for provision of search and rescue within a search and rescue region are determined by regional air navigation agreements and are specified in the appropriate Air Navigation Plan publications.

2.5.2 **Recommendation.—** *Contracting States should designate as parts of the search and rescue plan of operation, elements of public or private services that do not qualify as rescue units but are nevertheless able to participate in search and rescue operations, and should define the relative functions of these elements and the respective rescue co-ordination centres.*

2.6.—Equipment of rescue units

2.6.1 Rescue units shall be provided with facilities and equipment for locating promptly, and for providing adequate assistance at the scene of an accident.

Note.— In selecting equipment for rescue units it is important that due regard be given to the size and passenger capacity of modern aircraft.

2.6.2 **Recommendation.—** *In addition to the communications required by the Standards in 2.4.2 d) and 2.4.3 c), each rescue unit should have means of rapid and reliable communication with other units or elements engaged in the same operation.*

Note.— See Note following 2.4.2.

2.6.3 Each search and rescue aircraft shall be equipped to be able to communicate on the aeronautical distress and scene of action frequencies and on such other frequencies as may be prescribed.

2.6.4 Each search and rescue aircraft shall be equipped with a device for homing on emergency locator transmitters transmitting on 121.5 MHz required to be carried by aircraft in accordance with the provisions of Annex 6, Parts I, II and III.

Note.— Specifications for emergency locator transmitter (ELT) are given in Annex 10, Vol. I.

2.6.5 Each search and rescue aircraft, when used for search and rescue over maritime areas and required to communicate with merchant ships, shall be equipped to be able to communicate with such ships on 2182 kHz.

2.6.6 Each search and rescue aircraft, when used for search and rescue over maritime areas and required to communicate with merchant ships, shall carry a copy of the International Code of Signals to enable it to overcome language difficulties that may be experienced in communicating with such ships.

2.6.7 **Recommendation.—** *Unless it is known that there is no need to provide supplies to survivors by air, at least one of the aircraft participating in a search and rescue operation should carry droppable survival equipment.*

2.6.8 **Recommendation.—** *States should provide at appropriate aerodromes where search and rescue aircraft are not readily available, survival equipment suitably packed for dropping by aircraft not normally participating in search and rescue operations.*

2.6.9 **Recommendation.—** *Containers or packages containing survival equipment for dropping to survivors should have the general nature of their contents indicated by a colour code, by printed indication, and by self-explanatory symbols, to the extent that such symbols exist.*

2.6.9.1 **Recommendation.—** *The colour identification of the contents of droppable containers and packages containing survival equipment should take the form of coloured streamers according to the following code:*

Red — medical supplies and first aid equipment.
Blue — food and water.
Yellow — blankets and protective clothing.
Black — miscellaneous equipment such as stoves, axes, compasses, cooking utensils, etc.

2.6.9.2 **Recommendation.—** *Where supplies of a mixed nature are dropped in one container or package, the colour code should be used in combination.*

2.6.10 **Recommendation.—** *Instructions on the use of the survival equipment should be enclosed in each of the droppable containers or packages. They should be printed in at least three languages of which at least one should be one of the working languages of ICAO.*

CHAPTER 3. — CO-OPERATION

3.1.—Co-operation between States

3.1.1 Contracting States shall co-ordinate their search and rescue organizations with those of neighbouring Contracting States.

3.1.2 **Recommendation.**— *Contracting States should, whenever necessary, co-ordinate their search and rescue operations with those of neighbouring States.*

3.1.2.1 **Recommendation.**— *Contracting States should, in so far as practicable, develop common search and rescue procedures to facilitate co-ordination of search and rescue operations with those of neighbouring States.*

3.1.3 Subject to such conditions as may be prescribed by its own authorities, a Contracting State shall permit immediate entry into its territory of rescue units of other States for the purpose of searching for the site of aircraft accidents and rescuing survivors of such accidents.

3.1.4 The authorities of a Contracting State which wishes its rescue units to enter the territory of another Contracting State for search and rescue purposes shall transmit a request, giving full details of the projected mission and the need for it, to the rescue co-ordination centre of the State concerned or to such other authority as has been designated by that State.

3.1.4.1 The authorities of Contracting States shall:

— immediately acknowledge the receipt of such a request, and

— as soon as possible indicate the conditions, if any, under which the projected mission may be undertaken.

3.1.5 **Recommendation.**— *Contracting States should enter into agreements with neighbouring States setting forth the conditions for entry of each other's rescue units into their respective territories. These agreements should also provide for expediting entry of such units with the least possible formalities.*

3.1.6 **Recommendation.**— *Each Contracting State should authorize its rescue co-ordination centres to:*

a) request from other rescue co-ordination centres such assistance, including aircraft, vessels, personnel or equipment, as may be needed;

b) grant any necessary permission for the entry of such aircraft, vessels, personnel or equipment into its territory; and

c) make the necessary arrangements with the appropriate customs, immigration or other authorities with a view to expediting such entry.

3.1.7 **Recommendation.**— *Each Contracting State should authorize its rescue co-ordination centres to provide, when requested, assistance to other rescue co-ordination centres, including assistance in the form of aircraft, vessels, personnel or equipment.*

3.1.8 **Recommendation.**— *Contracting States should make arrangements for joint training exercises involving their search and rescue units, those of other States and operators, in order to promote search and rescue efficiency.*

3.1.9 **Recommendation.**— *Contracting States should make arrangements for periodic liaison visits by personnel of their rescue co-ordination centres and subcentres to the centres of neighbouring States.*

3.2.—Co-operation with other services

3.2.1 Contracting States shall arrange for all aircraft, vessels and local services and facilities which do not form part of the search and rescue organization to co-operate fully with the latter in search and rescue and to extend any possible assistance to the survivors of aircraft accidents.

3.2.2 Contracting States shall ensure that their search and rescue services co-operate with those responsible for investigating accidents and with those responsible for the care of those who suffered from the accident.

3.2.3 **Recommendation.**— *To facilitate accident investigation, rescue units should, when practicable, be accompanied by persons qualified in the conduct of aircraft accident investigations.*

3.2.4 States shall designate a search and rescue point of contact (SPOC) for the receipt of COSPAS-SARSAT distress data.

3.3.—Dissemination of information

3.3.1 Each Contracting State shall publish and disseminate all information necessary for the entry of rescue units of other States into its territory.

Note.— See 3.1.3.

3.3.2 **Recommendation.**— *When requested, Contracting States should make available, through the rescue co-ordination centres or other agencies, information regarding their search and rescue plans of operation.*

3.3.3 **Recommendation.**— *Each Contracting State recording information on the position of ships at sea should disseminate, on a regular basis, in so far as practicable, such information to other Contracting States concerned requesting it.*

3.3.4 **Recommendation.**— *Contracting States should, to the extent desirable and practicable, disseminate to the general public directives on actions to be taken when there is reason to believe that an aircraft is in emergency and in the event of an aircraft accident.*

CHAPTER 4.—PREPARATORY MEASURES

4.1.—Requirements for information

4.1.1 Each rescue co-ordination centre shall have available at all times up-to-date information concerning the following in respect of its search and rescue region:

a) rescue units, rescue subcentres and alerting posts;

b) air traffic services units;

c) means of communication that may be used in search and rescue operations;

d) cable addresses and telephone numbers of all operators or their designated representatives, engaged in operations in the region;

e) any other public and private resources including medical and transportation facilities that are likely to be useful in search and rescue.

4.1.2 **Recommendation.**— *Each rescue co-ordination centre should have available all other information of interest to search and rescue, including information regarding:*

a) the locations, call signs, hours of watch, and frequencies of all radio stations likely to be employed in search and rescue;

b) the locations and hours of watch of services keeping radio watch, and the frequencies guarded;

c) objects which it is known might be mistaken for unlocated or unreported wreckage, particularly if viewed from the air;

d) locations where supplies of droppable emergency and survival equipment are stored.

4.1.3 **Recommendation.**— *Each rescue co-ordination centre whose search and rescue region includes maritime areas should have ready access to information regarding the position, true track, speed and call sign of ships within such areas, which may be able to provide assistance to aircraft in distress.*

Note.—This information may either be kept in the rescue co-ordination centres or be readily obtainable if and when necessary.

4.1.4 A large-scale map of the search and rescue region shall be provided at each rescue co-ordination centre for the purpose of displaying and plotting information of interest to search and rescue.

4.2.—Plan of operation

4.2.1 Each rescue co-ordination centre shall prepare a detailed plan for the conduct of search and rescue operations within its search and rescue region.

4.2.2 The plan of operation shall specify arrangements for the servicing and refuelling, to the extent possible, of aircraft, vessels and vehicles employed in search and rescue, including those made available by other States.

4.2.3 **Recommendation.**— *The plan of operation should contain details regarding all actions to be taken by those engaged in search and rescue, including:*

a) the manner in which search and rescue is to be conducted in the search and rescue region;

b) the use of available communication systems and facilities;

c) the actions to be taken jointly with adjacent rescue co-ordination centres;

d) the methods of alerting en-route aircraft and ships at sea;

e) the duties and prerogatives of personnel assigned to search and rescue;

f) possible redeployment of equipment that may be necessitated by meteorological or other conditions;

g) the methods for obtaining essential information relevant to search and rescue operations, such as weather reports and forecasts, appropriate NOTAM, etc.;

h) the methods for obtaining, from other rescue co-ordination centres, such assistance, including aircraft, vessels, personnel or equipment, as may be needed;

i) the methods for assisting distressed aircraft being compelled to ditch to rendezvous with surface craft;

j) the methods for assisting search and rescue or other aircraft to rendezvous with aircraft in distress.

4.3.—Preparatory procedures for rescue units

4.3.1 Each rescue unit shall:

a) be cognizant of all parts of the plan of operation prescribed in 4.2 that are necessary for the effective conduct of its duties;

b) maintain in readiness the required number of rescue craft and vehicles;

c) maintain supplies of rations, medical stores, signalling devices and other survival and rescue equipment;

d) keep the rescue co-ordination centre currently informed of the quantity and preparedness of its equipment.

4.3.2 **Recommendation.**— *Each rescue unit should make arrangements for the supply of additional craft or vehicles in case replacement of those already engaged in search and rescue is required.*

4.4.—Training

4.4.1 **Recommendation.**— *To achieve and maintain maximum efficiency in search and rescue, Contracting States should provide for regular training of their search and rescue personnel and arrange appropriate search and rescue exercises.*

4.5.—Removal of wreckage

4.5.1 Each Contracting State shall ensure that wreckage resulting from aircraft accidents within its territory or, in the case of accidents on the high seas or in areas of undetermined sovereignty, within the search and rescue regions for which it is responsible is removed or obliterated following completion of the accident investigation, or charted, so as to prevent subsequent confusion.

4.5.2 **Recommendation.**— *To facilitate compliance with 4.5.1, each Contracting State should require any person finding wreckage of aircraft to notify the appropriate authority as soon as possible.*

CHAPTER 5. — OPERATING PROCEDURES

5.1.—Information concerning emergencies

5.1.1 **Recommendation.**— *Contracting States should encourage any person observing an accident or having reason to believe that an aircraft is in an emergency to give immediately all available information to the appropriate alerting post or to the rescue co-ordination centre concerned.*

5.1.2 Any authority or any element of the search and rescue organization having reason to believe that an aircraft is in an emergency shall give immediately all available information to the rescue co-ordination centre concerned.

5.1.3 Rescue co-ordination centres shall, immediately upon receipt of information concerning aircraft in emergency, evaluate such information and determine the extent of the operation required.

5.1.4 When information concerning aircraft in emergency is received from other sources than air traffic services units, the rescue co-ordination centre shall determine to which emergency phase the situation corresponds and shall apply the procedures applicable to that phase.

5.2.—Procedures for rescue co-ordination centres during emergency phases

5.2.1.—Uncertainty phase

During the uncertainty phase, the rescue co-ordination centre shall co-operate to the utmost with air traffic services units and other appropriate agencies and services in order that incoming reports may be speedily evaluated.

5.2.2.—Alert phase

Upon the occurrence of an alert phase the rescue co-ordination centre shall immediately alert appropriate search and rescue services units and rescue units and initiate any necessary action.

5.2.3.—Distress phase

When an aircraft is believed to be in distress, or when a distress phase exists, the rescue co-ordination centre shall:

a) initiate action by appropriate search and rescue services units and rescue units in accordance with the detailed plan of operation;

b) ascertain the position of the aircraft, estimate the degree of uncertainty of this position, and, on the basis of this information and the circumstances, determine the extent of the area to be searched;

c) notify the operator, where possible, and keep him informed of developments;

d) notify adjacent rescue co-ordination centres, the help of which seems likely to be required, or which may be concerned in the operation;

e) notify the associated air traffic services unit, when the information on the emergency has been received from another source;

f) request at an early stage such aircraft, vessels, coastal stations, or other services not specifically included in a) as are in a position to do so, to:

   1) maintain a listening watch for transmission from the aircraft in distress or from an emergency locator transmitter;

   Note.—The frequencies contained in the specifications for emergency locator transmitter (ELT) given in Annex 10, Vol. I, are 121.5 MHz and 406 MHz.

   2) assist the aircraft in distress as far as practicable;

   3) inform the rescue co-ordination centre of any developments;

g) from the information available, draw up a plan for the conduct of the search and/or rescue operation required and communicate such plan for the guidance of the authorities immediately directing the conduct of such an operation;

h) amend as necessary, in the light of circumstances, the guidance already given in g);

i) notify the State of Registry of the aircraft;

j) notify the appropriate accident investigation authorities.

The order in which these actions are described shall be followed unless circumstances dictate otherwise.

5.2.4.—Initiation of search and rescue action in respect of an aircraft whose position is unknown

5.2.4.1 In the event that an emergency phase is declared in respect of an aircraft whose position is unknown and may be in one of two or more search and rescue regions, the following shall apply:

a) When a rescue co-ordination centre is notified of the existence of an emergency phase and is unaware of other centres taking appropriate action, it shall assume responsibility for initiating suitable action in accordance with 5.2 and confer with neighbouring rescue co-ordination centres with the objective of designating one rescue co-ordination centre to assume responsibility forthwith.

b) Unless otherwise decided by common agreement of the rescue co-ordination centres concerned, the rescue co-ordination centre to co-ordinate search and rescue action shall be the centre responsible for:

— the region in which the aircraft was according to its last reported position; or

— the region to which the aircraft was proceeding when last reported position was at the boundary of two search and rescue regions; or

— the region to which the aircraft was destined when it was not equipped with suitable two-way radio communication or not under obligation to maintain radio communication.

c) After declaration of the distress phase, the rescue co-ordination centre co-ordinating search and rescue action shall inform all rescue co-ordination centres that may become involved in the operation, of all the circumstances of the emergency and subsequent developments. Likewise all rescue co-ordination centres becoming aware of any information pertaining to the incident, shall inform the rescue co-ordination centre which is co-ordinating the search and rescue action.

5.2.5.—Passing of information to aircraft in respect of which an emergency phase has been declared

5.2.5.1 Whenever applicable, the rescue co-ordination centre responsible for search and rescue action shall forward to the air traffic services unit serving the flight information region in which the aircraft is operating, information of the search and rescue action initiated, in order that such information can be passed to the aircraft.

5.3.—Procedures where responsibility for operations extends to two or more Contracting States

5.3.1 Where the conduct of operations over the entire search and rescue region is the responsibility of more than one Contracting State, each such State shall take action in accordance with the plan of operation when so requested by the rescue co-ordination centre of the region.

5.4.—Procedures for authorities in the field

5.4.1 The authorities immediately directing the conduct of operations or any part thereof shall:

a) give instructions to the units under their direction and inform the rescue co-ordination centre of such instructions;

b) keep the rescue co-ordination centre informed of developments.

5.5.—Procedures for rescue co-ordination centres — Termination and suspension of operations

5.5.1.—Uncertainty and alert phases

5.5.1.1 When during an uncertainty or an alert phase the rescue co-ordination centre is informed that the emergency no longer exists, it shall so inform any unit or service which it has activated or notified.

5.5.2.—Distress phase

5.5.2.1 When during a distress phase the rescue co-ordination centre is informed that the emergency no longer exists, it shall take the necessary action to terminate the operations and to inform any authority, unit or service which it has activated or notified.

5.5.2.2 If during a distress phase it is determined that the search should be discontinued, the rescue co-ordination centre shall suspend the operations and so inform any authority, unit or service which has been activated. Pertinent information subsequently received shall be evaluated and operations resumed when justified on the basis of such information.

5.5.2.3 If during a distress phase it is determined that further search would be of no avail, the rescue co-ordination centre shall terminate the operations and so inform any authority, unit or service which has been activated.

5.6.—Procedures for rescue units

5.6.1 When notified by the rescue co-ordination centre the rescue unit shall:

a) act as required in the notification;

b) keep the rescue co-ordination centre currently informed of the quantity and preparedness of its search and rescue equipment;

c) keep the rescue co-ordination centre currently informed of its operations.

5.7.—Procedures for person-in-charge of the rescue unit at the scene of an accident

5.7.1 The person assigned to be in charge of the rescue unit at the scene of an accident shall act as required by the rescue co-ordination centre and shall:

a) ensure that no risk of setting fire to the aircraft is created by the use of improper types of lights or by equipment likely to produce electric or friction sparks;

b) give aid to survivors;

c) except as necessary for b), or when otherwise directed, ensure that the wreckage of the aircraft or marks made by it in landing are not disturbed until all information required for investigation of the causes of the accident has been obtained.

5.8.—Procedures for pilots-in-command at the scene of an accident

5.8.1 When a pilot-in-command observes that either another aircraft or a surface craft is in distress, he shall, unless he is unable, or in the circumstances of the case considers it unreasonable or unnecessary:

a) keep in sight the craft in distress until such time as his presence is no longer necessary;

b) if his position is not known with certainty, take such action as will facilitate the determination of it;

c) report to the rescue co-ordination centre or air traffic services unit as much of the following information as possible:

- type of craft in distress, its identification and condition;
- its position, expressed in geographical coordinates or in distance and true bearing from a distinctive landmark or from a radio navigation aid;
- time of observation expressed in hours and minutes GMT;
- number of persons observed;
- whether persons have been seen to abandon the craft in distress;
- number of persons observed to be afloat;
- apparent physical condition of survivors;

d) act as instructed by the rescue co-ordination centre or the air traffic services unit.

5.8.1.1 If the first aircraft to reach the scene of an accident is not a search and rescue aircraft it shall take charge of on-scene activities of all other aircraft subsequently arriving until the first search and rescue aircraft reaches the scene of the accident. If, in the meantime, such aircraft is unable to establish communication with the appropriate rescue co-ordination centre or air traffic services unit, it shall, by mutual agreement, hand over to an aircraft capable of establishing and maintaining such communications until the arrival of the first search and rescue aircraft.

5.8.2 When it is necessary for an aircraft to direct a surface craft to the place where an aircraft or surface craft is in distress, the aircraft shall do so by transmitting precise instructions by any means at its disposal. If no radio communication can be established the aircraft shall use the appropriate signal in Appendix A.

5.8.3 When it is necessary for an aircraft to convey information to survivors or surface rescue units, and two-way communication is not available, it shall, if practicable, drop communication equipment that would enable direct contact to be established, or convey the information by dropping the message.

5.8.4 When a ground signal has been displayed, the aircraft shall indicate whether the signal has been understood or not by the means described in 5.8.3 or, if this is not practicable, by use of the appropriate signal in Appendix A.

5.9.—Procedures for pilots-in-command intercepting a distress transmission

Whenever a distress signal and/or message or equivalent transmission is intercepted on radiotelegraphy or radiotelephony by a pilot-in-command of an aircraft, he shall:

a) record the position of the craft in distress if given;

b) if possible take a bearing on the transmission;

c) inform the appropriate rescue co-ordination centre or air traffic services unit of the distress transmission, giving all available information;

d) at his discretion, while awaiting instructions, proceed to the position given in the transmission.

5.10.—Search and rescue signals

5.10.1 The signals of Appendix A shall, when used, have the meaning indicated therein. They shall be used only for the purpose indicated and no other signals likely to be confused with them shall be used.

5.10.2 Upon observing any of the signals given in Appendix A, aircraft shall take such action as may be required by the interpretation of the signal given in that Appendix.

5.11.—Maintenance of records

5.11.1 Recommendation.—*Each rescue co-ordination centre should keep a record of the operational efficiency of the search and rescue organization in its region.*

5.11.2 Recommendation.—*Each rescue co-ordination centre should prepare appraisals of actual search and rescue operations in its region. These appraisals should comprise any pertinent remarks on the procedures used by the pilot and on the emergency and survival equipment, and any suggestions for improvement of those procedures and equipment. Those appraisals which are likely to be of interest to other States should be submitted to ICAO for information and dissemination as appropriate.*

APPENDIX A.–SEARCH AND RESCUE SIGNALS

(Note.–See Chapter 5, 5.10 of the Annex)

1.–Signals with surface craft

Note.–The following replies may be made by surface craft to the signal in 1.1:

– *For acknowledging receipt of signals:*

1) the hoisting of the "Code pennant" (vertical red and white stripes) close up (meaning understood);

2) the flashing of a succession of "T's" by signal lamp in the Morse code;

3) the changing of heading to follow the aircraft.

– *For indicating inability to comply:*

1) the hoisting of the international flag "N" (a blue and white checkered square);

2) the flashing of a succession of "N's" in the Morse code.

1.1 The following manoeuvres performed in sequence by an aircraft mean that the aircraft wishes to direct a surface craft towards an aircraft or a surface craft in distress:

a) circling the surface craft at least once;

b) crossing the projected course of the surface craft close ahead at low altitude and:

1) rocking the wings; or

2) opening and closing the throttle; or

3) changing the propeller pitch.

Note.–Due to high noise level on board surface craft, the sound signals in 2) and 3) may be less effective than the visual signal in 1) and are regarded as alternative means of attracting attention.

c) heading in the direction in which the surface craft is to be directed.

Repetition of such manoeuvres has the same meaning.

1.2 The following manoeuvre by an aircraft means that the assistance of the surface craft to which the signal is directed is no longer required:

– crossing the wake of the surface craft close astern at a low altitude and:

1) rocking the wings; or

2) opening and closing the throttle; or

3) changing the propeller pitch.

Note.–See Note following 1.1 b).

2.–Ground-air visual signal code

2.1.–Ground-air visual signal code for use by survivors

No.	Message	Code Symbol
1	Require assistance	V
2	Require medical assistance	X
3	No or Negative	N
4	Yes or Affirmative	Y
5	Proceeding in this direction	↑

2.2.–Ground-air visual signal code for use by rescue units

No.	Message	Code Symbol
1	Operation completed	LLL
2	We have found all personnel	LL
3	We have found only some personnel	+ +
4	We are not able to continue. Returning to base	XX
5	Have divided into two groups. Each proceeding in direction indicated	⇄
6	Information received that aircraft is in this direction	→ →
7	Nothing found. Will continue to search	NN

2.3 Symbols shall be at least 2.5 metres (8 feet) long and shall be made as conspicuous as possible.

Note 1.–Symbols may be formed by any means such as: strips of fabric, parachute material, pieces of wood, stones or such like material; marking the surface by tramping, or staining with oil, etc.

Note 2.–Attention to the above signals may be attracted by other means such as radio, flares, smoke, reflected light, etc.

3.–Air-to-ground signals

3.1 The following signals by aircraft mean that the ground signals have been understood:

a) during the hours of daylight:
   – by rocking the aircraft's wings;

b) during the hours of darkness:
   – flashing on and off twice the aircraft's landing lights or, if not so equipped, by switching on and off twice its navigation lights.

3.2 Lack of the above signal indicates that the ground signal is not understood.

– END –

26/11/81
No. 13

SUPPLEMENT TO ANNEX 12 (SIXTH EDITION)

SEARCH AND RESCUE

Differences between the national regulations and practices of States and the corresponding International Standards and Recommendations contained in Annex 12, as notified to ICAO in accordance with Article 38 of the Convention on International Civil Aviation and the Council's resolution of 21 November 1950.

FEBRUARY 1984

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT

No.	Date	Entered by	No.	Date	Entered by
1	15 May 1986	ICAO			

AMENDMENTS TO ANNEX 12 ADOPTED OR APPROVED BY THE COUNCIL
SUBSEQUENT TO PUBLICATION OF THE SIXTH EDITION ISSUED MARCH 1975

No.	Date of adoption or approval	Date applicable	No.	Date of adoption or approval	Date applicable
12	8 Dec. 1975	12 Aug. 1976			
13	15 Dec. 1980	26 Nov. 1981			
14	Fotocópia				
15	26/7/93	11/11/93			

15 Feb. 1984

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards of Annex 12, Sixth Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	Date of notification	Pages in Supplement	Date of publication
Australia	14/4/82	1	15/2/84
Austria	29/10/81	1	15/2/84
Bangladesh	3/2/85	1	15/5/86
Canada	18/11/81	1	15/2/84
Djibouti	22/3/82	1	15/2/84
France	9/2/82	1	15/2/84
Gambia	9/11/83	1	15/2/84
Italy	1/9/82	1	15/2/84
Lao People's Democratic Republic	15/6/85	1	15/5/86
Malaysia	15/3/84	1	15/5/86
Mauritius	12/10/82	1	15/2/84
Netherlands, Kingdom of the	1/1/85	1	15/5/86
New Zealand	31/3/81	1	15/2/84
Oman	19/9/81	1	15/2/84
Papua New Guinea	28/11/84	1	15/5/86
Romania	31/5/82	1	15/2/84
Seychelles	22/1/81	1	15/2/84
Thailand	29/4/81	1	15/2/84
Uganda	1/4/81	1	15/2/84
Union of Soviet Socialist Republics	1/3/85	1	15/5/86
Zambia	10/7/81	1	15/2/84

2. Contracting States which have notified ICAO that no differences exist

State	Date of notification	State	Date of notification
Argentina	10/4/81	Ecuador	1/4/85
Bahamas	4/3/81	Ethiopia	10/3/81
Barbados	25/5/84	Finland	6/10/81
Belgium	22/5/81	Germany, Fed. Rep. of	15/10/81
Botswana	13/1/86	Greece	21/10/81
Brazil	22/4/81	Grenada	8/8/83
Chile	28/10/81	Guyana	11/2/81
China	22/11/85	Haiti	13/1/81
Cyprus	7/2/81	Hungary	23/10/81
Czechoslovakia	6/4/81	India	31/10/81
Denmark	28/10/81	Ireland	10/4/84
Dominican Republic	19/2/81	Japan	14/4/81

State	Date of notification	State	Date of notification
Jordan	1/10/81	Sweden	14/10/81
Lesotho	26/7/83	Switzerland	26/10/81
Malawi	2/2/81	Syrian Arab Republic	11/3/81
Norway	20/3/81	Tunisia	30/5/83
Pakistan	16/4/85	United Kingdom	10/11/81
Portugal	14/11/83	United Republic of Tanzania	25/9/81
Republic of Korea	29/6/85	United States	7/4/81
Rwanda	10/11/81	Uruguay	29/1/82
Singapore	22/3/84	Venezuela	21/7/81
South Africa	7/4/81		
Sudan	7/12/83		

3. Contracting States from which no information has been received

Afghanistan
Algeria
Angola
Antigua and Barbuda
Bahrain
Benin
Bolivia
Brunei Darussalam
Bulgaria
Burkina Faso
Burma
Burundi
Cameroon
Cape Verde
Central African Republic
Chad
Colombia
Comoros
Congo
Costa Rica
Côte d'Ivoire
Cuba
Democratic Kampuchea
Democratic People's Republic of Korea
Democratic Yemen
Egypt
El Salvador
Equatorial Guinea
Fiji
Gabon
Ghana
Guatemala
Guinea
Guinea-Bissau
Honduras
Iceland
Indonesia
Iran, Islamic Republic of
Iraq
Israel
Jamaica
Kenya
Kiribati
Kuwait
Lebanon
Liberia
Libyan Arab Jamahiriya
Luxembourg
Madagascar
Maldives
Mali
Malta
Mauritania
Mexico
Monaco
Morocco
Mozambique
Nauru
Nepal
Nicaragua
Niger
Nigeria
Panama
Paraguay
Peru
Philippines
Poland
Qatar
Saint Lucia
Saint Vincent and the Grenadines
Sao Tome and Principe
Saudi Arabia
Senegal
Sierra Leone
Solomon Islands
Somalia
Spain
Sri Lanka
Suriname
Swaziland
Togo
Tonga
Trinidad and Tobago
Turkey
United Arab Emirates
Vanuatu
Viet Nam
Yemen
Yugoslavia
Zaire
Zimbabwe

4. Paragraphs with respect to which differences have been notified

Paragraph	Differences notified by
2.2.1.1	Italy
2.4.3	Seychelles
2.4.4	Austria
	Bangalesh
	Gambia
	Malaysia
	Seychelles
	Thailand
	Zambia
2.6.3.1	USSR
2.6.4	Oman
2.6.8	Austria
	Canada
	Gambia
	Malaysia
	Mauritius
2.6.9	Australia
	Bangladesh
	Mauritius
	Papua New Guinea
2.6.9.1	Australia
	Mauritius
	Papua New Guinea
2.6.9.2	Australia
	Mauritius
	Papua New Guinea
2.6.10	Australia
	Malaysia
	Mauritius
	Oman
	Papua New Guinea

Paragraph	Differences notified by
3.1.3	Lao People's Dem. Rep.
	Romania
	USSR
3.1.8	Austria
3.1.9	Austria
	Bangladesh
4.1.3	Netherlands, Kingdom of the
4.1.4	Netherlands, Kingdom of the
5.2.3	Djibouti
	France
	Malaysia
	Oman
	Uganda
Appendix A	
2.1	Austria
	Canada
	New Zealand

15/5/86

AUSTRALIA

Chapter 2

2.6.9* 2.6.9.1* 2.6.9.2*	No colour coding is used, as yet, on Australian droppable equipment. Nor are self-explanatory symbols in use for such equipment.
2.6.10*	Limited instruction on the use of survival equipment is enclosed in each droppable container or package. These instructions are printed in English only.

* Recommended Practice

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15 Feb. 1984

Chapter 2

2.4.4* It is not intended to supplement the means of communication provided in accordance with 2.4.2 c) and 2.4.3 b), by other means of visual or audio communication, for example, closed circuit television, as the now existing means of communication are deemed to be sufficient.

2.6.8* Survival equipment for the whole territory of Austria is centrally provided at the Rescue Co-ordination Centre at Wien; it is, however, readily available and may, within the shortest time possible, be dropped by the two search and rescue aircraft at the required location.

Chapter 3

3.1.8* Apart from informal ad hoc arrangements with the Federal Republic of Germany and Switzerland, there are no arrangements for joint training exercises. It is, however, intended to make such arrangements with all neighbouring States.

3.1.9* No arrangements for periodic liaison visits exist at present; appropriate measures will be taken in the near future.

Appendix A

2.1 In Austria, the ground-air visual signal code for use by survivors is applied as it stood before Amendment 13. However, in the next months the Austrian regulations will be streamlined to conform to the provisions of Amendment 13 to Annex 12.

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* Recommended Practice

15 Feb. 1984

Chapter 2

2.4.4* There is no provision for visual or audio communication.

2.6.9* No colour coding is used.

Chapter 3

3.1.9* No arrangement for periodic liaison visits exists.

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* Recommended Practice

15 May 1986

CANADA

Chapter 2

2.6.8* The airdrop of survival equipment requires qualified personnel who are only available at aerodromes where SAR aircraft are based, hence survival equipment for air dropping is not provided elsewhere.

Appendix A

2.1 In addition to the five (5) international ground-air visual signal codes outlined in Amendment 13, four (4) additional signals are required for use within Canada only:

LL - All is well

F - Require food and water

L - Require fuel and oil

W - Need repairs

---

* Recommended Practice

15 Feb. 1984

DJIBOUTI

Chapter 5

5.2.3 j) Responsibility for notifying the units in charge of accident investigations during the phase of distress rests with the competent Area Control Centre and not the Rescue Co-ordination Centre.

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15 Feb. 1984

FRANCE

Chapter 5

5.2.3 j) In France, the relevant Regional Control Centre and not the Rescue Co-ordination Centre is responsible for notifying the appropriate accident investigation authorities.

---

15 Feb. 1984

GAMBIA

Chapter 2

2.4.4* and 2.6.8* — Unable to comply with these recommendations at present.

* Recommended Practice

15 Feb. 1984

ITALY

Chapter 2

2.2.1.1* — In the framework of the three Italian Flight Information Regions, two Rescue Co-ordination Centres are established and their boundaries, therefore, are not coincident with the boundaries of the three FIRs.

* Recommended Practice

15 Feb. 1984

LAO PEOPLE'S DEMOCRATIC REPUBLIC

Chapter 3

3.1.3 — Rescue units of other States may enter the territory of Lao People's Democratic Republic for search and rescue purposes only after authorization has been obtained from the Ministry of Defence.

15 May 1986

MALAYSIA

Chapter 2

2.4.4*	It is not intended to supplement the means of communication provided in accordance with 2.4.2 c) and 2.4.3 b) by other means of visual or audio communication, e.g. closed circuit television, as the existing means of communication are deemed to be sufficient.
2.6.8*	Survival equipment will be airdropped by the Royal Malaysian Air Force (RMAF) which has the trained personnel and aircraft. This equipment is available at selected RMAF bases which are strategically located to cover the main air routes.
2.6.10*	Instructions on the use of survival equipment are printed in English only.

Chapter 5

5.2.3 i)	The States of Registry of aircraft are not notified when their aircraft are believed to be in distress. However, notification is made when aircraft are involved in accidents.

* Recommended Practice

15 May 1986

MAURITIUS

Chapter 2

2.6.8* 2.6.9* 2.6.9.1* 2.6.9.2* 2.6.10*	Survival equipment suitably packed for dropping by aircraft not normally participating in search and rescue operations is not provided.

* Recommended Practice

15 Feb. 1984

NETHERLANDS, KINGDOM OF THE

Chapter 4

4.1.3* and 4.1.4	Due to the great density of shipping in the Netherlands Maritime Area (for instance, the entrances to the ports of Rotterdam, Amsterdam, Antwerp and the crossroads of main shipping lines to other major ports in Western Europe) a merchant shipping plot is not kept ready. Via Scheveningen Radio, the merchant shipping coastal radio-station, all ships in this area can be reached within minutes as a direct telephone communication exists between RCC Valkenburg and Scheveningen Radio. As a result of this dense shipping and the comparatively small size of the Netherlands Maritime Area, there will normally always be ships in the direct vicinity of a disaster area.

* Recommended Practice

15 May 1986

NEW ZEALAND

Appendix A

2.1 In addition to the five ground-air visual codes for use by survivors, New Zealand will retain the signal "All Well" - "LL". This signal will give the survivors a positive way to indicate that all is well.

15 Feb. 1984

OMAN

Chapter 2

2.6.4* SAR aircraft are equipped for homing on UHF only. No compliance is expected in the immediate future.

2.6.10* Instructions for use of survival equipment printed in English only. No compliance is expected in the immediate future.

Chapter 5

5.2.3 i) The State of Registry is not systematically notified upon initiation of the distress phase. No compliance is expected in the immediate future.

* Recommended Practice

15 Feb. 1984

PAPUA NEW GUINEA

Chapter 2

2.6.9* Papua New Guinea does not use colour coding to mark survival equipment.

2.6.9.1* Papua New Guinea does not use colour coding to mark survival equipment.

2.6.9.2* Papua New Guinea does not use colour coding to mark survival equipment.

2.6.10* Printed instructions on the use of survival equipment are in English only.

* Recommended Practice

15 May 1986

ROMANIA

Chapter 3

3.1.3 To enter the territory and the airspace of the Socialist Republic of Romania, a prior authorization obtained from the Department of Civil Aviation is needed.

---

15 Feb. 1984

SEYCHELLES

Chapter 2

2.4.3 and 2.4.4* Due to communications difficulties, Seychelles is unable to comply at all times with the requirements of Chapter 2, 2.4.3 and 2.4.4.

---

* Recommended Practice

15 Feb. 1984

THAILAND

Chapter 2

2.4.4* There is no visual or audio communication in Thailand.

---

* Recommended Practice

15 Feb. 1984

UGANDA

Chapter 5

5.2.3 i) Other States of Registry of aircraft are not notified when their aircraft are believed to be in distress. However, they are notified when their aircraft are involved in an accident.

---

15 Feb. 1984

UNION OF SOVIET SOCIALIST REPUBLICS

Chapter 2

2.6.3.1 Search and rescue aircraft belonging to USSR civil aviation do not at this time carry homing or communications equipment capable of operating on 243 MHz.

Chapter 3

3.1.3 Permission for foreign aircraft, equipment and personnel to enter the territory of the USSR to take part in search and rescue is granted by special permit, for which application must be made through diplomatic channels.

---

15 May 1986

ZAMBIA

Chapter 2

2.4.4* The implementation of this provision will be considered when circumstances permit.

---

* Recommended Practice

15 Feb. 1984

ANNEX 12 — SEARCH AND RESCUE

(Sixth Edition)

1. The attached Supplement supersedes all previous Supplements to Annex 12 and includes differences notified by Contracting States up to 10 November 1994.

2. This Supplement should be inserted at the end of Annex 12, Sixth Edition. Additional differences and revised comments received from Contracting States will be issued at intervals as amendments to this Supplement.

10/11/94

SUPPLEMENT TO ANNEX 12 — SIXTH EDITION

SEARCH AND RESCUE

Differences between the national regulations and practices of States and the corresponding International Standards and Recommended Practices contained in Annex 12, as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

NOVEMBER 1994

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT

No.	*Date*	*Entered by*	*No.*	*Date*	*Entered by*

AMENDMENTS TO ANNEX 12 ADOPTED OR APPROVED BY THE COUNCIL SUBSEQUENT TO THE SIXTH EDITION ISSUED MARCH 1975

No.	*Date of adoption or approval*	*Date applicable*	*No.*	*Date of adoption or approval*	*Date applicable*
12	8/12/75	12/8/76			
13	15/12/80	26/11/81			
14	12/3/90	15/11/90			
15	12/3/93	11/11/93			

10/11/94

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards and Recommended Practices of Annex 12, Sixth Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
Australia	2/8/93	1	10/11/94
Austria	10/8/93	1	10/11/94
Canada	5/10/93	1	10/11/94
Congo	30/9/93	1	10/11/94
France	1/10/93	1	10/11/94
Germany	27/9/93	1	10/11/94
Netherlands, Kingdom of the	6/10/93	1	10/11/94
Niger	30/9/93	1	10/11/94
Poland	28/10/93	1	10/11/94
Russian Federation	11/11/93	1	10/11/94
Singapore	10/5/93	1	10/11/94
Vanuatu	15/10/93	1	10/11/94

2. Contracting States which have notified ICAO that no differences exist

State	*Date of notification*
Argentina	24/8/93
Barbados	8/6/93
Brazil	16/7/93
Chile	8/10/93
Costa Rica	24/9/93
Cyprus	7/10/93
Denmark	4/8/93
Jordan	27/9/93
Mauritius	16/7/93
Micronesia, Federated States of	5/10/93
Myanmar	6/10/93

State	*Date of notification*
Namibia	11/7/93
New Zealand	13/10/93
Norway	11/10/93
Pakistan	7/7/93
Republic of Korea	4/10/93
Sweden	19/10/93
Switzerland	9/7/93
United Arab Emirates	16/5/93
United Kingdom	30/9/93
United States	2/7/93
Zambia	28/6/93

3. Contracting States from which no information has been received

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Armenia
Azerbaijan
Bahamas
Bahrain
Bangladesh
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Colombia
Comoros
Cook Islands
Côte d'Ivoire
Croatia
Cuba
Czech Republic
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Ecuador
Egypt
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Fiji
Finland
Gabon
Gambia
Georgia
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
Iceland
India
Indonesia
Iran, Islamic Republic of
Iraq
Ireland
Israel
Italy
Jamaica
Japan
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Lithuania
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mexico
Monaco
Mongolia
Morocco
Mozambique
Nauru
Nepal
Nicaragua
Nigeria
Oman
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Portugal
Qatar
Republic of Moldova
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Saudi Arabia
Senegal
Seychelles
Sierra Leone
Slovakia
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
Sudan
Suriname
Swaziland
Syrian Arab Republic
Tajikistan
Thailand
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Republic of Tanzania
Uruguay
Uzbekistan
Venezuela
Viet Nam
Yemen
Zaire
Zimbabwe

10/11/94

4. Paragraphs with respect to which differences have been notified

Paragraph	*Differences notified by*
Definitions	Poland
2.2.1.1	Australia
2.3.2	Austria
2.4.2	Russian Federation
2.4.2	Poland
2.4.4	Austria
2.6.4	Germany
2.6.8	Australia
	Austria
	Canada
2.6.9	Australia
	Poland
2.6.9.1	Australia
2.6.9.2	Australia
2.6.10	Singapore
3.1.3	Russian Federation
3.1.5	Poland

Paragraph	*Differences notified by*
3.1.8	Austria
3.1.9	Austria
3.2.4	Poland
3.3.3	Australia
	Singapore
4.1.3	Netherlands, Kingdom of the
	Singapore
4.1.4	Netherlands, Kingdom of the
Chapter 5	Congo
	Niger
5.2.3	Australia
5.2.3	Austria
	France
	Poland
5.6	Vanuatu
Appendix A	Canada

10/11/94

AUSTRALIA

CHAPTER 2

2.2.1.1* Australia's internal search and rescue regions (SRRs) are not coincident with Australia's internal flight information regions.

2.6.8* Survival equipment packs are provided only at aerodromes used by SAR aircraft.

2.6.9*
2.6.9.1*
2.6.9.2* Australia's survival equipment containers are not colour-coded, nor do they have printed indications or symbols.

CHAPTER 3

3.3.3* Australia does not disseminate shipping information on a regular basis, but will make this information available on request.

CHAPTER 5

5.2.3 The State of Registry is not systematically notified upon declaration of a distress phase.

*Recommended Practice

10/11/94

CHAPTER 2

2.3.2* It is not deemed necessary to establish rescue sub-centres.

2.4.4* It is not intended to supplement the means of communication provided in accordance with 2.4.2 c) and 2.4.3 b), by other means of visual or audio communication, for example, closed circuit television, as the now-existing means of communication are deemed to be sufficient.

2.6.8* Survival equipment for the whole territory of Austria is centrally provided at the Rescue Co-ordination Centre at Wien; it is, however, readily available and may, within the shortest time possible, be dropped by the two search and rescue aircraft at the required location.

CHAPTER 3

3.1.8* Apart from informal *ad hoc* arrangements with Germany and Switzerland, there are no arrangements for joint training exercises. It is, however, intended to make such arrangements with all neighbouring States.

3.1.9* Apart from informal arrangements with Germany and Switzerland, there are no arrangements for periodic liaison visits.

CHAPTER 5

5.2.3 f) 1) SAR units are not equipped to maintain a listening watch for transmission on frequency 406 MHz.

---

*Recommended Practice

CHAPTER 2

2.6.8* The airdrop of survival equipment requires qualified personnel who are only available at aerodromes where SAR aircraft are based, hence survival equipment for air dropping is not provided elsewhere.

Appendix A

2.1 In addition to the five international ground-air visual signal codes outlined, four additional signals are required for use within Canada **only**:

LL — All is well
F — Require food and water
L — Require fuel and oil
W — Need repairs

---

*Recommended Practice

CONGO

CHAPTER 5

General — The State of Registry is not notified systematically when a distress phase is initiated.

Any major search and rescue operation for a foreign aircraft is brought to the attention of the State of Registry through diplomatic channels.

As soon as the site of the accident is determined, the department responsible for aircraft accident investigations notifies the State of Registry in accordance with Annex 13, Chapter 4, 4.1.

10/11/94

FRANCE

CHAPTER 5

5.2.3 j) — In France, the relevant Regional Control Centre and not the Rescue Co-ordination Centre is responsible for notifying the appropriate accident investigation authorities.

10/11/94

GERMANY

CHAPTER 2

2.6.4 — At present, not all search and rescue aircraft are equipped with a device for homing on the emergency frequency 121.5 MHz.

10/11/94

NETHERLANDS, KINGDOM OF THE

CHAPTER 4

4.1.3* and 4.1.4 — Due to the great density of shipping in the Netherlands Maritime Area (for instance, the entrances to the ports of Rotterdam, Amsterdam, Antwerp and the crossroads of main shipping lines to other major ports in Western Europe), a merchant shipping plot is not kept ready. Via Scheveningen Radio, the merchant shipping coastal radio station, all ships in this area can be reached within minutes as a direct telephone communication exists between RCC Ijmuiden and Scheveningen Radio. As a result of this dense shipping and the comparatively small size of the Netherlands Maritime Area, there will normally always be ships in the direct vicinity of a disaster area.

---

*Recommended Practice

10/11/94

NIGER

CHAPTER 5

General — The State of Registry is not notified systematically when a distress phase is initiated.

Any major search and rescue operation for a foreign aircraft is brought to the attention of the State of Registry through diplomatic channels.

As soon as the site of the accident is determined, the department responsible for aircraft accident investigations notifies the State of Registry in accordance with Annex 13, Chapter 4, 4.1.

10/11/94

POLAND

CHAPTER 1

Definitions — *Rescue co-ordination centre*. Duties of RCC performed by ACC WARSZAWA are shared with the military RCC of the Polish Air Force and Air Defence. ACC is responsible for immediately notifying the AF and AD Rescue Co-ordination Centre.

CHAPTER 2

2.4.2 b) — RCC WARSZAWA does not have the means to communicate rapidly and reliably with the following RCCs: Slovakia, Ukraine, Belarus, Lithuania, the Russian Federation, Latvia, Sweden and Denmark.

2.4.2 f) — ACC WARSZAWA has been designated the SAR point of contact (SPOC) but it does not have rapid and reliable communications with the COSPAS-SARSAT MCC MOSCOW.

2.6.9 — No colour coding is used for droppable containers and packages.

CHAPTER 3

3.1.5 — No SAR co-operation agreement exists between Poland, the Czech Republic, Slovakia, Ukraine, Belarus, Lithuania, the Russian Federation and Latvia.

Operational agreement and working agreement with Germany, letter of agreement with Denmark and with Sweden (entry agreement only) are existing presently.

3.2.4 — ACC WARSZAWA has been designated a SPOC for the receipt of COSPAS-SARSAT distress data.

CHAPTER 5

5.2.3 f) 1) — RCC WARSZAWA is able to maintain a listening watch for transmission from an emergency locator transmitter on the frequency 121.5 MHz only.

10/11/94

RUSSIAN FEDERATION

CHAPTER 2

2.4.2 Each regional rescue co-ordination centre receives information about a distress and/or emergency situation from the COSPAS-SARSAT system from the COSPAS co-ordination centre for civil aviation needs.

CHAPTER 3

3.1.3 Permission for foreign aircraft, equipment and personnel to enter the territory of the Russian Federation to take part in search and rescue is granted by special permit, for which application must be made through diplomatic channels.

10/11/94

SINGAPORE

CHAPTER 2

2.6.10* Instructions on the use of the survival equipment, in English only, are enclosed in each droppable container or package.

CHAPTER 3

3.3.3* Singapore does not disseminate information on ships at sea.

CHAPTER 4

4.1.3* Singapore RCC does not have ready access to information regarding position, track, speed and callsign of ships within its SRR.

*Recommended Practice

10/11/94

VANUATU

CHAPTER 5

5.6 Accredited representatives will be permitted to participate in all stages of the inquiry except the judicial stage.

10/11/94

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AIRCRAFT ACCIDENT AND INCIDENT INVESTIGATION

ANNEX 13

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

EIGHTH EDITION — JULY 1994

This edition incorporates all amendments adopted by the Council prior to 24 March 1994 and supersedes, on 10 November 1994, all previous editions of Annex 13.

For information regarding the applicability of the Standards and Recommended Practices, *see* Chapter 2 and the Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-9	Incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

ATTACHMENTS TO ANNEX 13

FOREWORD

Historical Background

Standards and Recommended Practices for Aircraft Accident Inquiries were first adopted by the Council on 11 April 1951 pursuant to Article 37 of the Convention on International Civil Aviation (Chicago, 1944) and were designated as Annex 13 to the Convention. The Standards and Recommended Practices were based on recommendations of the Accident Investigation Division at its First Session in February 1946 which were further developed at the Second Session of the Division in February 1947.

The Fourteenth Session of the Assembly (Rome, August-September 1962) considered the subject of aircraft accident investigation and adopted Resolutions A14-22 and A14-27, Appendix P.* The first of these:

1) *directed* "the Council to:

"a) study the possibility of initiating a uniform procedure to be used by States to make available promptly the reports of aircraft accident investigations and inquiries, particularly when related to large modern transport aircraft, so that the dissemination of such reports by all Contracting States may be improved;

"b) study whether it is practicable to establish procedures by which the State of Manufacture or the State that first certificated the aircraft type, would, in appropriate cases and upon invitation, make available competent experts for advice or consultation in the investigation of accidents, and in the light of the results of such study:

"i) determine the most practicable means of ensuring that the fullest possible advantage will be taken of the specialized knowledge of such experts and notify all Contracting States accordingly, and

"ii) urge all Contracting States to co-operate in the use of such experts so as to contribute to the safety of air navigation;"

and

2) *urged* "all Contracting States to provide timely notification of aircraft accidents, especially those involving large modern transport aircraft, to the State of Manufacture or the State that first certificated the aircraft type, whenever it is considered that such action would be appropriate."

In addition, by Resolution A14-27, Appendix P, the Assembly resolved that, "in respect of accident investigation, that it is of great importance for the general improvement of the safety of air navigation that, to the greatest practicable extent, a Contracting State in which an accident has occurred involving aircraft other than of its manufacture communicate to the State of Manufacture as soon as possible any pertinent information which results from the inquiry and which may reflect on the airworthiness of the aircraft type or its equipment, or which might be used to effect improvement in safety."

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

While the Annex has been adopted pursuant to the provisions of Article 37 of the Convention, Aircraft Accident Inquiry is itself the subject of Article 26 of the Convention. This Article imposes an obligation on the State in which the aircraft accident occurs to institute an inquiry in certain circumstances and, as far as its laws permit, to conduct the inquiry in accordance with ICAO procedure. However, Article 26 does not preclude the taking of further action in the field of aircraft accident investigation and the procedures set forth in this Annex are not limited solely to an inquiry instituted under the requirements of Article 26, but under prescribed circumstances apply in the event of an inquiry into any "aircraft accident" within the terms of the definition herein. In order to maintain the correct relationship between the provisions of Article 26 and those of the Annex, the following principles have been observed:

a) Article 37 of the Convention is the Controlling Article in the development of an Aircraft Accident Inquiry Annex, but nothing in the Annex must contravene the express terms of Article 26, or any other Article of the

* The Fifteenth Session of the Assembly (Montreal, June-July 1965) subsequently adopted Resolution A15-8, Appendix P, which consolidated and superseded resolving clause 2 of Resolution A14-22 and Resolution A14-27, Appendix P.

Convention, nor should it contain any provision which would do violence to the spirit and intent of the Convention.

b) Subject to a) the Annex may deal with any relevant matter whether or not expressly dealt with by Article 26 or by any other Article of the Convention. For instance it is not a contravention of the Convention for the Annex to deal with the rights or obligations of States other than the State of Registry and the State in which the accident occurred; similarly the Annex may deal with the privileges to be accorded to observers entitled by Article 26 to be "present" at the inquiry. These are matters upon which Article 26 is silent. The Annex may also deal with accidents of a kind which do not fall within the provisions of Article 26.

Relationship between Annex 13 and Article 26 of the Convention

In order to clarify the relationship between the provisions of Article 26 and those of the present Annex the Council, at the 20th meeting of its Twelfth Session on 13 April 1951, adopted the following additional resolution:

"*Whereas* Article 26 of the Convention provides that a State in which an accident to an aircraft occurs within the terms of the Article, 'will institute an inquiry into the circumstances of the accident in accordance, in so far as its laws permit, with the procedure which may be recommended by the International Civil Aviation Organization'; and

"*Whereas* the Council, at the 18th meeting of its Twelfth Session on 11 April 1951, adopted Annex 13 on Aircraft Accident Inquiry;

"*The Council recommends* the Standards and Recommended Practices for Aircraft Accident Inquiry contained in Annex 13 to the Convention, as the procedure to be followed by Contracting States for inquiries into accidents involving death or serious injury and instituted in accordance with the provisions of Article 26;

"*It being understood:*

"1) that States may in accordance with Article 38 of the Convention, deviate from any provision of Annex 13, except that, with respect to accidents covered by terms of Article 26 of the Convention and pursuant to this Article, 'the State in which the accident occurs will institute an inquiry', 'the State in which the aircraft is registered shall be given the opportunity to appoint observers to be present at the inquiry' and 'the State holding the inquiry shall communicate the report and findings in the matter to that State'; and

"2) that the procedure here recommended is not applicable when an accident to an aircraft not involving death or serious injury 'indicates serious technical defect in the aircraft or air navigation facilities', in which cases and until ICAO recommends a procedure to this effect, the inquiry shall be conducted in accordance with the national procedure of the State concerned, subject to the obligations deriving from the provisions of Article 26."

The accredited representative and the advisers referred to in the Annex together comprise the observers that are given the right to be present at an inquiry under Article 26.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

Attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as is practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. However, the Standards and Recommended Practices of Annex 13 while of general applicability will, in many cases, require amplification in order to enable a complete national code to be formulated.

Status of Annex Components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.—*Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interests of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Provisions* governing the applicability of the Standards and Recommended Practices.

d) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

2.—*Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of Language

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial Practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

Any reference to a portion of this document which is identified by a number includes all subdivisions of that portion.

Table A. Amendments to Annex 13

Amendment	*Source(s)*	*Subject*	*Adopted* *Effective* *Applicable*
1st Edition	First and Second Sessions of the Accident Investigation Division	—	11 April 1951 1 September 1951 1 December 1951
1 (2nd Edition)	Assembly Resolutions A14-22 and A14-27, Appendix P Third Session of the Accident Investigation Division	New definitions; rights and obligations of the State of Manufacture; initial and subsequent notification of an accident; attendance of representatives of the operator; report on the inquiry; summary of the Report and its format.	24 November 1965 24 March 1966 25 August 1966
2	Third Session of the Accident Investigation Division	Communication procedures for sending aircraft accident notification.	5 December 1966 5 April 1967 24 August 1967
3	Personnel Licensing/ Training Practices/ Medical Divisional Meeting (1970)	Autopsy of victims of aircraft accidents and reporting of the results.	27 March 1972 27 July 1972 7 December 1972
4 (3rd Edition)	Air Navigation Commission study	Notification of all accidents to multi-engined aircraft of over 2 250 kg (5 000 lb); notification and exchange of information on incidents.	12 December 1972 12 April 1973 16 August 1973
5 (4th Edition)	Accident Investigation and Prevention Divisional Meeting (AIG/1974) Committee on Unlawful Interference	Change of title; deletion and addition of definitions; objective of an investigation; use of flight recorders and privileged status to be granted to certain investigation records; action to be taken by a State receiving safety recommendations; responsibility of the State of Registry to participate in the investigation of certain accidents when requested, to provide flight recorders under certain circumstances and to request participation of the State of Manufacture when the former State conducts the investigation and matters of airworthiness are involved; rights and obligations of the State of Manufacture to participate in certain investigations; rights and entitlement of the State having special interest in an accident by virtue of fatalities to its citizens; the Accident/Incident Data Reporting (ADREP) system; Investigator-in-charge to inform aviation security authorities, when necessary.	18 December 1975 18 April 1976 12 August 1976
6 (5th Edition)	Accident Investigation and Prevention Divisional Meeting (AIG/1974)	Addition of the words "on the basis of his qualifications" in the definitions of accredited representative, adviser and investigator-in-charge; new definition and specifications regarding the State of the Operator in the case of aircraft leased, chartered or interchanged; responsibility of the State of Registry for sending accident notification any time that State institutes the investigation; co-ordination between investigator-in-charge and judicial authorities; elimination of reference to number of engines; new specification for publication of the Final Report.	24 November 1978 24 March 1979 29 November 1979

Amendment	*Source(s)*	*Subject*	*Adopted Effective Applicable*
7 (6th Edition)	Accident Investigation and Prevention Divisional Meeting (AIG/1979)	Addition, in the definition of accident, of injuries inflicted by parts of an aircraft or by jet blast; strengthening of the general specification concerning the conduct of the investigation; strengthening of the specification regarding disclosure of records; strengthening of the specification for consultation on the Final Report; deletion of the specifications regarding a "Summary of the Final Report" and references thereto; change of the specification concerning the forwarding to ICAO of the Final Report; expansion of the specification on publication of the Final Report or related documents; new chapter on accident prevention measures; new attachment regarding exchange of Final Reports between States and a list of Final Reports available in States.	24 November 1980 24 March 1981 26 November 1981
8 (7th Edition)	Air Navigation Commission	Addition, in the definition of serious injury, of exposure to infectious substances and injurious radiation; new attachment regarding disclosure of records; editorial changes.	22 January 1988 22 May 1988 17 November 1988
9 (8th Edition)	Accident Investigation Divisional Meeting (AIG/1992)	Change of title; new or revised definitions of causes, investigation, serious incident, State of Design, State of Manufacture, and State of the Operator; strengthening of the specifications concerning applicability and the objective of the investigation; strengthening of the specifications concerning the responsibilities, rights and entitlements of the State of Design and the State of Manufacture; new specifications concerning the notification and investigation of serious incidents; strengthening of the specifications concerning notification of accidents and serious incidents; new specification concerning assistance by States nearest to an accident in international waters; new specification concerning the separation of any judicial or administrative proceedings to apportion blame or liability from an accident investigation; strengthening of the specifications concerning the use and readout of the flight recorders; strengthening of the specifications concerning autopsy examinations and co-ordination with the judicial authorities; strengthening of the specifications concerning disclosure of records and deletion of the related attachment; strengthening of the specifications concerning the responsibility of other States to provide information and their rights of participation; new specification concerning organizational information and strengthening of the specifications concerning the participation of the operator; strengthening of the specifications concerning the entitlement of accredited representatives and a new specification concerning their obligations; strengthening of the specification concerning participation of States having suffered fatalities or serious injuries to its citizens; strengthening of the specifications concerning the ADREP preliminary report and the accident/incident data report; strengthening of the specifications concerning consultation, publication and dissemination of the Final Report; new and strengthened specifications concerning accident prevention measures; new sub-paragraph and changes to the format of the Final Report in the Appendix; updated notification and reporting checklist in Attachment B; list of examples of serious incidents as a new Attachment D.	23 March 1994 25 July 1994 10 November 1994

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

When the following terms are used in the Standards and Recommended practices for Aircraft Accident and Incident Investigation they have the following meaning:

Accident. An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which:

a) a person is fatally or seriously injured as a result of:

— being in the aircraft, or
— direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
— direct exposure to jet blast,

except when the injuries are from natural causes, self-inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

b) the aircraft sustains damage or structural failure which:

— adversely affects the structural strength, performance or flight characteristics of the aircraft, and
— would normally require major repair or replacement of the affected component,

except for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennas, tires, brakes, fairings, small dents or puncture holes in the aircraft skin; or

c) the aircraft is missing or is completely inaccessible.

Note 1.— For statistical uniformity only, an injury resulting in death within thirty days of the date of the accident is classified as a fatal injury by ICAO.

Note 2.— An aircraft is considered to be missing when the official search has been terminated and the wreckage has not been located.

Accredited representative. A person designated by a State, on the basis of his or her qualifications, for the purpose of participating in an investigation conducted by another State.

Adviser. A person appointed by a State, on the basis of his or her qualifications, for the purpose of assisting its accredited representative in an investigation.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Causes. Actions, omissions, events, conditions, or a combination thereof, which led to the accident or incident.

Flight recorder. Any type of recorder installed in the aircraft for the purpose of complementing accident/incident investigation.

Note.— See Annex 6, Parts I, II and III, for specifications relating to flight recorders.

Incident. An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

Note.— The type of incidents which are of main interest to the International Civil Aviation Organization for accident prevention studies are listed in the ICAO Accident/Incident Reporting Manual *(Doc 9156).*

Investigation. A process conducted for the purpose of accident prevention which includes the gathering and analysis of information, the drawing of conclusions, including the determination of causes and, when appropriate, the making of safety recommendations.

Investigator-in-charge. A person charged, on the basis of his or her qualifications, with the responsibility for the organization, conduct and control of an investigation.

Note.— Nothing in the above definition is intended to preclude the functions of an investigator-in-charge being assigned to a commission or other body.

Maximum mass. Maximum certificated take-off mass.

Operator. A person, organization or enterprise engaged in or offering to engage in aircraft operation.

Preliminary Report. The communication used for the prompt dissemination of data obtained during the early stages of the investigation.

Safety recommendation. A proposal of the accident investigation authority of the State conducting the investigation, based on information derived from the investigation, made with the intention of preventing accidents or incidents.

Serious incident. An incident involving circumstances indicating that an accident nearly occurred.

Note 1.— The difference between an accident and a serious incident lies only in the result.

Note 2.— Examples of serious incidents can be found in Attachment D of Annex 13 and in the ICAO Accident/Incident Reporting Manual *(Doc 9156)*

Serious injury. An injury which is sustained by a person in an accident and which:

a) requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; or

b) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); or

c) involves lacerations which cause severe haemorrhage, nerve, muscle or tendon damage; or

d) involves injury to any internal organ; or

e) involves second or third degree burns, or any burns affecting more than 5 per cent of the body surface; or

f) involves verified exposure to infectious substances or injurious radiation.

State of Design. The State having jurisdiction over the organization responsible for the type design.

State of Manufacture. The State having jurisdiction over the organization responsible for the final assembly of the aircraft.

State of Occurrence. The State in the territory of which an accident or incident occurs.

State of the Operator. The State in which the operator's principal place of business is located or, if there is no such place of business, the operator's permanent residence.

State of Registry. The State on whose register the aircraft is entered.

Note.— In the case of the registration of aircraft of an international operating agency on other than a national basis, the States constituting the agency are jointly and severally bound to assume the obligations which, under the Chicago Convention, attach to a State of Registry. See, in this regard, the Council Resolution of 14 December 1967 on Nationality and Registration of Aircraft Operated by International Operating Agencies *(Doc 8722).*

10/11/94

CHAPTER 2. APPLICABILITY

2.1 Unless otherwise stated, the specifications in this Annex apply to activities following accidents and incidents wherever they occurred.

Note.— The application of this specification with respect to accidents or serious incidents occurring in the territory of a non-Contracting State, in an area of undetermined sovereignty or on the high seas is addressed in 5.2 and 5.3.

2.2 In this Annex the specifications concerning the State of the Operator apply only when an aircraft is leased, chartered or interchanged and when that State is not the State of Registry and if it discharges, in respect of this Annex, in part or in whole, the functions and obligations of the State of Registry.

CHAPTER 3. GENERAL

Note.— Guidance material relating to the rights and obligations of the State of the Operator in respect of accidents and incidents involving leased, chartered or interchanged aircraft is provided in Attachment A.

OBJECTIVE OF THE INVESTIGATION

3.1 The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

PROTECTION OF EVIDENCE, CUSTODY AND REMOVAL OF AIRCRAFT

RESPONSIBILITY OF THE STATE OF OCCURRENCE

General

3.2 The State of Occurrence shall take all reasonable measures to protect the evidence and to maintain safe custody of the aircraft and its contents for such a period as may be necessary for the purposes of an investigation. Protection of evidence shall include the preservation, by photographic or other means of any evidence which might be removed, effaced, lost or destroyed. Safe custody shall include protection against further damage, access by unauthorized persons, pilfering and deterioration.

Note 1.— Control over the wreckage is dealt with in 5.6.

Note 2.— Protection of flight recorder evidence requires that the recovery and handling of the recorder and its recordings be assigned only to qualified personnel.

Request from State of Registry or State of the Operator.

3.3 If a request is received from the State of Registry or the State of the Operator that the aircraft, its contents, and any other evidence remain undisturbed pending inspection by an accredited representative of the requesting State, the State of Occurrence shall take all necessary steps to comply with such request, so far as this is reasonably practicable and compatible with the proper conduct of the investigation; provided that the aircraft may be moved to the extent necessary to extricate persons, animals, mails and valuables, to prevent destruction by fire or other causes, or to eliminate any danger or obstruction to air navigation, to other transport or to the public.

Request from State of Design or State of Manufacture

3.4 If a request is received from the State of Design or the State of Manufacture that the aircraft remain undisturbed pending inspection by an accredited representative of the requesting State, the State of Occurrence shall take all reasonable steps to comply with such request, so far as this is reasonably practicable and compatible with the proper conduct of the investigation and does not result in undue delay in returning the aircraft to service where this is practicable.

Release from custody

3.5 Subject to the provisions of 3.2, 3.3 and 3.4, the State of Occurrence shall release custody of the aircraft, its contents or any parts thereof which are no longer required in the investigation, to any person or persons duly designated by the State of Registry or the State of the Operator, as applicable. For this purpose the State of Occurrence shall facilitate access to the aircraft, its contents or any parts thereof, provided that, if the aircraft, its contents, or any parts thereof, lie in an area within which the State finds it impracticable to grant such access, it shall itself effect removal to a point where access can be given.

CHAPTER 4. NOTIFICATION

Note.— Attachment B provides a notification and reporting checklist.

ACCIDENTS OR SERIOUS INCIDENTS IN THE TERRITORY OF A CONTRACTING STATE TO AIRCRAFT OF ANOTHER CONTRACTING STATE

RESPONSIBILITY OF THE STATE OF OCCURRENCE

Forwarding

4.1 The State of Occurrence shall forward a notification of an accident or serious incident with a minimum of delay and by the most suitable and quickest means available to:

a) the State of Registry;

b) the State of the Operator;

c) the State of Design;

d) the State of Manufacture; and

e) the International Civil Aviation Organization, when the aircraft involved is of a maximum mass of over 2 250 kg.

However, when the State of Occurrence is not aware of a serious incident, the State of Registry or the State of the Operator, as appropriate, shall forward a notification of such an incident to the State of Design, the State of Manufacture and the State of Occurrence.

Note 1.— Telephone, facsimile or the Aeronautical Fixed Telecommunication Network (AFTN) will in most cases constitute "the most suitable and quickest means available".

Note 2.— Provision for the notification of a distress phase to the State of Registry by the Rescue Co-ordination Centre is contained in Annex 12.

Format and content

4.2 The notification shall be in plain language and contain as much of the following information as is readily available, but its dispatch shall not be delayed due to the lack of complete information:

a) for accidents the identifying abbreviation ACCID, for serious incidents INCID;

b) manufacturer, model, nationality and registration marks, and serial number of the aircraft;

c) name of owner, operator and hirer, if any, of the aircraft;

d) name of the pilot-in-command;

e) date and time (local time or UTC) of the accident or serious incident;

f) last point of departure and point of intended landing of the aircraft;

g) position of the aircraft with reference to some easily defined geographical point and latitude and longitude;

h) number of crew and passengers; aboard, killed and seriously injured; others, killed and seriously injured;

i) nature of the accident or serious incident and the extent of damage to the aircraft so far as is known;

j) an indication to what extent the investigation will be conducted or is proposed to be delegated by the State of Occurrence;

k) physical characteristics of the accident or serious incident area; and

l) identification of the originating authority.

Note 1.— The 4-letter designator "YLYX" in association with an ICAO 4-letter location indicator forms the 8-letter addressee indicator for messages sent over the AFTN to authorities responsible for aircraft accident and serious incident investigations. For messages sent over the public telecommunication service the addressee indicator cannot be used and a postal or telegraphic address must be substituted.

The 8-letter addressee indicators and the corresponding postal and telegraphic addresses, when notified to ICAO, are published in the ICAO Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services *(Doc 8585).*

Note 2.— The ICAO Manual of Aircraft Accident Investigation *(Doc 6920) contains guidance material concerning the preparation of notification messages and the arrangements to be made for their prompt delivery to the addressee.*

Language

4.3 The notification shall be prepared in one of the working languages of ICAO, taking into account the language of the recipient(s), whenever it is possible to do so without causing undue delay.

Additional information

4.4 As soon as it is possible to do so, the State of Occurrence shall dispatch the details omitted from the notification as well as other known relevant information.

RESPONSIBILITY OF THE STATE OF REGISTRY AND THE STATE OF THE OPERATOR

Information — Participation

4.5 Upon receipt of the notification the State of Registry and the State of the Operator shall, as soon as possible, provide the State of Occurrence with any relevant information available to them regarding the aircraft and flight crew involved in the accident or serious incident. Each State shall also inform the State of Occurrence whether it intends to be represented at the investigation, and, if so, it shall indicate the probable date of arrival of its accredited representative.

RESPONSIBILITY OF THE STATE OF DESIGN AND THE STATE OF MANUFACTURE

Participation and attendance

4.6 Upon receipt of the notification and a request by the State of Occurrence for participation, the State of Design and the State of Manufacture shall:

a) in the case of an accident or serious incident to an aircraft of a maximum mass of over 100 000 kg, inform the State of Occurrence of:

1) the name of its accredited representative; and

2) whether the accredited representative will be present at the investigation and, if in the affirmative, the expected date of his or her arrival; and

b) in the case of an accident or serious incident to aircraft other than those specified in a) above, inform the State of Occurrence whether it will appoint an accredited representative. If such a representative is appointed the same information required under a) 1) and 2) shall be provided.

ACCIDENTS OR SERIOUS INCIDENTS IN THE TERRITORY OF THE STATE OF REGISTRY, IN A NON-CONTRACTING STATE OR OUTSIDE THE TERRITORY OF ANY STATE

RESPONSIBILITY OF THE STATE OF REGISTRY

Forwarding

4.7 When the State of Registry institutes the investigation of an accident or serious incident to an aircraft of a maximum mass of over 2 250 kg that State shall forward a notification, in accordance with 4.2 and 4.3 above, with a minimum of delay and by the most suitable and quickest means available, to:

a) the State of the Operator;

b) the State of Design;

c) the State of Manufacture; and

d) the International Civil Aviation Organization.

4.7.1 **Recommendation.—** *When the State of Registry institutes the investigation of an accident or serious incident to an aircraft of a maximum mass of 2 250 kg or less that State should forward a notification, in accordance with 4.2 and 4.3 above, with a minimum of delay and by the most suitable and quickest means available, to:*

a) the State of the Operator;

b) the State of Design; and

c) the State of Manufacture.

Note 1.— Telephone, facsimile or the Aeronautical Fixed Telecommunication Network (AFTN) will in most cases constitute "the most suitable and quickest means available".

Note 2.— Provision for the notification of a distress phase to the State of Registry by the rescue co-ordination centre is contained in Annex 12.

RESPONSIBILITY OF THE STATE OF THE OPERATOR, THE STATE OF DESIGN AND THE STATE OF MANUFACTURE

Information — Participation

4.8 Upon receipt of the notification the State of the Operator, the State of Design and the State of Manufacture shall, upon request, provide the State of Registry with any relevant information available to them regarding the flight crew and the aircraft involved in the accident or serious incident. Each State shall also inform the State of Registry whether it intends to be represented at the investigation and, if so, shall indicate the probable date of arrival of its accredited representative.

CHAPTER 5. INVESTIGATION

RESPONSIBILITY FOR INSTITUTING AND CONDUCTING THE INVESTIGATION

ACCIDENTS OR SERIOUS INCIDENTS IN THE TERRITORY OF A CONTRACTING STATE TO AIRCRAFT OF ANOTHER CONTRACTING STATE

State of Occurrence

5.1 The State of Occurrence shall institute an investigation into the circumstances of the accident. Such State shall also be responsible for the conduct of the investigation, but it may delegate the whole or any part of the conducting of such investigation to the State of Registry or the State of the Operator. In any event the State of Occurrence shall use every means to facilitate the investigation.

5.1.1 **Recommendation.—** *The State of Occurrence should institute an investigation into the circumstances of a serious incident. Such State may delegate the whole or any part of the conducting of such investigation to the State of Registry, the State of the Operator, the State of Design or the State of Manufacture. In any event the State of Occurrence should use every means to facilitate the investigation.*

Note.— The above provision does not exclude other already existing types of investigation of incidents (serious or not) by other organizations.

ACCIDENTS OR SERIOUS INCIDENTS IN THE TERRITORY OF A NON-CONTRACTING STATE

State of Registry

5.2 **Recommendation.—** *When the accident or the serious incident has occurred in the territory of a non-Contracting State, the State of Registry should endeavour to institute and conduct an investigation in co-operation with the State of Occurrence but, failing such co-operation, should itself conduct an investigation with such information as is available.*

ACCIDENTS OR SERIOUS INCIDENTS OUTSIDE THE TERRITORY OF ANY STATE

State of Registry

5.3 When the location of the accident or the serious incident cannot definitely be established as being in the territory of any State, the State of Registry shall institute and conduct any necessary investigation of the accident or serious incident. However, it may delegate the whole or any part of the investigation to another State by mutual arrangement and consent.

5.3.1 States nearest the scene of an accident in international waters shall provide such assistance as they are able and shall, likewise, respond to requests by the State of Registry.

ORGANIZATION AND CONDUCT OF THE INVESTIGATION

Note.— The ICAO Manual of Aircraft Accident Investigation *(Doc 6920) contains guidance material for the organization, conduct and control of an investigation. Further, those States which may provide expert assistance and facilities for the investigation of major accidents are listed in an appendix to this manual.*

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION

Note.— Nothing in the following specifications is intended to preclude the State conducting the investigation from calling upon the best technical expertise from any source.

General

5.4 The accident investigation authority shall have independence in the conduct of the investigation and have unrestricted authority over its conduct. The investigation shall include the gathering, recording and analysis of all available relevant information, if possible the determination of the causes, and the completion of the Final Report followed, if appropriate, by safety recommendations. When possible the scene of the accident shall be visited, the wreckage examined and statements taken from witnesses.

5.4.1 **Recommendation.**— *Any judicial or administrative proceedings to apportion blame or liability should be separate from any investigation conducted under the provisions of this Annex.*

Investigator-in-charge — Initiation

5.5 The State conducting the investigation shall designate the investigator-in-charge of the investigation and shall initiate the investigation immediately.

Investigator-in-charge — Access and control

5.6 The investigator-in-charge shall have unhampered access to the wreckage and unrestricted control over it to ensure that a detailed examination can be made without delay by authorized personnel participating in the investigation.

Flight recorders — Accidents and serious incidents

5.7 Effective use shall be made of flight recorders in the investigation of an accident or a serious incident wherever it occurred. The State conducting the investigation shall arrange for the readout of the flight recorders.

5.7.1 **Recommendation.**— *In the event that the State conducting the investigation of an accident or a serious incident does not have adequate facilities to read out the flight recorders, it should use the facilities made available to it by other States, giving consideration to the following:*

a) the capabilities of the readout facility;

b) the timeliness of the readout; and

c) the location of the readout facility.

Flight recorders — Incidents

5.8 Effective use shall be made of flight recorders in the investigation of an incident wherever it occurred.

Autopsy examinations

5.9 The State conducting the investigation into a fatal accident shall arrange for complete autopsy examination of fatally injured flight crew and, subject to the particular circumstances, of fatally injured passengers and cabin attendants, by a pathologist, preferably experienced in accident investigation. These examinations shall be expeditious and complete.

Note.— Guidance material related to autopsies is provided in detail in the ICAO Manual of Civil Aviation Medicine *(Doc 8984) and the ICAO* Manual of Accident Investigation *(Doc 6920), the former containing detailed guidance on toxicological testing.*

Co-ordination — Judicial authorities

5.10 The State conducting the investigation shall recognize the need for co-ordination between the investigator-in-charge and the judicial authorities. Particular attention shall be given to evidence which requires prompt recording and analysis for the investigation to be successful, such as the examination and identification of victims and readouts of flight recorder recordings.

Note 1.— The responsibility of the State of Occurrence for such co-ordination is set out in 5.1.

Note 2.— Possible conflicts between investigating and judicial authorities regarding the custody of flight recorders and their recordings may be resolved by an official of the judicial authority carrying the recordings to the place of readout, thus maintaining custody.

Informing aviation security authorities

5.11 If, in the course of an investigation it becomes known, or it is suspected, that an act of unlawful interference was involved, the investigator-in-charge shall immediately initiate action to ensure that the aviation security authorities of the State(s) concerned are so informed.

Disclosure of records

5.12 The State conducting the investigation of an accident or incident, wherever it occurred, shall not make the following records available for purposes other than accident or incident investigation, unless the appropriate authority for the administration of justice in that State determines that their disclosure outweighs the adverse domestic and international impact such action may have on that or any future investigations:

a) all statements taken from persons by the investigation authorities in the course of their investigation;

b) all communications between persons having been involved in the operation of the aircraft;

c) medical or private information regarding persons involved in the accident or incident;

d) cockpit voice recordings and transcripts from such recordings; and

e) opinions expressed in the analysis of information, including flight recorder information.

These records shall be included in the final report or its appendices only when pertinent to the analysis of the accident or incident. Parts of the records not relevant to the analysis shall not be disclosed.

Note.— Information contained in the records listed above, which includes information given voluntarily by persons interviewed during the investigation of an accident or incident, could be utilized inappropriately for subsequent disciplinary, civil, administrative and criminal proceedings. If such information is distributed, it may, in the future, no longer be openly disclosed to investigators. Lack of access to such information would impede the investigative process and seriously affect flight safety.

Re-opening of investigation

5.13 If, after the investigation has been closed, new and significant evidence becomes available, the State which conducted the investigation shall re-open it. However, when the State which conducted the investigation did not institute it, that State shall first obtain the consent of the State which instituted the investigation.

RESPONSIBILITY OF ANY OTHER STATE

Information — Accidents and incidents

5.14 Any State shall, on request from the State conducting the investigation of an accident or an incident, provide that State with all the relevant information available to it.

Note.— See also 5.16.

Pertinent information — Accidents and incidents

5.15 Any State, the facilities or services of which have been, or would normally have been, used by an aircraft prior to an accident or an incident wherever it occurred, and which has information pertinent to the investigation, shall provide such information to the State conducting the investigation.

RESPONSIBILITY OF THE STATE OF REGISTRY AND THE STATE OF THE OPERATOR

Flight recorders — Accidents and serious incidents

5.16 When an aircraft involved in an accident or a serious incident lands in a State other than the State of Occurrence, the State of Registry or the State of the Operator shall, on request from the State conducting the investigation, furnish the latter State with the flight recorder records and, if necessary, the associated flight recorders.

Note.— In implementing 5.16, the State of Registry or the State of the Operator may request the co-operation of any other State in the retrieval of the flight recorder records.

Organizational information

5.17 The State of Registry and the State of the Operator, on request from the State conducting the investigation, shall provide pertinent information on any organization whose activities may have directly or indirectly influenced the operation of the aircraft.

PARTICIPATION IN THE INVESTIGATION

Note.— Nothing in this Annex is intended to imply that the accredited representative and advisers of a State have to be always present in the State in which the investigation is conducted.

PARTICIPATION OF THE STATE OF REGISTRY AND THE STATE OF THE OPERATOR

Rights

5.18 The State of Registry and the State of the Operator shall be entitled to appoint an accredited representative to participate in the investigation.

Operator — Adviser

5.19 The State of Registry or the State of the Operator shall appoint one or more advisers nominated by the operator, to assist its accredited representative.

5.19.1 **Recommendation.—** *When neither the State of Registry, nor the State of the Operator appoint an accredited representative, the State conducting the investigation should invite the operator to participate, subject to the procedures of the State conducting the investigation.*

Obligations

5.20 When the State conducting an investigation into an accident to an aircraft of a maximum mass of over 2 250 kg specifically requests participation by the State of Registry and/or the State of the Operator, the State(s) concerned shall provide an accredited representative.

PARTICIPATION OF THE STATE OF DESIGN AND THE STATE OF MANUFACTURE

Rights

5.21 The State of Design and the State of Manufacture shall each be entitled to appoint an accredited representative to participate in the investigation of an accident.

Note.— Nothing in this Standard is intended to preclude the State that designed or manufactured the powerplant or major components of the aircraft from requesting participation in the investigation of an accident.

Obligations

5.22 When the State conducting an investigation of an accident to an aircraft of a maximum mass of over 2 250 kg, whenever it occurred, specifically requests participation by the State of Design and the State of Manufacture, the latter State(s) shall each appoint an accredited representative.

Note 1.— Nothing in 5.22 is intended to preclude the State conducting an investigation from requesting the State that designed or manufactured the powerplant or major components of the aircraft to appoint an accredited representative whenever the former State believes that a useful contribution can be made to the investigation or, when such participation might result in increased safety.

Note 2.— Nothing in 5.22 is intended to preclude the State conducting an investigation from requesting the State of Design and the State of Manufacture to give assistance in the investigation of accidents other than those in 5.22.

PARTICIPATION OF OTHER STATES

Rights

5.23 Any State which on request provides information, facilities or experts to the State conducting the investigation shall be entitled to appoint an accredited representative to participate in the investigation.

Note.— Any State that provides an operational base for field investigations or is involved in search and rescue or wreckage recovery operations may also be entitled to appoint an accredited representative to participate in the investigation.

ENTITLEMENT OF ACCREDITED REPRESENTATIVES

Advisers

5.24 A State entitled to appoint an accredited representative shall also be entitled to appoint one or more advisers to assist the accredited representative in the investigation.

Note 1.— Nothing in the above specifications is intended to preclude a State participating in an investigation from calling upon the best technical expert(s) from any source and appointing such expert(s) as adviser(s) to its accredited representative.

Note 2.— Facilitation of the entry of the accredited representatives, their advisers and equipment, is covered in Annex 9 — Facilitation. *The carriage of official or service passport may expedite the entry.*

5.24.1 Advisers assisting an accredited representative shall be permitted, under the accredited representative's supervision, to participate in the investigation to the extent necessary to enable the accredited representative to make his or her participation effective.

Participation

5.25 Participation in the investigation shall confer entitlement to participate in all aspects of the investigation, under the control of the investigator-in-change, in particular to:

a) visit the scene of the accident;

b) examine the wreckage;

c) obtain witness information and suggest areas of questioning;

d) have full access to all relevant evidence as soon as possible;

e) receive copies of all pertinent documents;

f) participate in readouts of recorded media;

g) participate in off-scene investigative activities such as component examinations, technical briefings, tests and simulations;

h) participate in investigation progress meetings including deliberations related to analysis, findings, causes and safety recommendations; and

i) make submissions in respect of the various elements of the investigation.

However, participation of States other than the State of Registry, the State of the Operator, the State of Design and the State of Manufacture may be limited to those matters which entitled such States to participation under 5.23.

Note 1.— It is recognized that the form of participation would be subject to the procedures of the State in which the investigation, or part thereof, is being conducted.

Note 2.— The collection and recording of information need not be delayed to await the arrival of an accredited representative.

Note 3.— Nothing in this Standard precludes the State conducting the investigation from extending participation beyond the entitlement enumerated.

Obligations

5.26 The accredited representative and his or her advisers:

a) shall provide the State conducting the investigation with all relevant information available to them; and

b) shall not provide information on the progress and the findings of the investigation without the express consent of the State conducting the investigation.

PARTICIPATION OF STATES HAVING SUFFERED FATALITIES OR SERIOUS INJURIES TO ITS CITIZENS

Rights and entitlement

5.27 **Recommendation.—** *A State which has a special interest in an accident, wherever it occurred, by virtue of fatalities or serious injuries to its citizens should, upon making a request to do so, be permitted by the State conducting the investigation to appoint an expert who should be entitled to:*

a) visit the scene of the accident;

b) have access to the relevant factual information;

c) participate in the identification of the victims;

d) assist in questioning surviving passengers who are citizens of the expert's State; and

e) receive a copy of the Final Report.

The State requesting such participation should justify to the State conducting the investigation the basis for its request.

CHAPTER 6. REPORTING

Note 1.— Attachment B provides a notification and reporting checklist.

Note 2.— The specifications of this chapter may require three separate reports for any one accident or incident. They are:

Preliminary Report
Accident/Incident Data Report
Final Report

Note 3.— Guidance for preparing the Preliminary Report and the Accident/Incident Data Report is given in the ICAO Accident/Incident Reporting Manual *(Doc 9156).*

Note 4.— The Final Report may be prepared in the format considered to be the most appropriate in the circumstances. However, the format presented in the Appendix may be used to good advantage.

PRELIMINARY REPORT

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION — ACCIDENTS WHEREVER THEY OCCURRED

Aircraft over 2 250 kg

6.1 When the aircraft involved in an accident, wherever it occurred, is an aircraft of a maximum mass of over 2 250 kg, the State conducting the investigation shall send the Preliminary Report to:

a) the State of Registry or the State of Occurrence, as appropriate;

b) the State of the Operator;

c) the State of Design;

d) the State of Manufacture;

e) any State which provided relevant information, significant facilities or experts; and

f) the International Civil Aviation Organization.

Aircraft of 2 250 kg or less

6.2 **Recommendation.—** *When an aircraft, not covered by 6.1 above, is involved in an accident, wherever it occurred and when airworthiness or matters considered to be of interest to other States are involved, the State conducting the investigation should forward the Preliminary Report to:*

a) the State of Registry or the State of Occurrence, as appropriate;

b) the State of the Operator;

c) the State of Design;

d) the State of Manufacture; and

e) any State which provided relevant information, significant facilities or experts.

FORM AND DISPATCH OF THE PRELIMINARY REPORT

Note.— See Introductory Note 3 to Chapter 6.

Language

6.3 The Preliminary Report shall be submitted to appropriate States and to the International Civil Aviation Organization in one of the working languages of ICAO.

Coding

6.4 **Recommendation.—** *Preliminary Reports addressed to the International Civil Aviation Organization should also be submitted in code.*

Dispatch

6.5 The Preliminary Report shall be sent by airmail within thirty days of the date of the accident unless the Accident/Incident Data Report has been sent by that time. When matters directly affecting safety are involved it shall be sent as soon as the information is available and by the most suitable and quickest means available.

ACCIDENT/INCIDENT DATA REPORT

Note.— See Introductory Note 3 to Chapter 6.

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION — ACCIDENTS WHEREVER THEY OCCURRED

Aircraft over 2 250 kg

6.6 Wherever an accident occurs and when the aircraft involved is an aircraft of a maximum mass of over 2 250 kg, the State conducting the investigation shall send, as soon as practicable after the investigation, the Accident Data Report to the International Civil Aviation Organization.

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION — INCIDENTS WHEREVER THEY OCCURRED

Note.— The type of incidents which are of main interest to the International Civil Aviation Organization for accident prevention studies are listed in Attachment D.

Aircraft over 5 700 kg

6.7 If a State conducts an investigation into an incident to an aircraft of a maximum mass of over 5 700 kg that State shall send, as soon as is practicable after the investigation, the Incident Data Report to the International Civil Aviation Organization, when the investigation has revealed matters considered to be of interest to other States.

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION — ADDITIONAL INFORMATION

Accidents and incidents wherever they occurred

6.8 **Recommendation.—** *The State conducting the investigation should, upon request, provide other States with pertinent information additional to that made available in the Accident/Incident Data Report.*

FINAL REPORT

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION

Consultation

6.9 The State conducting the investigation shall send a copy of the draft Final Report to the State which instituted the investigation and to all States that participated in the investigation, inviting their significant and substantiated comments on the report as soon as possible. If the State conducting the investigation receives comments within sixty days of the date of the transmittal letter it shall either amend the draft Final Report to include the substance of the comments received, or append the comments to the Final Report. If the State conducting the investigation receives no comments within sixty days, it shall issue the Final Report in accordance with 6.10, unless an extension of that period has been agreed by the States concerned.

Note 1.— Comments to be appended to the Final Report are restricted to non-editorial specific technical aspects of the Final Report upon which no agreement could be reached.

Note 2.— The State conducting the investigation may consider using the most suitable and quickest means available when sending the draft Final Report to recipient States, such as facsimile, courier service or express mail.

Recipient States

6.10 The Final Report of the investigation of an accident shall be sent with a minimum of delay by the State conducting the investigation to:

a) the State which instituted the investigation;

b) the State of Registry;

c) the State of the Operator;

d) the State of Design;

e) the State of Manufacture;

f) any State having suffered fatalities or serious injuries to its citizens; and

g) any State which provided relevant information, significant facilities or experts.

Publication of the Final Report

6.11 In the interest of accident prevention, the State conducting the investigation of an accident shall publish the Final Report as soon as possible.

6.11.1 **Recommendation.—** *In the interest of accident prevention, the State conducting the investigation of a serious incident should publish the Final Report as soon as possible.*

International dissemination of the Final Report

6.12 When the State which has conducted an investigation into an accident involving an aircraft of a maximum mass of over 5 700 kg, wherever it occurred, has published a Final Report, that State shall send to the International Civil Aviation Organization a copy of the Final Report.

Note.— Whenever practicable the Final Report sent to ICAO is to be prepared in one of the working languages of the Organization and in the form shown in the Appendix.

RESPONSIBILITY OF ANY STATE

Publication — Consent

6.13 States shall not circulate, publish or give access to a draft report or any part thereof, or any documents obtained during an investigation of an accident or incident, without the express consent of the State which conducted the investigation, unless such reports or documents have already been published or released by that latter State.

FORWARDING OF INCIDENT INFORMATION

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION

Matters of interest to other States

6.14 **Recommendation.—** *If a State conducts an investigation into an incident which involves matters considered to be of interest to other States, that State should forward to them the related information as soon as possible.*

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CHAPTER 7. ACCIDENT PREVENTION MEASURES

Note.— The specifications in this Chapter apply only to accidents and those incidents on which an investigation has been conducted. The objective of these specifications is to promote accident prevention by a prompt exchange of information.

RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION

Prompt preventive action

7.1 At any stage of the investigation of an accident or incident, wherever it occurred, the accident investigation authority of the State conducting the investigation shall recommend to the appropriate authorities, including those in other States, any preventive action which needs to be taken promptly to prevent similar occurrences.

Report analysis — Preventive actions

7.2 A State conducting investigations of accidents or incidents, wherever they occurred, shall analyse the information contained in its accident/incident reports to determine the preventive actions required.

Incident reporting systems

7.3 **Recommendation.—** *States should establish formal incident reporting systems to facilitate collection of information on actual or potential safety deficiencies.*

Note.— Guidance related to both mandatory and voluntary State incident reporting systems is given in the ICAO Accident Prevention Manual *(Doc 9422).*

Data base systems

7.4 **Recommendation.—** *When practicable, States should establish systems, including data bases, to facilitate effective analysis of the information obtained from its investigations of accidents and incidents, wherever they occurred. The data base systems should use standardized formats to facilitate data exchange.*

Note.— Guidance material related to the specification for such data bases will be provided by ICAO upon request from States.

Safety recommendations — Dispatch

7.5 A State conducting investigations of accidents or incidents, wherever they occurred, and a State maintaining an incident reporting system, shall address, when appropriate, any safety recommendations arising out of its investigations to the accident investigation authorities of other State(s) concerned and, when ICAO documents are involved, to ICAO.

Note.— When Final Reports contain safety recommendations addressed to ICAO, because ICAO documents are involved, these reports must be accompanied by a letter outlining the specific action proposed.

RESPONSIBILITY OF A STATE RECEIVING SAFETY RECOMMENDATIONS

Action on safety recommendations

7.6 A State which receives safety recommendations or other proposals for preventive action shall inform the proposing State of the preventive action taken or under consideration, or the reasons why no action will be taken.

APPENDIX. FORMAT OF THE FINAL REPORT

(See Chapter 6)

PURPOSE

The purpose of this format is to present the Final Report in a convenient and uniform manner.

Detailed guidance on completing each section of the Final Report is found in the ICAO *Manual of Aircraft Accident Investigation* (Doc 6920).

FORMAT

Title. The Final Report begins with a title comprising:

name of the operator; manufacturer, model, nationality and registration marks of the aircraft; place and date of the accident or incident.

Synopsis. Following the title is a synopsis describing briefly all relevant information regarding:

notification of accident to national and foreign authorities; identification of the accident investigation authority and accredited representation; organization of the investigation; authority releasing the report and date of publication;

and concluding with a brief resumé of the circumstances leading to the accident.

Body. The body of the Final Report comprises the following main headings:

1. Factual information
2. Analysis
3. Conclusions
4. Safety recommendations

each heading consisting of a number of sub-headings as outlined in the following.

Appendices. Include as appropriate.

Note.— In preparing a Final Report, using this format, ensure that:

a) all information relevant to an understanding of the factual information, analysis and conclusions is included under each appropriate heading;

b) where information in respect of any of the items in 1.— Factual information is not available, or is irrelevant to the circumstances leading to the accident, a note to this effect is included under the appropriate sub-headings.

1. FACTUAL INFORMATION

1.1 ***History of the flight.*** A brief narrative giving the following information:

— Flight number, type of operation, last point of departure, time of departure (local time or UTC), point of intended landing.

— Flight preparation, description of the flight and events leading to the accident, including reconstruction of the significant portion of the flight path, if appropriate.

— Location (latitude, longitude, elevation), time of the accident (local time or UTC), whether day or night.

1.2 ***Injuries to persons.*** Completion of the following (in numbers):

Injuries	*Crew*	*Passengers*	*Others*
Fatal			
Serious			
Minor/None			

Note.— Fatal injuries include all deaths determined to be a direct result of injuries sustained in the accident. Serious injury is defined in Chapter 1 of the Annex.

1.3 ***Damage to aircraft.*** Brief statement of the damage sustained by aircraft in the accident (destroyed, substantially damaged, slightly damaged, no damage).

1.4 ***Other damage.*** Brief description of damage sustained by objects other than the aircraft.

1.5 ***Personnel information:***

a) Pertinent information concerning each of the flight crew members including: age, validity of licences, ratings, mandatory checks, flying experience (total and on type) and relevant information on duty time.

b) Brief statement of qualifications and experience of other crew members.

c) Pertinent information regarding other personnel, such as air traffic services, maintenance, etc., when relevant.

1.6 *Aircraft information:*

a) Brief statement on airworthiness and maintenance of the aircraft (indication of deficiencies known prior to and during the flight to be included, if having any bearing on the accident).

b) Brief statement on performance, if relevant, and whether the mass and centre of gravity were within the prescribed limits during the phase of operation related to the accident. (If not and if of any bearing on the accident give details.)

c) Type of fuel used.

1.7 *Meteorological information:*

a) Brief statement on the meteorological conditions appropriate to the circumstances including both forecast and actual conditions, and the availability of meteorological information to the crew.

b) Natural light conditions at the time of the accident (sunlight, moonlight, twilight, etc.).

1.8 *Aids to navigation.* Pertinent information on navigation aids available, including landing aids such as ILS, MLS, NDB, PAR, VOR, visual ground aids, etc., and their effectiveness at the time.

1.9 *Communications.* Pertinent information on aeronautical mobile and fixed service communications and their effectiveness.

1.10 *Aerodrome information.* Pertinent information associated with the aerodrome, its facilities and condition, or with the take-off or landing area if other than an aerodrome.

1.11 *Flight recorders.* Location of the flight recorder installations in the aircraft, their condition on recovery and pertinent data available therefrom.

1.12 *Wreckage and impact information.* General information on the site of the accident and the distribution pattern of the wreckage; detected material failures or component malfunctions. Details concerning the location and state of the different pieces of the wreckage are not normally required unless it is necessary to indicate a break-up of the aircraft prior to impact. Diagrams, charts and photographs may be included in this section or attached in the Appendices.

1.13 *Medical and pathological information.* Brief description of the results of the investigation undertaken and pertinent data available therefrom.

Note.— Medical information related to flight crew licences should be included in 1.5 — Personnel information.

1.14 *Fire.* If fire occurred, information on the nature of the occurrence, and of the fire fighting equipment used and its effectiveness.

1.15 *Survival aspects.* Brief description of search, evacuation and rescue, location of crew and passengers in relation to injuries sustained, failure of structures such as seats and seat-belt attachments.

1.16 *Tests and research.* Brief statements regarding the results of tests and research.

1.17 *Organizational and management information.* Pertinent information concerning the organizations and their management involved in influencing the operation of the aircraft. The organizations include, for example, the operator; the air traffic services, airway, aerodrome and weather service agencies; and the regulatory authority. The information could include, but not be limited to, organizational structure and functions, resources, economic status, management policies and practices, and regulatory framework.

1.18 *Additional information.* Relevant information not already included in 1.1 to 1.17 above.

1.19 *Useful or effective investigation techniques.* When useful or effective investigation techniques have been used during the investigation, briefly indicate the reason for using these techniques and refer here to the main features as well as describing the results under the appropriate sub-headings 1.1 to 1.18.

2. ANALYSIS

Analyse, as appropriate, only the information documented in 1. — Factual information and which is relevant to the determination of conclusions and causes.

3. CONCLUSIONS

List the findings and causes established in the investigation. The list of causes should include both the immediate and the deeper systemic causes.

4. SAFETY RECOMMENDATIONS

As appropriate, briefly state any recommendations made for the purpose of accident prevention and any resultant corrective action.

APPENDICES

Include, as appropriate, any other pertinent information considered necessary for the understanding of the report.

ATTACHMENTS TO ANNEX 13

These Attachments do not constitute a part of Annex 13 — Aircraft Accident and Incident Investigation. The material contained herein is intended to assist in the application of Annex 13.

ATTACHMENT A. RIGHTS AND OBLIGATIONS OF THE STATE OF THE OPERATOR IN RESPECT OF ACCIDENTS AND INCIDENTS INVOLVING LEASED, CHARTERED OR INTERCHANGED AIRCRAFT

The Standards and Recommended Practices of Annex 13 — Aircraft Accident and Incident Investigation were developed when the State of Registry and the State of the Operator normally were the same. In recent years, however, international aircraft leasing and interchanging arrangements have developed so that in many instances the State of the Operator is different from the State of Registry.

Leasing or interchange arrangements sometimes include the provision of flight crews from the State of Registry. However, more often, flight crews are provided by the State of the Operator and the aircraft operated under national legislation of the State of the Operator. Similarly, a variety of arrangements for airworthiness can emerge from these arrangements. Airworthiness responsibility may rest, wholly or partly, with the State of the Operator or State of Registry. Sometimes the operator, in conformity with an airworthiness control system specified by the State of Registry, carries out maintenance and keeps records.

In the event of an accident or an incident, it is important that any State which has assumed responsibility for the safety of an aircraft has the right to participate in an investigation, at least in respect of that responsibility. It is also important that the State conducting the investigation should have speedy access to all documents and other information relevant to that investigation.

When the location of an accident or an incident cannot definitely be established as being in the territory of another State, the State of the Operator, after consultation with the State of Registry, should accept full or partial responsibility for the conduct of the investigation.

ATTACHMENT B. NOTIFICATION AND REPORTING CHECKLIST

Note.— In this checklist the following terms have the meaning indicated below:
— International occurrences: *accidents and serious incidents occurring in the territory of a Contracting State to aircraft registered in another Contracting State;*
— Domestic occurrences: *accidents and serious incidents occurring in the territory of the State of Registry;*
— Other occurrences: *accidents and serious incidents occurring in the territory of a non-Contracting State, or outside the territory of any State.*

1. NOTIFICATION — ACCIDENTS AND SERIOUS INCIDENTS

From	*For*	*Send to*	*Annex 13 reference*
State of Occurrence	International occurrences: All aircraft	State of Registry State of the Operator State of Design State of Manufacture ICAO (when aircraft over 2 250 kg)	4.1
State of Registry	Domestic and other occurrences: Aircraft over 2 250 kg	State of the Operator State of Design State of Manufacture ICAO	4.7
State of Registry	Domestic and other occurrences: Aircraft of 2 250 kg or less	Same as above, *except* ICAO	4.7.1

2. ACCIDENT REPORTING

Accidents wherever they occurred

From	*Type of report*	*Concerning*	*Send to*	*Annex 13 reference*
State conducting the investigation	PRELIMINARY REPORT	Aircraft over 2 250 kg	State of Registry or State of Occurrence State of the Operator State of Design State of Manufacture State providing information, significant facilities or experts ICAO	6.1
		Aircraft of 2 250 kg or less if airworthiness or matters of interest	Same as above, *except* ICAO	6.2
	ACCIDENT DATA REPORT	Aircraft over 2 250 kg	ICAO	6.6
	FINAL REPORT	All aircraft	State instituting the investigation State of Registry State of the Operator State of Design State of Manufacture State having interest because of fatalities State providing information, significant facilities or experts	6.10
			ICAO	6.12

3. INCIDENT REPORTING

Incidents wherever they occurred (when investigated)

From	*Type of report*	*Concerning*	*Send to*	*Annex 13 reference*
State conducting the investigation	INCIDENT DATA REPORT	Aircraft over 5 700 kg, if matters of interest to other States are involved	ICAO	6.7
	INCIDENT INFORMATION	All aircraft, if matters of interest to other States are involved	Interested States	6.14

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ATTACHMENT C. EXCHANGE OF FINAL REPORTS BETWEEN STATES AND PUBLICATION OF A LIST OF FINAL REPORTS AVAILABLE IN STATES

EXCHANGE OF FINAL REPORTS BETWEEN STATES

Accident prevention to be effective depends greatly on the promptness with which the information on accidents is available.

For a variety of reasons Final Reports on accidents can only be published in the ICAO *Aircraft Accident Digest* some two to three years after the date of the accident.

In an attempt to shorten this delay, some States are disseminating their narrative Final Reports on domestic as well as international accidents, not only to the recipient States specified in 6.10 of the Annex, but also to many other States.

To speed up the exchange of accident/incident information all States are strongly encouraged to disseminate their Final Reports on domestic as well as on international accidents to other States. These reports should preferably be prepared in the format shown in the Appendix to Annex 13 and in one of the working languages of ICAO, or alternatively in the original language used.

LIST OF FINAL REPORTS AVAILABLE IN STATES

With the advent of the Accident/Incident Reporting (ADREP) system, States are normally aware of accidents or incidents, wherever they occurred, through the ICAO ADREP Summary. However, the information contained in this summary is rather brief and it would help States which require more detailed information in a narrative form, to know which Final Reports are available in other States so that they can request copies of such reports.

For that purpose all States are urged to send to ICAO on a six-monthly basis a list of the Final Reports which have become available in their own administration during the previous six months and which could be disseminated to other States on request. That list is to be sent in one of the working languages of ICAO and should provide the following information:

— name of the operator concerned (if desired);

— manufacturer, model, registration marks of the aircraft;

— place and date of the occurrence;

— type of occurrence; and

— language(s) in which the Final Report is available.

ATTACHMENT D. LIST OF EXAMPLES OF SERIOUS INCIDENTS

1. The term "serious incident" is defined in Chapter 1 as follows:

Serious incident. An incident involving circumstances indicating that an accident nearly occurred.

2. The incidents listed are typical examples of incidents that are likely to be serious incidents. The list is not exhaustive and only serves as guidance to the definition of serious incident.

Near collisions requiring an avoidance manoeuvre to avoid a collision or an unsafe situation or when an avoidance action would have been appropriate.

Controlled flight into terrain only marginally avoided.

Aborted take-offs on a closed or engaged runway.

Take-offs from a closed or engaged runway with marginal separation from obstacle(s).

Landings or attempted landings on a closed or engaged runway.

Gross failures to achieve predicted performance during take-off or initial climb.

Fires and smoke in the passenger compartment, in cargo compartments or engine fires, even though such fires were extinguished by the use of extinguishing agents.

Events requiring the emergency use of oxygen by the flight crew.

Aircraft structural failures or engine disintegrations not classified as an accident.

Multiple malfunctions of one or more aircraft systems seriously affecting the operation of the aircraft.

Flight crew incapacitation in flight.

Fuel quantity requiring the declaration of an emergency by the pilot.

Take-off or landing incidents. Incidents such as under-shooting, overrunning or running off the side of runways.

System failures, weather phenomena, operations outside the approved flight envelope or other occurrences which could have caused difficulties controlling the aircraft.

Failures of more than one system in a redundancy system mandatory for flight guidance and navigation.

— **END** —

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERODROMES

ANNEX 14

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I
AERODROME DESIGN AND OPERATIONS

SECOND EDITION — JULY 1995

This edition incorporates all amendments to Annex 14, Volume I, adopted by the Council prior to 14 March 1995 and supersedes on 9 November 1995 all previous editions of Annex 14, Volume I.

For information regarding the applicability of the Standards and Recommended Practices, *see* Chapter 1, 1.2 and Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1	Incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

ABBREVIATIONS AND SYMBOLS

(used in Annex 14, Volume I)

Abbreviations

ACN	Aircraft classification number
aprx	Approximately
ASDA	Accelerate-stop distance available
ATS	Air traffic services
cd	Candela
C	Degree Celsius
CBR	California bearing ratio
CIE	Commission Internationale de l'Éclairage
cm	Centimetre
DME	Distance measuring equipment
ft	Foot
ILS	Instrument landing system
IMC	Instrument meteorological conditions
K	Degree Kelvin
kg	Kilogram
km	Kilometre
km/h	Kilometre per hour
kt	Knot
L	Litre
LDA	Landing distance available
m	Metre
max	Maximum
mm	Millimetre
mnm	Minimum
MN	Meganewton

Abbreviations

MPa	Megapascal
NM	Nautical mile
NU	Not usable
OCA/H	Obstacle clearance altitude/height
OFZ	Obstacle free zone
PCN	Pavement classification number
RESA	Runway end safety area
RVR	Runway visual range
TODA	Take-off distance available
TORA	Take-off run available
VMC	Visual meteorological conditions
VOR	Very high frequency omnidirectional radio range

Symbols

°	Degree
=	Equals
′	Minute of arc
μ	Friction coefficient
>	Greater than
<	Less than
%	Percentage
±	Plus or minus

MANUALS

(related to the specifications of this Annex)

Aerodrome Design Manual (Doc 9157)
- Part 1 — Runways
- Part 2 — Taxiways, Aprons and Holding Bays
- Part 3 — Pavements
- Part 4 — Visual Aids
- Part 5 — Electrical Systems
- Part 6 — Frangibility (in preparation)

Airport Planning Manual (Doc 9184)
- Part 1 — Master Planning
- Part 2 — Land Use and Environmental Control
- Part 3 — Guidelines for Consultant/Construction Services

Airport Services Manual (Doc 9137)
- Part 1 — Rescue and Fire Fighting
- Part 2 — Pavement Surface Conditions
- Part 3 — Bird Control and Reduction
- Part 4 — Fog Dispersal (withdrawn)
- Part 5 — Removal of Disabled Aircraft
- Part 6 — Control of Obstacles
- Part 7 — Airport Emergency Planning
- Part 8 — Airport Operational Services
- Part 9 — Airport Maintenance Practices

Heliport Manual (Doc 9261)

Stolport Manual (Doc 9150)

Manual on the ICAO Bird Strike Information System (IBIS) (Doc 9332)

Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476)

FOREWORD

Historical background

Standards and Recommended Practices for Aerodromes were first adopted by the Council on 29 May 1951 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 14 to the Convention. The Standards and Recommended Practices were based on recommendations of the Aerodromes, Air Routes and Ground Aids Division at its third session in September 1947 and at its fourth session in November 1949.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specified request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 14, Volume I

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
1st Edition	Third and Fourth Sessions of the Aerodromes, Air Routes and Ground Aids Division	—	29 May 1951 1 November 1951 1 June 1952* 1 June 1954
1 to 6	Fifth Session of the Aerodromes, Air Routes and Ground Aids Division	Physical characteristics of runways, strips, clearways, stopways, taxiways and aprons; physical characteristics of channels, turning basins, taxi channels and mooring areas; approach areas; clearing and restriction of obstructions; obstruction marking; marking of unserviceable portions of the movement area; secondary power supply; aerodrome beacon; runway markings; stopway markers; approach, lead-in and runway lighting.	20 May 1953 1 September 1953 1 April 1954* 1 January 1955
7 to 13	Sixth Session of the Aerodromes, Air Routes and Ground Aids Division	Physical characteristics of runways, strips, taxiways and aprons; approach and take-off areas and surfaces; clearing and restriction of obstructions; obstruction markings; runway markings; stopway markers; taxiway markings; approach, runway and taxiway lighting; circling guidance lights; rescue and fire fighting services.	12 May 1958 1 September 1958 1 December 1958
14	Correspondence	Precision approach lighting system.	7 May 1959 1 October 1959 1 October 1959
15	Vertical Separation Panel	Pre-flight altimeter check-point.	15 May 1959 1 October 1959 1 October 1959
16	Correspondence	Extinguishing agents.	2 December 1960 2 December 1960 2 December 1960
17	Correspondence	Pre-flight altimeter check-point.	2 December 1960 2 December 1960 2 December 1960
18	First Meeting of the ANC Visual Aids Panel	VASIS	9 June 1961 1 October 1961 1 October 1961
19	Seventh Session of the Aerodromes, Air Routes and Ground Aids Division	Physical characteristics of runways, clearways, stopways, taxiways and aprons; take-off and approach areas; clearing and restriction of obstructions; obstruction markings; wind direction indicator; landing direction indicator; aerodrome beacon; runway markings; approach lighting system; runway alignment indicator; runway centre line; touchdown zone and taxiway lighting; rescue and fire fighting services.	23 March 1964 1 August 1964 1 November 1964
20	Second Meeting of the ANC Visual Aids Panel	Visual aids for use in operational performance category II conditions.	13 December 1965 13 April 1966 25 August 1966

* Two applicability dates approved.

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
21	Fourth Air Navigation Conference and Fourth Meeting of the ANC Visual Aids Panel	Emergency lighting: threshold marking: fixed distance marking: approach light beacons; taxiway centre line lighting; secondary power supply; maintenance of aerodrome lighting and marking aids: monitoring of visual aids.	28 June 1967 28 October 1967 8 February 1968
22	Correspondence and ANC Visual Aids Panel	VOR aerodrome check-point marking and sign.	28 June 1968 28 October 1968 18 September 1969
23	Fifth Air Navigation Conference	Declared distances: strength of pavements: information on aerodrome conditions; reference code letters: runway length correction for slope; runway strips; taxiway clearances: holding bays; taxi-holding position markings; approach lighting systems; visual approach slope indicator systems; secondary power supply; rescue and fire fighting services; bird hazard reduction services.	23 January 1969 23 May 1969 18 September 1969
24	Fifth Meeting of the ANC Visual Aids Panel and First Meeting of the ANC Rescue and Fire Fighting Panel	Marking of unusable or unserviceable portions of the movement area; touchdown zone markings; category II holding position marking and sign; T-VASIS and AT-VASIS; runway edge lighting: exit taxiway centre line lighting: stop bars and clearance bars: emergency access roads; colour specifications for lights.	31 March 1971 6 September 1971 6 January 1972
25	ANC Visual Aids Panel	Visual approach slope guidance for long-bodied aircraft.	26 May 1971 26 September 1971 6 January 1972
26	Seventeenth Session of the Assembly and Middle East/South East Asia Regional Air Navigation Meeting	Aerodrome security; water rescue vehicles.	15 December 1971 15 April 1972 7 December 1971
27	ANC Visual Aids Panel and Middle East/South East Asia Regional Air Navigation Meeting	Runway centre line light colour coding; maintenance services.	20 March 1972 20 July 1972 7 December 1972
28	Secretariat and Sixth Meeting of the ANC Visual Aids Panel	Definition for snow on the ground; frangibility of light fixtures; runway centre line marking; taxiway centre line lighting: colour specifications for lights.	11 December 1972 11 April 1973 16 August 1973
29	Council action in pursuance of Assembly Resolutions A17-10 and A18-10	Aerodrome security.	7 December 1973 7 April 1974 23 May 1974
30	Eighth Air Navigation Conference and editorial revision of the Annex	Runway shoulders and strips: runway end safety areas; aerodrome reference temperature: clearways: holding bays: physical characteristics of taxiways; taxiway shoulders and strips; pavement strength: runway transverse slopes; runway braking action: obstacle limitation surfaces: category III runway lighting and marking: taxiway lighting; stop bars; rescue and fire fighting services; disabled aircraft removal.	3 February 1976 3 June 1976 30 December 1976

Amendment	Source(s)	Subject(s)	Adopted Effective Applicable
31	Seventh Meeting of the ANC Visual Aids Panel and Fifth Meeting of the ANC Obstacle Clearance Panel	Obstacle limitation surfaces; light intensity control: inset light temperatures: taxiway centre line lights; apron floodlighting; visual docking guidance systems; signs; maintenance of visual aids.	13 December 1976 13 April 1977 6 October 1977
32	Correspondence and ANC Visual Aids Panel	Definition of frangibility; siting and construction of equipment and installations on operational areas; colour specifications for lights and markings.	14 December 1977 14 April 1978 10 August 1978
33	Correspondence and Secretariat	Reporting of information on visual approach slope indicator systems; runway, taxiway and taxi-holding position markings; approach lighting for displaced thresholds; runway edge and centre line lights; aerodrome emergency planning.	26 March 1979 26 July 1979 29 November 1979
34	Eighth Meeting of the ANC Visual Aids Panel	Apron markings; precision approach lighting systems; visual approach slope indicator systems; circling guidance lights; runway lead-in lighting systems; stop bars; visual docking guidance system; aircraft stand manoeuvring guidance lights; aircraft stand identification signs; marking and lighting of obstacles.	30 November 1979 30 March 1980 27 November 1980
35	Secretariat and the ANC Visual Aids Panel	Reporting of pavement strength; visual approach slope indicator systems; approach lighting systems; maintenance of lighting.	23 March 1981 23 July 1981 26 November 1981
36	Aerodromes, Air Routes and Ground Aids Divisional Meeting (1981), Ninth Meeting of the ANC Visual Aids Panel and Secretariat	Aerodrome reference code; runway friction characteristics; runway end safety areas; taxiway separation distances; rapid exit taxiways; taxiways on bridges; holding bays; obstacle limitation surfaces; PAPI; taxi-holding position marking and lights; runway centre line guidance; visual ground signals; rescue and fire fighting; apron management service; declared distances; ground servicing of aircraft; units of measure.	22 November 1982 23 March 1983 24 November 1983
37	Secretariat	Fuelling.	29 March 1983 29 July 1983 24 November 1983
38	Secretariat and the ANC Visual Aids Panel	Aerodrome data; APAPI; colour coding of exit taxiway centre line lights; stop bars; taxi-holding position lights; taxiway edge markers; markers for overhead wires; obstacle lighting of lighthouses; maintenance of taxiway centre line lights; surface marking colours.	17 March 1986 27 July 1986 20 November 1986
39 (Annex 14, Volume I, 1st Edition)	Secretariat and the ANC Visual Aids Panel	1. Annex to be issued in two volumes as follows: Volume I — *Aerodrome Design and Operations* (incorporating provisions in the eighth edition of Annex 14 as amended by Amendment 39) and Volume II — *Heliports*. 2. Take-off runways; aerodrome reference code; reporting of pavement strength; runway friction characteristics; conditions of movement area; separation of parallel runways; taxiway minimum separation distances; taxi-holding position marking; installation tolerances for PAPI; obstacle protection surface; stop bars; signs; taxiway centre line markers; aerodrome security; surface movement guidance and control; aerodrome emergency planning; rescue and fire fighting; maintenance; runway pavement overlay; bird hazard reduction; apron management service; colours for transilluminated signs and panels; aeronautical ground light characteristics.	9 March 1990 30 July 1990 15 November 1990
1 (Annex 14, Volume I, 2nd Edition)	Twelfth Meeting of the ANC Visual Aids Panel and Secretariat	Definitions of frangible object, precision approach runways, road, road-holding position, runway guard lights, and taxi-holding position; standard geodetic reference system; radio altimeter operating area, minimum distance between parallel runways; frangibility; runway and taxiway markings, aeronautical beacons, lighting aids for MLS operations, deletion of specifications on VASIS (AVASIS) and 3-BAR VASIS (3-BAR AVASIS), stop bars, runway guard lights, visual docking guidance system, taxiing guidance signs; obstacle lighting; visual aids for denoting restricted use areas; secondary power supply, electrical systems, monitoring, airport design, surface movement guidance and control systems; rescue and fire fighting, maintenance of visual aids; aeronautical ground light characteristics; form and proportions of information marking; design of taxiing guidance signs; friction characteristics of wet runways.	13 March 1995 24 July 1995 9 November 1995

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. GENERAL

Introductory Note.— This Annex contains Standards and Recommended Practices (specifications) that prescribe the physical characteristics and obstacle limitation surfaces to be provided for at aerodromes, and certain facilities and technical services normally provided at an aerodrome. It is not intended that these specifications limit or regulate the operation of an aircraft.

To a great extent, the specifications for individual facilities detailed in Annex 14, Volume I have been interrelated by a reference code system, described in this chapter, and by the designation of the type of runway for which they are to be provided, as specified in the definitions. This not only simplifies the reading of Volume I of this Annex, but in most cases, provides for efficiently proportioned aerodromes when the specifications are followed.

This document sets forth the minimum aerodrome specifications for aircraft which have the characteristics of those which are currently operating or for similar aircraft that are planned for introduction. Accordingly, any additional safeguards that might be considered appropriate to provide for more demanding aircraft are not taken into account. Such matters are left to appropriate authorities to evaluate and take into account as necessary for each particular aerodrome. Guidance on some possible effects of future aircraft on these specifications is given in the Aerodrome Design Manual, *Part 2.*

It is to be noted that the specifications for precision approach runways categories II and III are only applicable to runways intended to be used by aeroplanes in code numbers 3 and 4.

Annex 14, Volume I does not include specifications relating to the over-all planning of aerodromes (such as separation between adjacent aerodromes or capacity of individual aerodromes) or to economic and other non-technical factors that need to be considered in the development of an aerodrome. Information on these subjects is included in the Airport Planning Manual, *Part 1.*

Aviation security is an integral part of aerodrome planning and operations. Annex 14, Volume I contains several specifications aimed at enhancing the level of security at aerodromes. Specifications on other facilities related to security are given in Annex 17 and detailed guidance on the subject is contained in the ICAO Security Manual.

1.1 Definitions

When the following terms are used in this Annex they have the following meanings:

Aerodrome. A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome beacon. Aeronautical beacon used to indicate the location of an aerodrome from the air.

Aerodrome elevation. The elevation of the highest point of the landing area.

Aerodrome identification sign. A sign placed on an aerodrome to aid in identifying the aerodrome from the air.

Aerodrome reference point. The designated geographical location of an aerodrome.

Aeronautical beacon. An aeronautical ground light visible at all azimuths, either continuously or intermittently, to designate a particular point on the surface of the earth.

Aeronautical ground light. Any light specially provided as an aid to air navigation, other than a light displayed on an aircraft.

Aeroplane reference field length. The minimum field length required for take-off at maximum certificated take-off mass, sea level, standard atmospheric conditions, still air and zero runway slope, as shown in the appropriate aeroplane flight manual prescribed by the certificating authority or equivalent data from the aeroplane manufacturer. Field length means balanced field length for aeroplanes, if applicable, or take-off distance in other cases.

Note.— Attachment A, Section 2 provides information on the concept of balanced field length and the Airworthiness Technical Manual *(Doc 9051) contains detailed guidance on matters related to take-off distance.*

Aircraft classification number (ACN). A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category.

Note.— The aircraft classification number is calculated with respect to the center of gravity (CG) position which yields the critical loading on the critical gear. Normally the aftmost CG position appropriate to the maximum gross apron (ramp) mass is used to calculate the ACN. In exceptional cases the forwardmost CG position may result in the nose gear loading being more critical.

Aircraft stand. A designated area on an apron intended to be used for parking an aircraft.

Apron. A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking or maintenance.

Apron management service. A service provided to regulate the activities and the movement of aircraft and vehicles on an apron.

Barrette. Three or more aeronautical ground lights closely spaced in a transverse line so that from a distance they appear as a short bar of light.

Capacitor discharge light. A lamp in which high-intensity flashes of extremely short duration are produced by the discharge of electricity at high voltage through a gas enclosed in a tube.

Clearway. A defined rectangular area on the ground or water under the control of the appropriate authority, selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.

Declared distances.

a) *Take-off run available (TORA).* The length of runway declared available and suitable for the ground run of an aeroplane taking off.

b) *Take-off distance available (TODA).* The length of the take-off run available plus the length of the clearway, if provided.

c) *Accelerate-stop distance available (ASDA).* The length of the take-off run available plus the length of the stopway, if provided.

d) *Landing distance available (LDA).* The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Dependent parallel approaches. Simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centre lines are prescribed.

Displaced threshold. A threshold not located at the extremity of a runway.

Effective intensity. The effective intensity of a flashing light is equal to the intensity of a fixed light of the same colour which will produce the same visual range under identical conditions of observation.

Fixed light. A light having constant luminous intensity when observed from a fixed point.

Frangible object. An object of low mass designed to break, distort or yield on impact so as to present the minimum hazard to aircraft.

Note.— Guidance on design for frangibility is contained in the Aerodrome Design Manual, *Part 6 (in preparation).*

Hazard beacon. An aeronautical beacon used to designate a danger to air navigation.

Heliport. An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Holding bay. A defined area where aircraft can be held, or bypassed, to facilitate efficient surface movement of aircraft.

Identification beacon. An aeronautical beacon emitting a coded signal by means of which a particular point of reference can be identified.

Independent parallel approaches. Simultaneous approaches to parallel or near-parallel instrument runways where radar separation minima between aircraft on adjacent extended runway centre lines are not prescribed.

Independent parallel departures. Simultaneous departures from parallel or near-parallel instrument runways.

Instrument runway. One of the following types of runways intended for the operation of aircraft using instrument approach procedures:

a) *Non-precision approach runway.* An instrument runway served by visual aids and a non-visual aid providing at least directional guidance adequate for a straight-in approach.

b) *Precision approach runway, category I.* An instrument runway served by ILS and/or MLS and visual aids intended for operations with a decision height not lower than 60 m (200 ft) and either a visibility not less than 800 m or a runway visual range not less than 550 m.

c) *Precision approach runway, category II.* An instrument runway served by ILS and/or MLS and visual aids intended for operations with a decision height lower than 60 m (200 ft) but not lower than 30 m (100 ft) and a runway visual range not less than 350 m.

d) *Precision approach runway, category III.* An instrument runway served by ILS and/or MLS to and along the surface of the runway and:

A — intended for operations with a decision height lower than 30 m (100 ft), or no decision height and a runway visual range not less than 200 m.

B — intended for operations with a decision height lower than 15 m (50 ft), or no decision height and a runway visual range less than 200 m but not less than 50 m.

C — intended for operations with no decision height and no runway visual range limitations.

Note 1.— See Annex 10, Volume I, Part I, for related ILS and/or MLS specifications.

Note 2.— Visual aids need not necessarily be matched to the scale of non-visual aids provided. The criterion for the selection of visual aids is the conditions in which operations are intended to be conducted.

Landing area. That part of a movement area intended for the landing or take-off of aircraft.

Landing direction indicator. A device to indicate visually the direction currently designated for landing and for take-off.

Light failure. A light shall be considered to have failed when for any reason the average intensity determined using the specified angles of beam elevation, toe-in and spread falls below 50 per cent of the specified average intensity of a new light.

Lighting system reliability. The probability that the complete installation operates within the specified tolerances and that the system is operationally usable.

Manoeuvring area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Marker. An object displayed above ground level in order to indicate an obstacle or delineate a boundary.

Marking. A symbol or group of symbols displayed on the surface of the movement area in order to convey aeronautical information.

Movement area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

Near-parallel runways. Non-intersecting runways whose extended centre lines have an angle of convergence/divergence of 15 degrees or less.

Non-instrument runway. A runway intended for the operation of aircraft using visual approach procedures.

Obstacle. All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a defined surface intended to protect aircraft in flight.

Obstacle free zone (OFZ). The airspace above the inner approach surface, inner transitional surfaces, and balked landing surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacle other than a low-mass and frangibly mounted one required for air navigation purposes.

Pavement classification number (PCN). A number expressing the bearing strength of a pavement for unrestricted operations.

Precision approach runway, see ***Instrument runway.***

Primary runway(s). Runway(s) used in preference to others whenever conditions permit.

Road. An established surface route on the movement area meant for the exclusive use of vehicles.

Road-holding position. A designated position at which vehicles may be required to hold.

Runway. A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Runway end safety area (RESA). An area symmetrical about the extended runway centre line and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway.

Runway guard lights. A light system intended to caution pilots or vehicle drivers that they are about to enter an active runway.

Runway strip. A defined area including the runway and stopway, if provided, intended:

a) to reduce the risk of damage to aircraft running off a runway; and

b) to protect aircraft flying over it during take-off or landing operations.

Runway visual range (RVR). The range over which the pilot of an aircraft on the centre line of a runway can see the runway surface markings or the lights delineating the runway or identifying its centre line.

Segregated parallel operations. Simultaneous operations on parallel or near-parallel instrument runways in which one runway is used exclusively for approaches and the other runway is used exclusively for departures.

Shoulder. An area adjacent to the edge of a pavement so prepared as to provide a transition between the pavement and the adjacent surface.

Signal area. An area on an aerodrome used for the display of ground signals.

Slush. Water-saturated snow which with a heel-and-toe slap-down motion against the ground will be displaced with a splatter; specific gravity: 0.5 up to 0.8.

Note.— Combinations of ice, snow and/or standing water may, especially when rain, rain and snow, or snow is falling, produce substances with specific gravities in excess of 0.8. These substances, due to their high water/ice content, will have a transparent rather than a cloudy appearance and, at the higher specific gravities, will be readily distinguishable from slush.

Snow (on the ground).

a) *Dry snow.* Snow which can be blown if loose or, if compacted by hand, will fall apart again upon release; specific gravity: up to but not including 0.35.

b) *Wet snow.* Snow which, if compacted by hand, will stick together and tend to or form a snowball; specific gravity: 0.35 up to but not including 0.5.

c) *Compacted snow.* Snow which has been compressed into a solid mass that resists further compression and will hold together or break up into lumps if picked up; specific gravity: 0.5 and over.

Stopway. A defined rectangular area on the ground at the end of take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abandoned take-off.

Take-off runway. A runway intended for take-off only.

Taxi-holding position. A designated position at which taxiing aircraft and vehicles shall stop and hold position, unless otherwise authorized by the aerodrome control tower.

Taxiway. A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another, including:

a) *Aircraft stand taxilane.* A portion of an apron designated as a taxiway and intended to provide access to aircraft stands only.

b) *Apron taxiway.* A portion of a taxiway system located on an apron and intended to provide a through taxi route across the apron.

c) *Rapid exit taxiway.* A taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than are achieved on other exit taxiways thereby minimizing runway occupancy times.

Taxiway intersection. A junction of two or more taxiways.

Taxiway strip. An area including a taxiway intended to protect an aircraft operating on the taxiway and to reduce the risk of damage to an aircraft accidentally running off the taxiway.

Threshold. The beginning of that portion of the runway usable for landing.

Touchdown zone. The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway.

Usability factor. The percentage of time during which the use of a runway or system of runways is not restricted because of the cross-wind component.

Note.— Cross-wind component means the surface wind component at right angles to the runway centre line.

1.2 Applicability

1.2.1 The interpretation of some of the specifications in the Annex expressly requires the exercising of discretion, the taking of a decision or the performance of a function by the appropriate authority. In other specifications, the expression appropriate authority does not actually appear although its inclusion is implied. In both cases, the responsibility for whatever determination or action is necessary shall rest with the State having jurisdiction over the aerodrome.

1.2.2 The specifications, unless otherwise indicated in a particular context, shall apply to all aerodromes open to public use in accordance with the requirements of Article 15 of the Convention. The specifications of Annex 14, Volume I, Chapter 3 shall apply only to land aerodromes. The specifications in this volume shall apply, where appropriate, to heliports but shall not apply to stolports.

Note.— Although there are at present no specifications relating to stolports, it is intended that specifications for these aerodromes will be included as they are developed. In the interim, guidance material on stolports is given in the Stolport Manual.

1.2.3 Wherever a colour is referred to in this Annex, the specifications for that colour given in Appendix 1 shall apply.

1.3 Reference code

Introductory Note.— The intent of the reference code is to provide a simple method for interrelating the numerous specifications concerning the characteristics of aerodromes so as to provide a series of aerodrome facilities that are suitable for the aeroplanes that are intended to operate at the aerodrome. The code is not intended to be used for determining runway length or pavement strength requirements. The code is composed of two elements which are related to the aeroplane performance characteristics and dimensions. Element 1 is a number based on the aeroplane reference field length and element 2 is a letter based on the aeroplane wing span and outer main gear wheel span. A particular specification is related to the more appropriate of the two elements of the code or to an appropriate combination of the two code elements. The code letter or number within an element selected for design purposes is related to the critical aeroplane characteristics for which the facility is provided. When applying Annex 14, Volume I, the aeroplanes which the aerodrome is intended to serve are first identified and then the two elements of the code.

1.3.1 An aerodrome reference code — code number and letter — which is selected for aerodrome planning purposes shall be determined in accordance with the characteristics of the aeroplane for which an aerodrome facility is intended.

1.3.2 The aerodrome reference code numbers and letters shall have the meanings assigned to them in Table 1-1.

1.3.3 The code number for element 1 shall be determined from Table 1-1, column 1, selecting the code number corresponding to the highest value of the aeroplane reference field lengths of the aeroplanes for which the runway is intended.

Note.— The determination of the aeroplane reference field length is solely for the selection of a code number and is not intended to influence the actual runway length provided.

1.3.4 The code letter for element 2 shall be determined from Table 1-1, column 3, by selecting the code letter which corresponds to the greatest wing span, or the greatest outer main gear wheel span, whichever gives the more demanding code letter of the aeroplanes for which the facility is intended.

Note.— Guidance to assist the appropriate authority in determining the aerodrome reference code is given in the Aerodrome Design Manual, *Parts 1 and 2.*

Table 1-1. Aerodrome reference code
(see 1.3.2 to 1.3.4)

Code element 1		Code element 2		
Code number (1)	Aeroplane reference field length (2)	Code letter (3)	Wing span (4)	Outer main gear wheel span[a] (5)
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4.5 m
2	800 m up to but not including 1 200 m	B	15 m up to but not including 24 m	4.5 m up to but not including 6 m
3	1 200 m up to but not including 1 800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1 800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m

a. Distance between the outside edges of the main gear wheels.

9/11/95

CHAPTER 2. AERODROME DATA

Introductory Note.— This chapter contains specifications relating to the provision of data about aerodromes to be determined and reported to the appropriate aeronautical information service unless specified otherwise. Specifications concerning the manner in which the data are to be published and the services to which they are to be made available are prescribed in Annexes 4 and 15.

2.1 Geographical coordinates

2.1.1 Geographical coordinates indicating latitude and longitude shall be determined and reported to the aeronautical information services authority in terms of the World Geodetic System — 1984 (WGS-84) geodetic reference datum, identifying those geographical coordinates which have been transformed into WGS-84 coordinates by mathematical means and whose accuracy of original field work does not meet the requirements in 2.1.2 below.

2.1.2 The order of accuracy of the field work shall be such that the resulting operational navigation data for the phases of flight will be within the maximum deviations, with respect to an appropriate reference frame, as indicated herein:

a) significant obstacles in the approach and take-off areas, in the circling area and in the vicinity of aerodrome and positions of radio navigation aids located on the aerodrome: three metres;

b) runway thresholds and centre line points: one metre;

c) taxiway centre line points and aircraft stands: one-half metre; and

d) aerodrome reference point: thirty metres.

Note 1.— An appropriate reference frame is that which enables WGS-84 to be realized on a given aerodrome and with respect to which all coordinate data are related.

Note 2.— Specifications governing the publication of WGS-84 coordinates are given in Annex 4, Chapter 2 and Annex 15, Chapter 3.

2.2 Aerodrome reference point

2.2.1 An aerodrome reference point shall be established for an aerodrome.

2.2.2 The aerodrome reference point shall be located near the initial or planned geometric centre of the aerodrome and shall normally remain where first established.

2.2.3 The position of the aerodrome reference point shall be measured and reported to the aeronautical information services authority in degrees, minutes and seconds.

2.3 Aerodrome and runway elevations

2.3.1 The aerodrome elevation shall be measured and given to the nearest metre or foot.

2.3.2 For an aerodrome used by international civil aviation, the elevation of each threshold, the elevation of the runway end and any significant high and low intermediate points along the runway, and the highest elevation of the touchdown zone of a precision approach runway shall be given to the nearest metre or foot.

2.4 Aerodrome reference temperature

2.4.1 An aerodrome reference temperature shall be determined for an aerodrome in degrees Celsius.

2.4.2 **Recommendation.**— *The aerodrome reference temperature should be the monthly mean of the daily maximum temperatures for the hottest month of the year (the hottest month being that which has the highest monthly mean temperature). This temperature should be averaged over a period of years.*

2.5 Aerodrome dimensions and related information

2.5.1 The following data shall be measured or described, as appropriate, for each facility provided on an aerodrome:

a) runway — true bearing, designation number, length, width, displaced threshold location, slope, surface type, type of runway and, for a precision approach runway category I, the existence of an obstacle free zone when provided;

b) strip, runway end safety area, stopway } length, width, surface type;

c) taxiway — designation, width, surface type;

d) apron — surface type, aircraft stands;

e) the boundaries of the air traffic control service;

f) clearway — length, ground profile;

g) visual aids for approach procedures, marking and lighting of runways, taxiways and aprons, other visual guidance and control aids on taxiways and aprons, including taxi-holding positions and stopbars, and location and type of visual docking guidance systems;

h) location and radio frequency of any VOR aerodrome check-point; and

i) location and designation of standard taxi-routes.

2.5.2 The geographical coordinates of each threshold shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

2.5.3 The geographical coordinates of appropriate taxiway centre line points shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

2.5.4 The geographical coordinates of each aircraft stand shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

2.5.5 The geographical coordinates of significant obstacles in the approach and take-off areas, in the circling area and in the vicinity of an aerodrome shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and tenths of seconds. In addition, the top elevation rounded up to the nearest metre or foot, type, marking and lighting (if any) of the significant obstacles shall be reported to the aeronautical information services authority.

Note.— This information may best be shown in the form of charts such as those required for the preparation of aeronautical publications as specified in Annexes 4 and 15.

2.6 Strength of pavements

2.6.1 The bearing strength of a pavement shall be determined.

2.6.2 The bearing strength of a pavement intended for aircraft of apron (ramp) mass greater than 5 700 kg shall be made available using the aircraft classification number — pavement classification number (ACN-PCN) method by reporting all of the following information:

a) the pavement classification number (PCN);

b) pavement type for ACN-PCN determination;

c) subgrade strength category;

d) maximum allowable tire pressure category or maximum allowable tire pressure value; and

e) evaluation method.

Note.— If necessary, PCNs may be published to an accuracy of one-tenth of a whole number.

2.6.3 The pavement classification number (PCN) reported shall indicate that an aircraft with an aircraft classification number (ACN) equal to or less than the reported PCN can operate on the pavement subject to any limitation on the tire pressure, or aircraft all-up mass for specified aircraft type(s).

Note.— Different PCNs may be reported if the strength of the pavement is subject to significant seasonal variation.

2.6.4 The ACN of an aircraft shall be determined in accordance with the standard procedures associated with the ACN-PCN method.

Note.— The standard procedures for determining the ACN of an aircraft are given in the Aerodrome Design Manual, *Part 3. For convenience several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four subgrade categories in 2.6.6 b) below and the results tabulated in that manual.*

2.6.5 For the purposes of determining the ACN, the behaviour of a pavement shall be classified as equivalent to a rigid or flexible construction.

2.6.6 Information on pavement type for ACN-PCN determination, subgrade strength category, maximum allowable tire pressure category and evaluation method shall be reported using the following codes:

a) *Pavement type for ACN-PCN determination:*

	Code
Rigid pavement	R
Flexible pavement	F

Note.— If the actual construction is composite or non-standard, include a note to that effect (see example 2 below).

b) *Subgrade strength category:*

	Code
High strength: characterized by K = 150 MN/m^3 and representing all K values above 120 MN/m^3 for rigid pavements, and by CBR = 15 and representing all CBR values above 13 for flexible pavements.	A
Medium strength: characterized by K = 80 MN/m^3 and representing a range in K of 60 to 120 MN/m^3 for rigid pavements, and by CBR = 10 and representing a range in CBR of 8 to 13 for flexible pavements.	B
Low strength: characterized by K = 40 MN/m^3 and representing a range in K of 25 to 60 MN/m^3 for rigid pavements, and by CBR = 6 and representing a range in CBR of 4 to 8 for flexible pavements.	C
Ultra low strength: characterized by K = 20 MN/m^3 and representing all K values below 25 MN/m^3 for rigid pavements, and by CBR = 3 and representing all CBR values below 4 for flexible pavements.	D

c) *Maximum allowable tire pressure category:*

	Code
High: no pressure limit	W
Medium: pressure limited to 1.50 MPa	X
Low: pressure limited to 1.00 MPa	Y
Very low: pressure limited to 0.50 MPa	Z

d) *Evaluation method:*

	Code
Technical evaluation: representing a specific study of the pavement characteristics and application of pavement behaviour technology.	T
Using aircraft experience: representing a knowledge of the specific type and mass of aircraft satisfactorily being supported under regular use.	U

Note.— The following examples illustrate how pavement strength data are reported under the ACN-PCN method.

Example 1.— If the bearing strength of a rigid pavement, resting on a medium strength subgrade, has been assessed by technical evaluation to be PCN 80 and there is no tire pressure limitation, then the reported information would be:

PCN 80 / R / B / W / T

Example 2.— If the bearing strength of a composite pavement, behaving like a flexible pavement and resting on a high strength subgrade, has been assessed by using aircraft experience to be PCN 50 and the maximum tire pressure allowable is 1.00 MPa, then the reported information would be:

PCN 50 / F / A / Y / U

Note.— Composite construction.

Example 3.— If the bearing strength of a flexible pavement, resting on a medium strength subgrade, has been assessed by technical evaluation to be PCN 40 and the maximum allowable tire pressure is 0.80 MPa, then the reported information would be:

PCN 40 / F / B / 0.80 MPa /T

Example 4.— If a pavement is subject to a B747-400 all-up mass limitation of 390 000 kg, then the reported information would include the following note.

Note.— The reported PCN is subject to a B747-400 all-up mass limitation of 390 000 kg.

2.6.7 **Recommendation.—** *Criteria should be established to regulate the use of a pavement by an aircraft with an ACN higher than the PCN reported for that pavement in accordance with 2.6.2 and 2.6.3.*

Note.— Attachment A, Section 18 details a simple method for regulating overload operations while the Aerodrome Design Manual, *Part 3 includes the descriptions of more detailed procedures for evaluation of pavements and their suitability for restricted overload operations.*

2.6.8 The bearing strength of a pavement intended for aircraft of apron (ramp) mass equal to or less than 5 700 kg shall be made available by reporting the following information:

a) maximum allowable aircraft mass; and

b) maximum allowable tire pressure.

Example: 4 000 kg/0.50 MPa.

2.7 Pre-flight altimeter check location

2.7.1 One or more pre-flight altimeter check locations shall be established for an aerodrome.

2.7.2 **Recommendation.—** *A pre-flight check location should be located on an apron.*

Note 1.— Locating a pre-flight altimeter check location on an apron enables an altimeter check to be made prior to *obtaining taxi clearance and eliminates the need for stopping for that purpose after leaving the apron.*

Note 2.— Normally an entire apron can serve as a satisfactory altimeter check location.

2.7.3 The elevation of a pre-flight altimeter check location shall be given as the average elevation, rounded to the nearest metre or foot, of the area on which it is located. The elevation of any portion of a pre-flight altimeter check location shall be within 3 m (10 ft) of the average elevation for that location.

2.8 Declared distances

The following distances shall be calculated for a runway intended for use by international commercial air transport:

a) take-off run available;

b) take-off distance available;

c) accelerate-stop distance available; and

d) landing distance available.

Note.— Guidance on calculation of declared distances is given in Attachment A, Section 3.

2.9 Condition of the movement area and related facilities

2.9.1 Information on the condition of the movement area and the operational status of related facilities shall be provided to the appropriate aeronautical information service units, and similar information of operational significance to the air traffic services units, to enable those units to provide the necessary information to arriving and departing aircraft. The information shall be kept up to date and changes in conditions reported without delay.

2.9.2 The condition of the movement area and the operational status of related facilities shall be monitored and reports on matters of operational significance or affecting aircraft performance given, particularly in respect of the following:

a) construction or maintenance work;

b) rough or broken surfaces on a runway, a taxiway or an apron;

c) snow, slush or ice on a runway, a taxiway or an apron;

d) water on a runway, a taxiway or an apron;

e) snow banks or drifts adjacent to a runway, a taxiway or an apron;

f) anti-icing or de-icing liquid chemicals on a runway or a taxiway;

g) other temporary hazards, including parked aircraft;

h) failure or irregular operation of part or all of the aerodrome visual aids; and

i) failure of the normal or secondary power supply.

2.9.3 **Recommendation.**— *To facilitate compliance with 2.9.1 and 2.9.2 inspections of the movement area should be carried out each day at least once where the code number is 1 or 2 and at least twice where the code number is 3 or 4.*

Note.— Guidance on carrying out daily inspections of the movement area is given in the Airport Services Manual, *Part 8 and in the* Manual of Surface Movement Guidance and Control Systems (SMGCS).

Water on a runway

2.9.4 **Recommendation.**— *Whenever water is present on a runway, a description of the runway surface conditions on the centre half of the width of the runway, including the possible assessment of water depth, where applicable, should be made available using the following terms:*

DAMP — the surface shows a change of colour due to moisture.
WET — the surface is soaked but there is no standing water.
WATER PATCHES — significant patches of standing water are visible.
FLOODED — extensive standing water is visible.

2.9.5 Information that a runway or portion thereof may be slippery when wet shall be made available.

2.9.6 A runway or portion thereof shall be determined as being slippery when wet when the measurements specified in 9.4.4 show that the runway surface friction characteristics as measured by a continuous friction measuring device are below the minimum friction level specified by the State.

Note.— Guidance on determining and expressing the minimum friction level is provided in Attachment A, Section 7.

2.9.7 Information on the minimum friction level specified by the State for reporting slippery runway conditions and the type of friction measuring device used shall be made available.

2.9.8 **Recommendation.**— *When it is suspected that a runway may become slippery under unusual conditions, then additional measurements should be made when such conditions occur, and information on the runway surface friction charac-*

teristics made available when these additional measurements show that the runway or a portion thereof has become slippery.

Snow, slush or ice on a runway

Note 1.— The intent of these specifications is to satisfy the SNOWTAM and NOTAM promulgation requirements contained in Annex 15.

Note 2.— Runway surface condition sensors may be used to detect and continuously display current or predicted information on surface conditions such as the presence of moisture, or imminent formation of ice on pavements.

2.9.9 **Recommendation.—** *Whenever a runway is affected by snow, slush or ice, and it has not been possible to clear the precipitant fully, the condition of the runway should be assessed, and the friction coefficient measured.*

Note.— Guidance on determining and expressing the friction characteristics of snow- and ice-covered paved surfaces is provided in Attachment A, Section 6.

2.9.10 **Recommendation.—** *The readings of the friction measuring device on snow-, slush-, or ice-covered surfaces should adequately correlate with the readings of one other such device.*

Note.— The principal aim is to measure surface friction in a manner that is relevant to the friction experienced by an aircraft tire, thereby providing correlation between the friction measuring device and aircraft braking performance.

2.9.11 **Recommendation.—** *Whenever dry snow, wet snow or slush is present on a runway, an assessment of the mean depth over each third of the runway should be made to an accuracy of approximately 2 cm for dry snow, 1 cm for wet snow and 0.3 cm for slush.*

2.10 Disabled aircraft removal

Note.— See 9.3 for information on disabled aircraft removal services.

2.10.1 **Recommendation.—** *The telephone/telex number(s) of the office of the aerodrome co-ordinator of operations for the removal of an aircraft disabled on or adjacent to the movement area should be made available, on request, to aircraft operators.*

2.10.2 **Recommendation.—** *Information concerning the capability to remove an aircraft disabled on or adjacent to the movement area should be made available.*

Note.— The capability to remove a disabled aircraft may be expressed in terms of the largest type of aircraft which the aerodrome is equipped to remove.

2.11 Rescue and fire fighting

Note.— See 9.2 for information on rescue and fire fighting services.

2.11.1 Information concerning the level of protection provided at an aerodrome for aircraft rescue and fire fighting purposes shall be made available.

2.11.2 **Recommendation.—** *The level of protection normally available at an aerodrome should be expressed in terms of the category of the rescue and fire fighting services as described in 9.2 and in accordance with the types and amounts of extinguishing agents normally available at the aerodrome.*

2.11.3 Significant changes in the level of protection normally available at an aerodrome for rescue and fire fighting shall be notified to the appropriate air traffic services units and aeronautical information units to enable those units to provide the necessary information to arriving and departing aircraft. When such a change has been corrected, the above units shall be advised accordingly.

Note.— A significant change in the level of protection is considered to be a change in the category of the rescue and fire fighting service from the category normally available at the aerodrome, resulting from a change in availability of extinguishing agents, equipment to deliver the agents or personnel to operate the equipment, etc.

2.11.4 **Recommendation.—** *A significant change should be expressed in terms of the new category of the rescue and fire fighting service available at the aerodrome.*

2.12 Visual approach slope indicator systems

The following information concerning a visual approach slope indicator system installation shall be made available:

a) associated runway designation number;

b) type of system according to 5.3.5.2. For an AT-VASIS, PAPI or APAPI installation, the side of the runway on which the lights are installed, i.e. left or right, shall be given;

c) where the axis of the system is not parallel to the runway centre line, the angle of displacement and the direction of displacement, i.e. left or right shall be indicated;

d) nominal approach slope angle(s). For a T-VASIS or an AT-VASIS this shall be angle θ according to the formula in Figure 5-11 and for a PAPI and an APAPI this shall be angle (B + C) ÷ 2 and (A + B) ÷ 2, respectively as in Figure 5-13; and

e) minimum eye height(s) over the threshold of the on-slope signal(s). For a T-VASIS or an AT-VASIS this shall be the lowest height at which only the wing bar(s) are visible; however, the additional heights at which the wing bar(s) plus one, two or three fly down light units come into view may also be reported if such information would be of benefit to aircraft using the approach. For a PAPI this shall be the setting angle of the third unit from the runway minus 2′, i.e. angle B minus 2′, and for an APAPI this shall be the setting angle of the unit farther from the runway minus 2′, i.e. angle A minus 2′.

CHAPTER 3. PHYSICAL CHARACTERISTICS

3.1 Runways

Number and orientation of runways

Introductory Note.— Many factors affect the determination of the orientation, siting and number of runways.

One important factor is the usability factor, as determined by the wind distribution, which is specified hereunder. Another important factor is the alignment of the runway to facilitate the provision of approaches conforming to the approach surface specifications of Chapter 4. In Attachment A, Section 1, information is given concerning these and other factors.

When a new instrument runway is being located, particular attention needs to be given to areas over which aeroplanes will be required to fly when following instrument approach and missed approach procedures, so as to ensure that obstacles in these areas or other factors will not restrict the operation of the aeroplanes for which the runway is intended.

3.1.1 **Recommendation.—** *The number and orientation of runways at an aerodrome should be such that the usability factor of the aerodrome is not less than 95 per cent for the aeroplanes that the aerodrome is intended to serve.*

3.1.2 Choice of maximum permissible cross-wind components

Recommendation.— *In the application of 3.1.1 it should be assumed that landing or take-off of aeroplanes is, in normal circumstances, precluded when the cross-wind component exceeds:*

— *37 km/h (20 kt) in the case of aeroplanes whose reference field length is 1 500 m or over, except that when poor runway braking action owing to an insufficient longitudinal coefficient of friction is experienced with some frequency, a cross-wind component not exceeding 24 km/h (13 kt) should be assumed;*

— *24 km/h (13 kt) in the case of aeroplanes whose reference field length is 1 200 m or up to but not including 1 500 m; and*

— *19 km/h (10 kt) in the case of aeroplanes whose reference field length is less than 1 200 m.*

Note.— In Attachment A, Section 1, guidance is given on factors affecting the calculation of the estimate of the usability factor and allowances which may have to be made to take account of the effect of unusual circumstances.

3.1.3 Data to be used

Recommendation.— *The selection of data to be used for the calculation of the usability factor should be based on reliable wind distribution statistics that extend over as long a period as possible, preferably of not less than five years. The observations used should be made at least eight times daily and spaced at equal intervals of time.*

Note.— These winds are mean winds. Reference to the need for some allowance for gusty conditions is made in Attachment A, Section 1.

Location of threshold

3.1.4 **Recommendation.—** *A threshold should normally be located at the extremity of a runway unless operational considerations justify the choice of another location.*

Note.— Guidance on the siting of the threshold is given in Attachment A, Section 10.

3.1.5 **Recommendation.—** *When it is necessary to displace a threshold, either permanently or temporarily, from its normal location, account should be taken of the various factors which may have a bearing on the location of the threshold. Where this displacement is due to an unserviceable runway condition, a cleared and graded area of at least 60 m in length should be available between the unserviceable area and the displaced threshold. Additional distance should also be provided to meet the requirements of the runway end safety area as appropriate.*

Note.— Guidance on factors which may be considered in the determination of the location of a displaced threshold is given in Attachment A, Section 10.

Actual length of runways

3.1.6 Primary runway

Recommendation.— *Except as provided in 3.1.8, the actual runway length to be provided for a primary runway* *should be adequate to meet the operational requirements of the aeroplanes for which the runway is intended and should be not less than the longest length determined by applying the corrections for local conditions to the operations and performance characteristics of the relevant aeroplanes.*

Note 1.— This specification does not necessarily mean providing for operations by the critical aeroplane at its maximum mass.

Note 2.— Both take-off and landing requirements need to be considered when determining the length of runway to be provided and the need for operations to be conducted in both directions of the runway.

Note 3.— Local conditions that may need to be considered include elevation, temperature, runway slope, humidity and the runway surface characteristics.

Note 4.— When performance data on aeroplanes for which the runway is intended are not known, guidance on the determination of the actual length of a primary runway by application of general correction factors is given in the Aerodrome Design Manual, *Part 1.*

3.1.7 Secondary runway

Recommendation.— *The length of a secondary runway should be determined similarly to primary runways except that it needs only to be adequate for those aeroplanes which require to use that secondary runway in addition to the other runway or runways in order to obtain a usability factor of at least 95 per cent.*

3.1.8 Runways with stopways or clearways

Recommendation.— *Where a runway is associated with a stopway or clearway, an actual runway length less than that resulting from application of 3.1.6 or 3.1.7, as appropriate, may be considered satisfactory, but in such a case any combination of runway, stopway and clearway provided should permit compliance with the operational requirements for take-off and landing of the aeroplanes the runway is intended to serve.*

Note.— Guidance on use of stopways and clearways is given in Attachment A, Section 2.

Width of runways

3.1.9 **Recommendation.—** *The width of a runway should be not less than the appropriate dimension specified in the following tabulation:*

Code number	Code letter A	B	C	D	E
1[a]	*18 m*	*18 m*	*23 m*	–	–
2[a]	*23 m*	*23 m*	*30 m*	–	–
3	*30 m*	*30 m*	*30 m*	*45 m*	–
4	–	–	*45 m*	*45 m*	*45 m*

a. The width of a precision approach runway should be not less than 30 m where the code number is 1 or 2.

Note.— The combinations of code numbers and letters for which widths are specified have been developed for typical aeroplane characteristics.

Minimum distance between parallel runways

3.1.10 **Recommendation.—** *Where parallel non-instrument runways are intended for simultaneous use, the minimum distance between their centre lines should be:*

— 210 m where the higher code number is 3 or 4;

— 150 m where the higher code number is 2; and

— 120 m where the higher code number is 1.

Note.— Procedures for wake turbulence categorization of aircraft and wake turbulence separation minima are contained in the Procedures for Air Navigation Services — Rules of the Air and Air Traffic Services (PANS-RAC), *Doc 4444, Part V, Section 16.*

3.1.11 **Recommendation.—** *Where parallel instrument runways are intended for simultaneous use subject to conditions specified in the PANS-RAC (Doc 4444) and the PANS-OPS (Doc 8168), Volume I, the minimum distance between their centre lines should be:*

— 1 035 m for independent parallel approaches;

— 915 m for dependent parallel approaches;

— 760 m for independent parallel departures;

— 760 m for segregated parallel operations;

except that:

a) for segregated parallel operations the specified minimum distance:

1) may be decreased by 30 m for each 150 m that the arrival runway is staggered toward the arriving aircraft, to a minimum of 300 m; and

2) *should be increased by 30 m for each 150 m that the arrival runway is staggered away from the arriving aircraft;*

b) *for independent parallel approaches, combinations of minimum distances and associated conditions other than those specified in the PANS-RAC (Doc 4444) may be applied when it is determined that such combinations would not adversely affect the safety of aircraft operations.*

Note.— Procedures and facilities requirements for simultaneous operations on parallel or near-parallel instrument runways are contained in the PANS-RAC (Doc 4444), Part IV and the PANS-OPS (Doc 8168), Volume I, Part VII and Volume II, Parts II and III and relevant guidance is contained in the Manual of Simultaneous Operations on Parallel or Near-Parallel Instrument Runways *(Doc 9642).*

Slopes on runways

3.1.12 Longitudinal slopes

Recommendation.— *The slope computed by dividing the difference between the maximum and minimum elevation along the runway centre line by the runway length should not exceed:*

— *1 per cent where the code number is 3 or 4; and*

— *2 per cent where the code number is 1 or 2.*

3.1.13 **Recommendation.—** *Along no portion of a runway should the longitudinal slope exceed:*

— *1.25 per cent where the code number is 4, except that for the first and last quarter of the length of the runway the longitudinal slope should not exceed 0.8 per cent;*

— *1.5 per cent where the code number is 3, except that for the first and last quarter of the length of a precision approach runway category II or III the longitudinal slope should not exceed 0.8 per cent; and*

— *2 per cent where the code number is 1 or 2.*

3.1.14 Longitudinal slope changes

Recommendation.— *Where slope changes cannot be avoided, a slope change between two consecutive slopes should not exceed:*

— *1.5 per cent where the code number is 3 or 4; and*

— *2 per cent where the code number is 1 or 2.*

Note.— Guidance on slope changes before a runway is given in Attachment A, Section 4.

3.1.15 **Recommendation.—** *The transition from one slope to another should be accomplished by a curved surface with a rate of change not exceeding:*

— *0.1 per cent per 30 m (minimum radius of curvature of 30 000 m) where the code number is 4;*

— *0.2 per cent per 30 m (minimum radius of curvature of 15 000 m) where the code number is 3; and*

— *0.4 per cent per 30 m (minimum radius of curvature of 7 500 m) where the code number is 1 or 2.*

3.1.16 Sight distance

Recommendation.— *Where slope changes cannot be avoided, they should be such that there will be an unobstructed line of sight from:*

— *any point 3 m above a runway to all other points 3 m above the runway within a distance of at least half the length of the runway where the code letter is C, D or E;*

— *any point 2 m above a runway to all other points 2 m above the runway within a distance of at least half the length of the runway where the code letter is B; and*

— *any point 1.5 m above a runway to all other points 1.5 m above the runway within a distance of at least half the length of the runway where the code letter is A.*

3.1.17 Distance between slope changes

Recommendation.— *Undulations or appreciable changes in slopes located close together along a runway should be avoided. The distance between the points of intersection of two successive curves should not be less than:*

a) *the sum of the absolute numerical values of the corresponding slope changes multiplied by the appropriate value as follows:*

— *30 000 m where the code number is 4;*

— *15 000 m where the code number is 3; and*

— *5 000 m where the code number is 1 or 2; or*

b) *45 m;*

whichever is greater.

Note.— Guidance on implementing this specification is given in Attachment A, Section 4.

3.1.18 Transverse slopes

Recommendation.— *To promote the most rapid drainage of water, the runway surface should, if practicable, be cambered except where a single crossfall from high to low in the direction of the wind most frequently associated with rain would ensure rapid drainage. The transverse slope should ideally be:*

— *1.5 per cent where the code letter is C, D or E; and*

— *2 per cent where the code letter is A or B;*

but in any event should not exceed 1.5 per cent or 2 per cent, as applicable, nor be less than 1 per cent except at runway or taxiway intersections where flatter slopes may be necessary.

For a cambered surface the transverse slope on each side of the centre line should be symmetrical.

Note.— On wet runways with cross-wind conditions the problem of aquaplaning from poor drainage is apt to be accentuated. In Attachment A, Section 7, information is given concerning this problem and other relevant factors.

3.1.19 **Recommendation.—** *The transverse slope should be substantially the same throughout the length of a runway except at an intersection with another runway or a taxiway where an even transition should be provided taking account of the need for adequate drainage.*

Note.— Guidance on transverse slope is given in the Aerodrome Design Manual, *Part 3.*

Strength of runways

3.1.20 **Recommendation.—** *A runway should be capable of withstanding the traffic of aeroplanes the runway is intended to serve.*

Surface of runways

3.1.21 The surface of a runway shall be constructed without irregularities that would result in loss in friction characteristics or otherwise adversely affect the take-off or landing of an aeroplane.

Note 1.— Surface irregularities may adversely affect the take-off or landing of an aeroplane by causing excessive bouncing, pitching, vibration, or other difficulties in the control of an aeroplane.

Note 2.— Guidance on design tolerances and other information is given in Attachment A, Section 5. Additional guidance is included in the Aerodrome Design Manual, *Part 3.*

3.1.22 The surface of a paved runway shall be so constructed as to provide good friction characteristics when the runway is wet.

3.1.23 **Recommendation.—** *Measurements of the friction characteristics of a new or resurfaced runway should be made with a continuous friction measuring device using self-wetting features in order to assure that the design objectives with respect to its friction characteristics have been achieved.*

Note.— Guidance on friction characteristics of new runway surfaces is given in Attachment A, Section 7. Additional guidance is included in the Airport Services Manual, *Part 2.*

3.1.24 **Recommendation.—** *The average surface texture depth of a new surface should be not less than 1.0 mm.*

Note 1.— This normally requires some form of special surface treatment.

Note 2.— Guidance on methods used to measure surface texture is given in the Airport Services Manual, *Part 2.*

3.1.25 **Recommendation.—** *When the surface is grooved or scored, the grooves or scorings should be either perpendicular to the runway centre line or parallel to non-perpendicular transverse joints, where applicable.*

Note.— Guidance on methods for improving the runway surface texture is given in the Aerodrome Design Manual, *Part 3.*

3.2 Runway shoulders

General

Note.— Guidance on characteristics and treatment of runway shoulders is given in Attachment A, Section 8, and in the Aerodrome Design Manual, *Part 2.*

3.2.1 **Recommendation.—** *Runway shoulders should be provided for a runway where the code letter is D or E, and the runway width is less than 60 m.*

Width of runway shoulders

3.2.2 **Recommendation.—** *The runway shoulders should extend symmetrically on each side of the runway so that the over-all width of the runway and its shoulders is not less than 60 m.*

Slopes on runway shoulders

3.2.3 **Recommendation.—** *The surface of the shoulder that abuts the runway should be flush with the surface of the runway and its transverse slope should not exceed 2.5 per cent.*

Strength of runway shoulders

3.2.4 **Recommendation.**— *A runway shoulder should be prepared or constructed so as to be capable, in the event of an aeroplane running off the runway, of supporting the aeroplane without inducing structural damage to the aeroplane and of supporting ground vehicles which may operate on the shoulder.*

3.3 Runway strips

General

3.3.1 A runway and any associated stopways shall be included in a strip.

Length of runway strips

3.3.2 **Recommendation.**— *A strip should extend before the threshold and beyond the end of the runway or stopway for a distance of at least:*

— *60 m where the code number is 2, 3 or 4;*

— *60 m where the code number is 1 and the runway is an instrument one; and*

— *30 m where the code number is 1 and the runway is a non-instrument one.*

Width of runway strips

3.3.3 A strip including a precision approach runway shall, wherever practicable, extend laterally to a distance of at least:

— 150 m where the code number is 3 or 4; and

— 75 m where the code number is 1 or 2;

on each side of the centre line of the runway and its extended centre line throughout the length of the strip.

3.3.4 **Recommendation.**— *A strip including a non-precision approach runway should extend laterally to a distance of at least:*

— *150 m where the code number is 3 or 4; and*

— *75 m where the code number is 1 or 2;*

on each side of the centre line of the runway and its extended centre line throughout the length of the strip.

3.3.5 **Recommendation.**— *A strip including a non-instrument runway should extend on each side of the centre line of the runway and its extended centre line throughout the length of the strip, to a distance of at least:*

— *75 m where the code number is 3 or 4;*

— *40 m where the code number is 2; and*

— *30 m where the code number is 1.*

Objects on runway strips

Note.— See 8.7 for information regarding siting and construction of equipment and installations on runway strips.

3.3.6 **Recommendation.**— *An object situated on a runway strip which may endanger aeroplanes should be regarded as an obstacle and should, as far as practicable, be removed.*

3.3.7 No fixed object, other than visual aids required for air navigation purposes and satisfying the relevant frangibility requirement in Chapter 5, shall be permitted on a runway strip:

a) within 60 m of the runway centre line of a precision approach runway category I, II or III where the code number is 3 or 4; or

b) within 45 m of the runway centre line of a precision approach runway category I where the code number is 1 or 2.

No mobile object shall be permitted on this part of the runway strip during the use of the runway for landing or take-off.

Grading of runway strips

3.3.8 **Recommendation.**— *That portion of a strip of an instrument runway within a distance of at least:*

— *75 m where the code number is 3 or 4; and*

— *40 m where the code number is 1 or 2;*

from the centre line of the runway and its extended centre line should provide a graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

Note.— Guidance on grading of a greater area of a strip including a precision approach runway where the code number is 3 or 4 is given in Attachment A, Section 8.

3.3.9 **Recommendation.**— *That portion of a strip of a non-instrument runway within a distance of at least:*

— *75 m where the code number is 3 or 4;*

— 40 m where the code number is 2; and

— 30 m where the code number is 1;

from the centre line of the runway and its extended centre line should provide a graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.3.10 The surface of that portion of a strip that abuts a runway, shoulder or stopway shall be flush with the surface of the runway, shoulder or stopway.

3.3.11 **Recommendation.—** *That portion of a strip to at least 30 m before a threshold should be prepared against blast erosion in order to protect a landing aeroplane from the danger of an exposed edge.*

Slopes on runway strips

3.3.12 Longitudinal slopes

Recommendation.— *A longitudinal slope along that portion of a strip to be graded should not exceed:*

— 1.5 per cent where the code number is 4;

— 1.75 per cent where the code number is 3; and

— 2 per cent where the code number is 1 or 2.

3.3.13 Longitudinal slope changes

Recommendation.— *Slope changes on that portion of a strip to be graded should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.*

3.3.14 Transverse slopes

Recommendation.— *Transverse slopes on that portion of a strip to be graded should be adequate to prevent the accumulation of water on the surface but should not exceed:*

— 2.5 per cent where the code number is 3 or 4; and

— 3 per cent where the code number is 1 or 2;

except that to facilitate drainage the slope for the first 3 m outward from the runway, shoulder or stopway edge should be negative as measured in the direction away from the runway and may be as great as 5 per cent.

3.3.15 **Recommendation.—** *The transverse slopes of any portion of a strip beyond that to be graded should not exceed an upward slope of 5 per cent as measured in the direction away from the runway.*

Strength of runway strips

3.3.16 **Recommendation.—** *That portion of a strip of an instrument runway within a distance of at least:*

— 75 m where the code number is 3 or 4; and

— 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line should be so prepared or constructed as to minimize hazards arising from differences in load bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.3.17 **Recommendation.—** *That portion of a strip containing a non-instrument runway within a distance of at least:*

— 75 m where the code number is 3 or 4;

— 40 m where the code number is 2; and

— 30 m where the code number is 1;

from the centre line of the runway and its extended centre line should be so prepared or constructed as to minimize hazards arising from differences in load bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.4 Runway end safety areas

General

3.4.1 **Recommendation.—** *A runway end safety area should be provided at each end of a runway strip where:*

— the code number is 3 or 4; and

— the code number is 1 or 2 and the runway is an instrument one.

Note.— Guidance on runway end safety areas is given in Attachment A, Section 9.

Dimensions of runway end safety areas

3.4.2 **Recommendation.—** *A runway end safety area should extend from the end of a runway strip for as great a distance as practicable, but at least 90 m.*

3.4.3 **Recommendation.—** *The width of a runway end safety area should be at least twice that of the associated runway.*

Objects on runway end safety areas

Note.— See 8.7 for information regarding siting and construction of equipment and installations on runway end safety areas.

3.4.4 **Recommendation.—** *An object situated on a runway end safety area which may endanger aeroplanes should be regarded as an obstacle and should, as far as practicable, be removed.*

Clearing and grading of runway end safety areas

3.4.5 **Recommendation.—** *A runway end safety area should provide a cleared and graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane undershooting or overrunning the runway.*

Note.— The surface of the ground in the runway end safety area does not need to be prepared to the same quality as the runway strip. See, however, 3.4.9.

Slopes on runway end safety areas

3.4.6 General

Recommendation.— *The slopes of a runway end safety area should be such that no part of the runway end safety area penetrates the approach or take-off climb surface.*

3.4.7 Longitudinal slopes

Recommendation.— *The longitudinal slopes of a runway end safety area should not exceed a downward slope of 5 per cent. Longitudinal slope changes should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.*

3.4.8 Transverse slopes

Recommendation.— *The transverse slopes of a runway end safety area should not exceed an upward or downward slope of 5 per cent. Transitions between differing slopes should be as gradual as practicable.*

Strength of runway end safety areas

3.4.9 **Recommendation.—** *A runway end safety area should be so prepared or constructed as to reduce the risk of damage to an aeroplane undershooting or overrunning the runway and facilitate the movement of rescue and fire fighting vehicles.*

3.5 Clearways

Note.— The inclusion of detailed specifications for clearways in this section is not intended to imply that a clearway has to be provided. Attachment A, Section 2 provides information on the use of clearways.

Location of clearways

3.5.1 **Recommendation.—** *The origin of a clearway should be at the end of the take-off run available.*

Length of clearways

3.5.2 **Recommendation.—** *The length of a clearway should not exceed half the length of the take-off run available.*

Width of clearways

3.5.3 **Recommendation.—** *A clearway should extend laterally to a distance of at least 75 m on each side of the extended centre line of the runway.*

Slopes on clearways

3.5.4 **Recommendation.—** *The ground in a clearway should not project above a plane having an upward slope of 1.25 per cent, the lower limit of this plane being a horizontal line which:*

a) is perpendicular to the vertical plane containing the runway centre line; and

b) passes through a point located on the runway centre line at the end of the take-off run available.

Note.— Because of transverse or longitudinal slopes on a runway, shoulder or strip, in certain cases the lower limit of the clearway plane specified above may be below the corresponding elevation of the runway, shoulder or strip. It is not intended that these surfaces be graded to conform with the lower limit of the clearway plane nor is it intended that terrain or objects which are above the clearway plane beyond the end of the strip but below the level of the strip be removed unless it is considered they may endanger aeroplanes.

3.5.5 **Recommendation.—** *Abrupt upward changes in slope should be avoided when the slope on the ground in a clearway is relatively small or when the mean slope is upward. In such situations, in that portion of the clearway within a distance of 22.5 m on each side of the extended centre line, the slopes, slope changes and the transition from runway to clearway should generally conform with those of the runway with which the clearway is associated except that isolated depressions such as ditches running across the clearway may be permitted.*

Objects on clearways

Note.— See 8.7 for information regarding siting and construction of equipment and installations on clearways.

3.5.6 **Recommendation.—** *An object situated on a clearway which may endanger aeroplanes in the air should be regarded as an obstacle and should be removed.*

3.6 Stopways

Note.— The inclusion of detailed specifications for stopways in this section is not intended to imply that a stopway has to be provided. Attachment A, Section 2 provides information on the use of stopways.

Width of stopways

3.6.1 A stopway shall have the same width as the runway with which it is associated.

Slopes on stopways

3.6.2 **Recommendation.—** *Slopes and changes in slope on a stopway, and the transition from a runway to a stopway, should comply with the specifications of 3.1.12 to 3.1.18 for the runway with which the stopway is associated except that:*

a) the limitation in 3.1.13 of a 0.8 per cent slope for the first and last quarter of the length of a runway need not be applied to the stopway; and

b) at the junction of the stopway and runway and along the stopway the maximum rate of slope change may be 0.3 per cent per 30 m (minimum radius of curvature of 10 000 m) for a runway where the code number is 3 or 4.

Strength of stopways

3.6.3 **Recommendation.—** *A stopway should be prepared or constructed so as to be capable, in the event of an abandoned take-off, of supporting the aeroplane which the stopway is intended to serve without inducing structural damage to the aeroplane.*

Note.— Attachment A, Section 2 presents guidance relative to the support capability of a stopway.

Surface of stopways

3.6.4 **Recommendation.—** *The surface of a paved stopway should be so constructed as to provide a good coefficient of friction when the stopway is wet.*

3.6.5 **Recommendation.—** *The friction characteristics of an unpaved stopway should not be substantially less than that of the runway with which the stopway is associated.*

3.7 Radio altimeter operating area

General

3.7.1 **Recommendation.—** *A radio altimeter operating area should be established in the pre-threshold area of a precision approach runway.*

Length of the area

3.7.2 **Recommendation.—** *A radio altimeter operating area should extend before the threshold for a distance of at least 300 m.*

Width of the area

3.7.3 **Recommendation.—** *A radio altimeter operating area should extend laterally, on each side of the extended centre line of the runway, to a distance of 60 m, except that, when special circumstances so warrant, the distance may be reduced to no less than 30 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft.*

Longitudinal slope changes

3.7.4 **Recommendation.—** *On a radio altimeter operating area, slope changes should be avoided or kept to a minimum. Where slope changes cannot be avoided, the slope changes should be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided. The rate of change between two consecutive slopes should not exceed 2 per cent per 30 m.*

Note.— Guidance on radio altimeter operating area is given in Attachment A, Section 4.3 and in the Manual of All-Weather Operations, *Section 5.2. Guidance on the use of radio altimeter is given in the PANS-OPS, Volume II, Part III, Chapter 21.*

3.8 Taxiways

Note.— Unless otherwise indicated the requirements in this section are applicable to all types of taxiways.

General

3.8.1 **Recommendation.**— *Taxiways should be provided to permit the safe and expeditious surface movement of aircraft.*

Note.— Guidance on layout of taxiways is given in the Aerodrome Design Manual, *Part 2.*

3.8.2 **Recommendation.**— *Sufficient entrance and exit taxiways for a runway should be provided to expedite the movement of aeroplanes to and from the runway and provision of rapid exit taxiways considered when traffic volumes are high.*

Note.— Where the end of a runway is not served by a taxiway, it may be necessary to provide additional pavement at the end of the runway for the turning of aeroplanes. Such areas may also be useful along the runway to reduce taxiing time and distance for some aeroplanes.

3.8.3 **Recommendation.**— *The design of a taxiway should be such that, when the cockpit of the aeroplane for which the taxiway is intended remains over the taxiway centre line markings, the clearance distance between the outer main wheel of the aeroplane and the edge of the taxiway should be not less than that given by the following tabulation:*

Code letter	Clearance
A	*1.5 m*
B	*2.25 m*
C	*3 m if the taxiway is intended to be used by aeroplanes with a wheel base less than 18 m;* *4.5 m if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.*
D	*4.5 m*
E	*4.5 m*

Note.— Wheel base means the distance from the nose gear to the geometric centre of the main gear.

Width of taxiways

3.8.4 **Recommendation.**— *A straight portion of a taxiway should have a width of not less than that given by the following tabulation:*

Code letter	Taxiway width
A	*7.5 m*
B	*10.5 m*
C	*15 m if the taxiway is intended to be used by aeroplanes with a wheel base less than 18 m;* *18 m if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.*
D	*18 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span of less than 9 m;* *23 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span equal to or greater than 9 m.*
E	*23 m*

Taxiway curves

3.8.5 **Recommendation.**— *Changes in direction of taxiways should be as few and small as possible. The radii of the curves should be compatible with the manoeuvring capability and normal taxiing speeds of the aeroplanes for which the taxiway is intended. The design of the curve should be such that, when the cockpit of the aeroplane remains over the taxiway centre line markings, the clearance distance between the outer main wheels of the aeroplane and the edge of the taxiway should not be less than those specified in 3.8.3.*

Note 1.— An example of widening taxiways to achieve the wheel clearance specified is illustrated in Figure 3-1. Guidance on the values of suitable dimensions is given in the Aerodrome Design Manual, *Part 2.*

Note 2.— The location of taxiway centre line markings and lights is specified in 5.2.8.4 and 5.3.15.7.

Note 3.— Compound curves may reduce or eliminate the need for extra taxiway width.

Junctions and intersections

3.8.6 **Recommendation.**— *To facilitate the movement of aeroplanes, fillets should be provided at junctions and intersections of taxiways with runways, aprons and other taxiways. The design of the fillets should ensure that the minimum wheel clearances specified in 3.8.3 are maintained when aeroplanes are manoeuvring through the junctions or intersections.*

Note.— Guidance on the design of fillets is given in the Aerodrome Design Manual, *Part 2.*

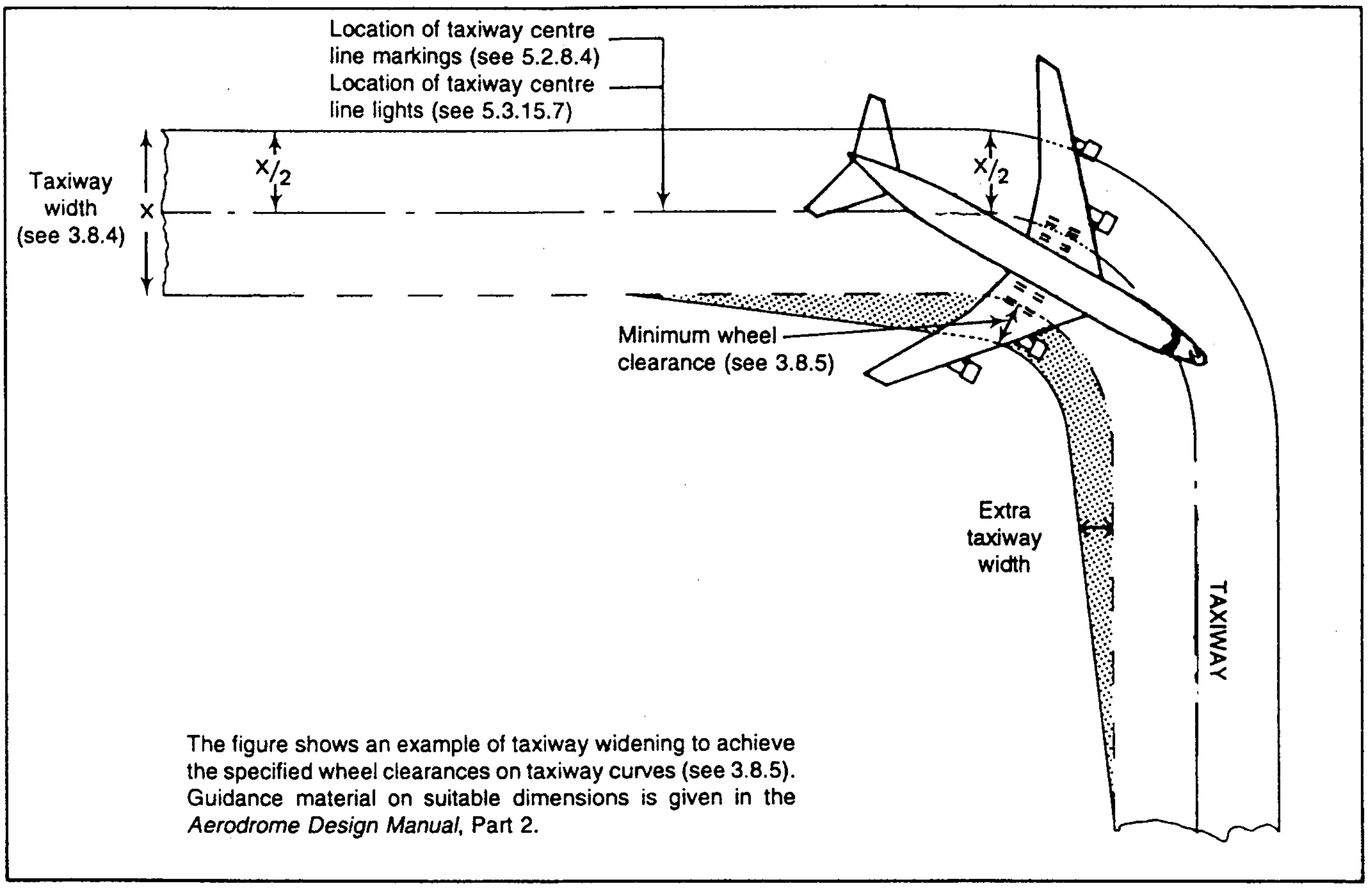


Figure 3-1. Taxiway curve

Taxiway minimum separation distances

3.8.7 **Recommendation.**— *The separation distance between the centre line of a taxiway and the centre line of a runway, the centre line of a parallel taxiway or an object should not be less than the appropriate dimension specified in Table 3-1, except that it may be permissible to operate with lower separation distances at an existing aerodrome if an aeronautical study indicates that such lower separation distances would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note 1.— Guidance on factors which may be considered in the aeronautical study is given in the Aerodrome Design Manual, *Part 2.*

Note 2.— ILS and MLS installations may also influence the location of taxiways due to interferences to ILS and MLS signals by a taxiing or stopped aircraft. Information on critical and sensitive areas surrounding ILS and MLS installations is contained in Annex 10, Volume I, Attachments C and G (respectively) to Part I.

Note 3.— The separation distances of Table 3-1, column 10, do not necessarily provide the capability of making a normal turn from one taxiway to another parallel taxiway. Guidance for this condition is given in the Aerodrome Design Manual, *Part 2.*

Note 4.— The separation distance between the centre line of an aircraft stand taxilane and an object shown in Table 3-1, column 12 may need to be increased when jet exhaust wake velocity may cause hazardous conditions for ground servicing.

Slopes on taxiways

3.8.8 Longitudinal slopes

Recommendation.— *The longitudinal slope of a taxiway should not exceed:*

— *1.5 per cent where the code letter is C, D or E; and*

— *3 per cent where the code letter is A or B.*

Table 3-1. Taxiway minimum separation distances

Code letter	Distance between taxiway centre line and runway centre line (metres)								Taxiway centre line to taxiway centre line (metres)	Taxiway, other than aircraft stand taxilane, centre line to object (metres)	Aircraft stand taxilane centre line to object (metres)
	Instrument runways Code number				Non-instrument runways Code number						
	1	2	3	4	1	2	3	4			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A	82.5	82.5	–	–	37.5	47.5	–	–	23.75	16.25	12
B	87	87	–	–	42	52	–	–	33.5	21.5	16.5
C	–	–	168	–	–	–	93	–	44	26	24.5
D	–	–	176	176	–	–	101	101	66.5	40.5	36
E	–	–	–	182.5	–	–	–	107.5	80	47.5	42.5

Note.— The separation distances shown in columns (2) to (9) represent ordinary combinations of runways and taxiways. The basis for development of these distances is given in the Aerodrome Design Manual, *Part 2.*

3.8.9 Longitudinal slope changes

Recommendation.— *Where slope changes on a taxiway cannot be avoided, the transition from one slope to another slope should be accomplished by a curved surface with a rate of change not exceeding:*

— 1 per cent per 30 m (minimum radius of curvature of 3 000 m) where the code letter is C, D or E; and

— 1 per cent per 25 m (minimum radius of curvature of 2 500 m) where the code letter is A or B.

3.8.10 Sight distance

Recommendation.— *Where a change in slope on a taxiway cannot be avoided, the change should be such that, from any point:*

— 3 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 300 m from that point, where the code letter is C, D or E;

— 2 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 200 m from that point, where the code letter is B; and

— 1.5 m above the taxiway, it will be possible to see the whole surface of the taxiway for a distance of at least 150 m from that point, where the code letter is A.

3.8.11 Transverse slopes

Recommendation.— *The transverse slopes of a taxiway should be sufficient to prevent the accumulation of water on the surface of the taxiway but should not exceed:*

— 1.5 per cent where the code letter is C, D or E; and

— 2 per cent where the code letter is A or B.

Note.— See 3.12.4 regarding transverse slopes on an aircraft stand taxilane.

Strength of taxiways

3.8.12 **Recommendation.—** *The strength of a taxiway should be at least equal to that of the runway it serves, due consideration being given to the fact that a taxiway will be subjected to a greater density of traffic and, as a result of slow moving and stationary aeroplanes, to higher stresses than the runway it serves.*

Note.— Guidance on the relation of the strength of taxiways to the strength of runways is given in the Aerodrome Design Manual, *Part 3.*

Surface of taxiways

3.8.13 **Recommendation.—** *The surface of a taxiway should not have irregularities that cause damage to aeroplane structures.*

3.8.14 **Recommendation.—** *The surface of a paved taxiway should be so constructed as to provide good friction characteristics when the taxiway is wet.*

Rapid exit taxiways

Note.— The following specifications detail requirements particular to rapid exit taxiways. See Figure 3-2. General requirements for taxiways also apply to this type of taxiway. Guidance on the provision, location and design of rapid exit taxiways is included in the Aerodrome Design Manual, *Part 2.*

3.8.15 **Recommendation.—** *A rapid exit taxiway should be designed with a radius of turn-off curve of at least:*

— 550 m where the code number is 3 or 4; and

— 275 m where the code number is 1 or 2;

to enable exit speeds under wet conditions of:

— 93 km/h where the code number is 3 or 4; and

— 65 km/h where the code number is 1 or 2.

Note.— The locations of rapid exit taxiways along a runway are based on several criteria described in the Aerodrome Design Manual, *Part 2, in addition to different speed criteria.*

3.8.16 **Recommendation.—** *The radius of the fillet on the inside of the curve at a rapid exit taxiway should be sufficient to provide a widened taxiway throat in order to facilitate early recognition of the entrance and turn-off onto the taxiway.*

3.8.17 **Recommendation.—** *A rapid exit taxiway should include a straight distance after the turn-off curve sufficient for an exiting aircraft to come to a full stop clear of any intersecting taxiway.*

3.8.18 **Recommendation.—** *The intersection angle of a rapid exit taxiway with the runway should not be greater than 45° nor less than 25° and preferably should be 30°.*

Taxiways on bridges

3.8.19 The width of that portion of a taxiway bridge capable of supporting aeroplanes, as measured perpendicularly to the taxiway centre line, shall not be less than the width of

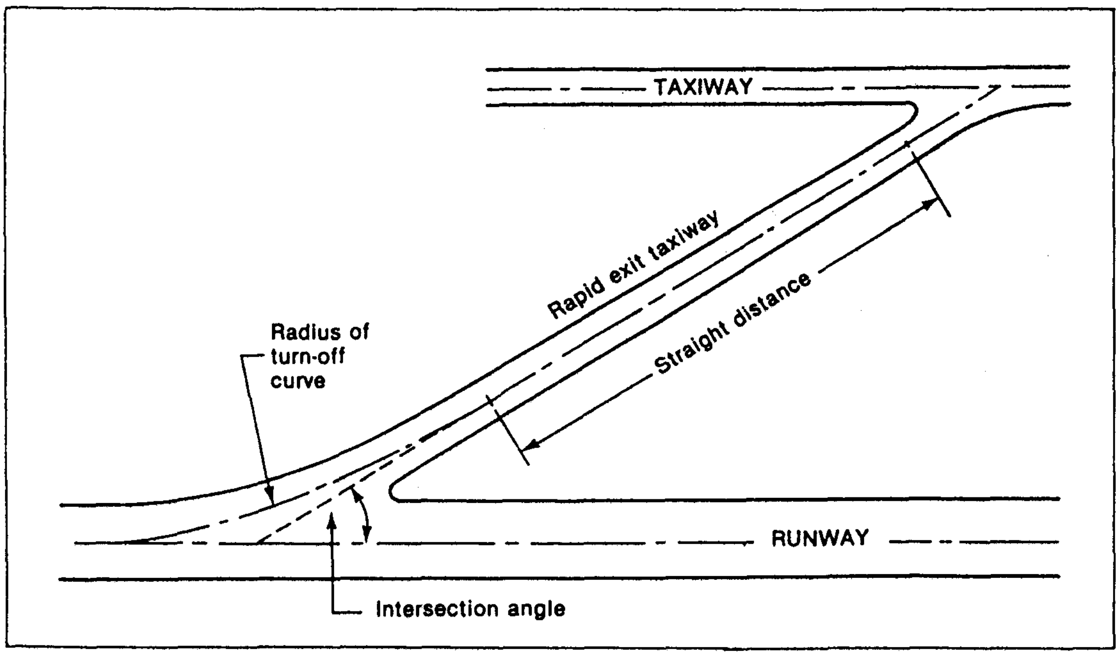


Figure 3-2. Rapid exit taxiway

the graded area of the strip provided for that taxiway, unless a proven method of lateral restraint is provided which shall not be hazardous for aeroplanes for which the taxiway is intended.

Note 1.— When a width less than the width of the graded area of the strip is provided, consideration will have to be given to access by rescue and fire fighting vehicles.

Note 2.— If aeroplane engines overhang the bridge structure, protection of adjacent areas below the bridge from engine blast may be required.

3.8.20 **Recommendation.**— *A bridge should be constructed on a straight section of the taxiway with a straight section on both ends of the bridge to facilitate the alignment of aeroplanes approaching the bridge.*

3.9 Taxiway shoulders

Note.— Guidance on characteristics of taxiway shoulders and on shoulder treatment is given in the Aerodrome Design Manual, *Part 2.*

3.9.1 **Recommendation.**— *Straight portions of a taxiway where the code letter is C, D or E should be provided with shoulders which extend symmetrically on each side of the taxiway so that the over-all width of the taxiway and its shoulders on straight portions is not less than:*

— *44 m where the code letter is E;*

— *38 m where the code letter is D; and*

— *25 m where the code letter is C.*

On taxiway curves and on junctions or intersections where increased pavement is provided, the shoulder width should be not less than that on the adjacent straight portions of the taxiway.

3.9.2 **Recommendation.**— *When a taxiway is intended to be used by turbine-engined aeroplanes, the surface of the taxiway shoulder should be so prepared as to resist erosion and the ingestion of the surface material by aeroplane engines.*

3.10 Taxiway strips

Note.— Guidance on characteristics of taxiway strips is given in the Aerodrome Design Manual, *Part 2.*

General

3.10.1 A taxiway, other than an aircraft stand taxilane, shall be included in a strip.

Width of taxiway strips

3.10.2 **Recommendation.**— *A taxiway strip should extend symmetrically on each side of the centre line of the taxiway throughout the length of the taxiway to at least the distance from the centre line given in Table 3-1, column 11.*

Objects on taxiway strips

Note.— See 8.7 for information regarding siting and construction of equipment and installations on taxiway strips.

3.10.3 **Recommendation.**— *The taxiway strip should provide an area clear of objects which may endanger taxiing aeroplanes.*

Grading of taxiway strips

3.10.4 **Recommendation.**— *The centre portion of a taxiway strip should provide a graded area to a distance from the centre line of the taxiway of at least:*

— *11 m where the code letter is A;*

— *12.5 m where the code letter is B or C;*

— *19 m where the code letter is D; and*

— *22 m where the code letter is E.*

Slopes on taxiway strips

3.10.5 **Recommendation.**— *The surface of the strip should be flush at the edge of the taxiway or shoulder, if provided, and the graded portion should not have an upward transverse slope exceeding:*

— *2.5 per cent for strips of taxiways where the code letter is C, D or E; and*

— *3 per cent for strips of taxiways where the code letter is A or B;*

the upward slope being measured with reference to the transverse slope of the adjacent taxiway surface and not the horizontal. The downward transverse slope should not exceed 5 per cent measured with reference to the horizontal.

3.10.6 **Recommendation.**— *The transverse slopes on any portion of a taxiway strip beyond that to be graded should not exceed an upward slope of 5 per cent as measured in the direction away from the taxiway.*

3.11 Holding bays, taxi-holding positions and road-holding positions

General

3.11.1 **Recommendation.—** *Holding bay(s) should be provided when the traffic volume is high.*

3.11.2 A taxi-holding position or positions shall be established:

a) at an intersection of a taxiway with a runway; and

b) at an intersection of a runway with another runway when the former runway is part of a standard taxi-route.

3.11.3 A taxi-holding position shall be established on a taxiway if its location or alignment is such that a taxiing aircraft or vehicle can infringe an obstacle limitation surface or interfere with the operation of radio navigation aids.

3.11.4 A road-holding position shall be established at an intersection of a road with a runway.

Location

3.11.5 The distance between a holding bay, taxi-holding position established at a taxiway/runway intersection or road-holding position and the centre line of a runway shall be in accordance with Table 3-2 and in the case of a precision approach runway, such that a holding aircraft or vehicle will not interfere with the operation of radio navigation aids.

3.11.6 **Recommendation.—** *At elevations greater than 700 m (2 300 ft) the distance of 90 m specified in Table 3-2 for a precision approach runway code number 4 should be increased as follows:*

a) up to an elevation of 2 000 m (6 600 ft); 1 m for every 100 m (330 ft) in excess of 700 m (2 300 ft);

b) elevation in excess of 2 000 m (6 600 ft) and up to 4 000 m (13 320 ft); 13 m plus 1.5 m for every 100 m (330 ft) in excess of 2 000 m (6 600 ft); and

c) elevation in excess of 4 000 m (13 320 ft) and up to 5 000 m (16 650 ft); 43 m plus 2 m for every 100 m (330 ft) in excess of 4 000 m (13 320 ft).

Table 3-2. Minimum distance from the runway centre line to a holding bay, taxi-holding position or road-holding position

	Code number			
Type of runway	1	2	3	4
Non-instrument	30 m	40 m	75 m	75 m
Non-precision approach	40 m	40 m	75 m	75 m
Precision approach category I	60 m[b]	60 m[b]	90 m[a,b]	90 m[a,b]
Precision approach categories II and III	–	–	90 m[a,b]	90 m[a,b]
Take-off runway	30 m	40 m	75 m	75 m

a. If a holding bay, taxi-holding position or road-holding position is at a lower elevation compared to the threshold, the distance may be decreased 5 m for every metre the bay or holding position is lower than the threshold, contingent upon not infringing the inner transitional surface.

b. This distance may need to be increased to avoid interference with radio navigation aids, particularly the glide path and localizer facilities. Information on critical and sensitive areas of ILS and MLS is contained in Annex 10, Volume I, Attachments C and G to Part I, respectively (see also 3.11.5).

Note 1.— The distance of 90 m for code number 3 or 4 is based on an aircraft with a tail height of 20 m, a distance from the nose to the highest part of the tail of 52.7 m and a nose height of 10 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone and not accountable for the calculation of OCA/H.

Note 2.— The distance of 60 m for code number 2 is based on an aircraft with a tail height of 8 m, a distance from the nose to the highest part of the tail of 24.6 m and a nose height of 5.2 m holding at an angle of 45° or more with respect to the runway centre line, being clear of the obstacle free zone.

3.11.7 **Recommendation.—** *If a holding bay, taxi-holding position or road-holding position for a precision approach runway code number 4 is at a greater elevation compared to the threshold, the distance of 90 m specified in Table 3-2 should be further increased 5 m for every metre the bay or position is higher than the threshold.*

3.11.8 The location of a taxi-holding position established at other than a taxiway/runway intersection shall be such that a holding aircraft or vehicle will not infringe the obstacle free zone, approach surface, take-off climb surface or ILS/MLS critical/sensitive area or interfere with the operation of radio navigation aids.

3.12 Aprons

General

3.12.1 **Recommendation.—** *Aprons should be provided where necessary to permit the on- and off-loading of passengers, cargo or mail as well as the servicing of aircraft without interfering with the aerodrome traffic.*

Size of aprons

3.12.2 **Recommendation.—** *The total apron area should be adequate to permit expeditious handling of the aerodrome traffic at its maximum anticipated density.*

Strength of aprons

3.12.3 **Recommendation.—** *Each part of an apron should be capable of withstanding the traffic of the aircraft it is intended to serve, due consideration being given to the fact that some portions of the apron will be subjected to a higher density of traffic and, as a result of slow moving or stationary aircraft, to higher stresses than a runway.*

Slopes on aprons

3.12.4 **Recommendation.—** *Slopes on an apron, including those on an aircraft stand taxilane, should be sufficient to prevent accumulation of water on the surface of the apron but should be kept as level as drainage requirements permit.*

3.12.5 **Recommendation.—** *On an aircraft stand the maximum slope should not exceed 1 per cent.*

Clearance distances on aircraft stands

3.12.6 **Recommendation.—** *An aircraft stand should provide the following minimum clearances between an aircraft using the stand and any adjacent building, aircraft on another stand and other objects:*

Code letter	Clearance
A	*3 m*
B	*3 m*
C	*4.5 m*
D	*7.5 m*
E	*7.5 m*

When special circumstances so warrant, these clearances may be reduced at a nose-in aircraft stand, where the code letter is D or E:

a) between the terminal, including any fixed passenger bridge, and the nose of an aircraft; and

b) over any portion of the stand provided with azimuth guidance by a visual docking guidance system.

Note.— On aprons, consideration also has to be given to the provision of service roads and to manoeuvring and storage area for ground equipment.

3.13 Isolated aircraft parking position

3.13.1 An isolated aircraft parking position shall be designated or the aerodrome control tower shall be advised of an area or areas suitable for the parking of an aircraft which is known or believed to be the subject of unlawful interference, or which for other reasons needs isolation from normal aerodrome activities.

3.13.2 **Recommendation.—** *The isolated aircraft parking position should be located at the maximum distance practicable and in any case never less than 100 m from other parking positions, buildings or public areas, etc. Care should be taken to ensure that the position is not located over underground utilities such as gas and aviation fuel and, to the extent feasible, electrical or communication cables.*

CHAPTER 4. OBSTACLE RESTRICTION AND REMOVAL

Note 1.— The objectives of the specifications in this chapter are to define the airspace around aerodromes to be maintained free from obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

Note 2.— Objects which penetrate the obstacle limitation surfaces contained in this chapter may in certain circumstances cause an increase in the obstacle clearance altitude/height for an instrument approach procedure or any associated visual circling procedure. Criteria for evaluating obstacles are contained in Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS) *(Doc 8168).*

Note 3.— The establishment of, and requirements for, an obstacle protection surface for visual approach slope indicator systems are specified in 5.3.5.41 to 5.3.5.45.

4.1 Obstacle limitation surfaces

Note.— See Figure 4-1.

Outer horizontal surface

Note.— Guidance on the need to provide an outer horizontal surface and its characteristics is contained in the Airport Services Manual, *Part 6.*

Conical surface

4.1.1 *Description.— Conical surface.* A surface sloping upwards and outwards from the periphery of the inner horizontal surface.

4.1.2 *Characteristics.—* The limits of the conical surface shall comprise:

a) a lower edge coincident with the periphery of the inner horizontal surface; and

b) an upper edge located at a specified height above the inner horizontal surface.

4.1.3 The slope of the conical surface shall be measured in a vertical plane perpendicular to the periphery of the inner horizontal surface.

Inner horizontal surface

4.1.4 *Description.— Inner horizontal surface.* A surface located in a horizontal plane above an aerodrome and its environs.

4.1.5 *Characteristics.—* The radius or outer limits of the inner horizontal surface shall be measured from a reference point or points established for such purpose.

Note.— The shape of the inner horizontal surface need not necessarily be circular. Guidance on determining the extent of the inner horizontal surface is contained in the Airport Services Manual, *Part 6.*

4.1.6 The height of the inner horizontal surface shall be measured above an elevation datum established for such purpose.

Note.— Guidance on determining the elevation datum is contained in the Airport Services Manual, *Part 6.*

Approach surface

4.1.7 *Description.— Approach surface.* An inclined plane or combination of planes preceding the threshold.

4.1.8 *Characteristics.—* The limits of the approach surface shall comprise:

a) an inner edge of specified length, horizontal and perpendicular to the extended centre line of the runway and located at a specified distance before the threshold;

b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway; and

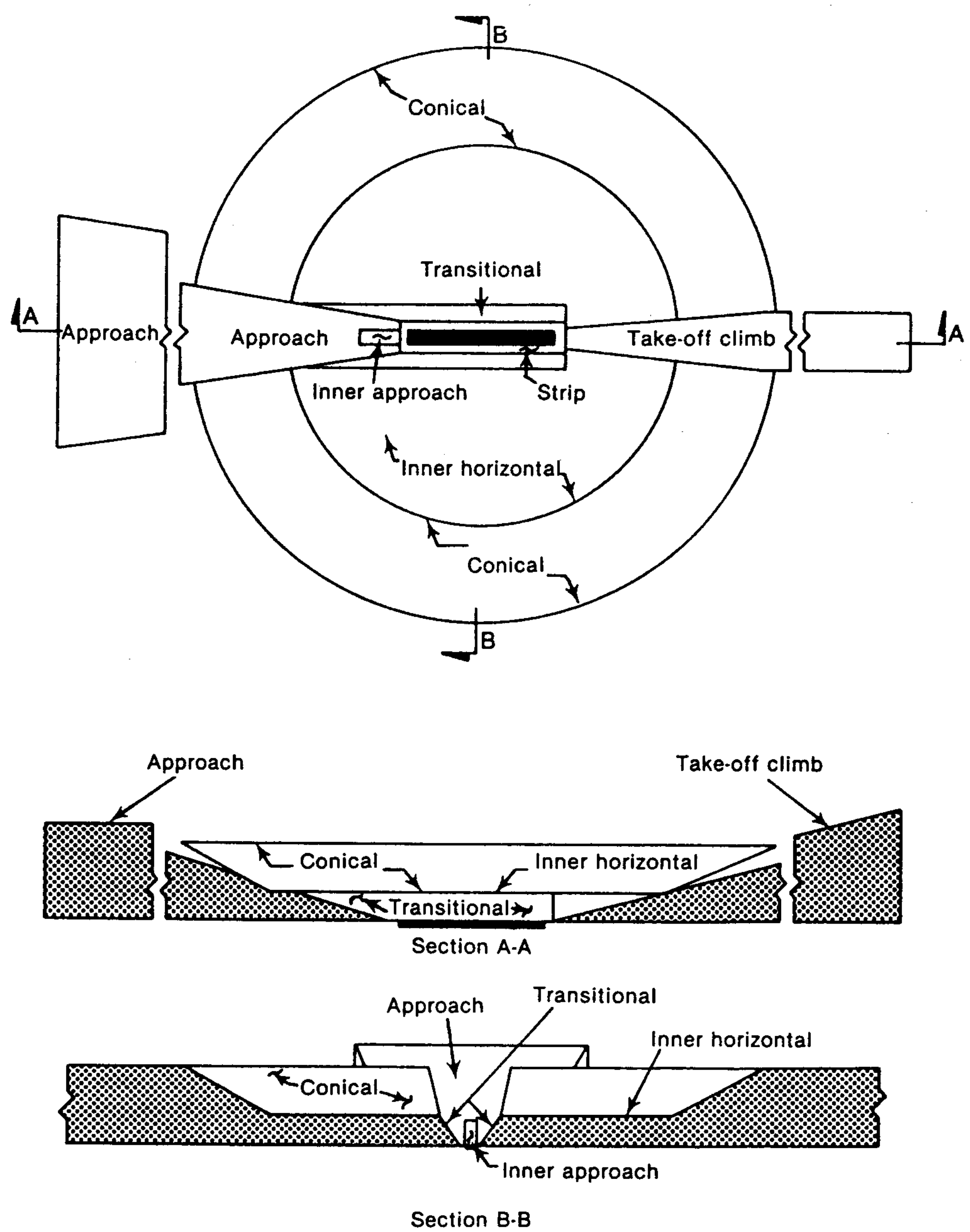
c) an outer edge parallel to the inner edge.

4.1.9 The elevation of the inner edge shall be equal to the elevation of the mid-point of the threshold.

4.1.10 The slope(s) of the approach surface shall be measured in the vertical plane containing the centre line of the runway.

Inner approach surface

4.1.11 *Description.— Inner approach surface.* A rectangular portion of the approach surface immediately preceding the threshold.



See Figure 4-2 for inner transitional and balked landing obstacle limitation surfaces and Attachment B for a three-dimensional view

Figure 4-1. Obstacle limitation surfaces

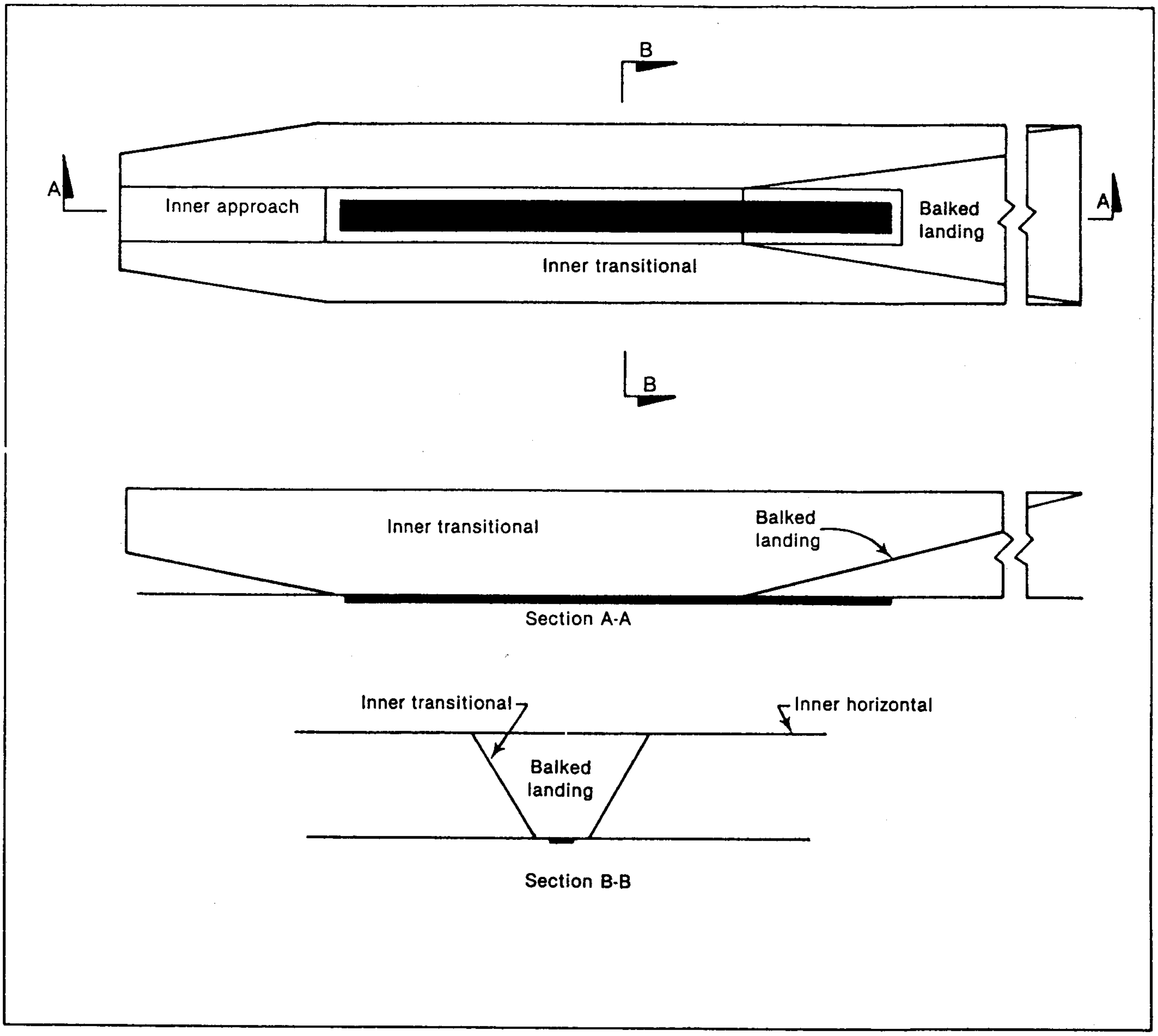


Figure 4-2. Inner approach, inner transitional and balked landing obstacle limitation surfaces

4.1.12 *Characteristics.*— The limits of the inner approach surface shall comprise:

a) an inner edge coincident with the location of the inner edge of the approach surface but of its own specified length;

b) two sides originating at the ends of the inner edge and extending parallel to the vertical plane containing the centre line of the runway; and

c) an outer edge parallel to the inner edge.

Transitional surface

4.1.13 *Description.— Transitional surface.* A complex surface along the side of the strip and part of the side of the approach surface, that slopes upwards and outwards to the inner horizontal surface.

4.1.14 *Characteristics.*— The limits of a transitional surface shall comprise:

a) a lower edge beginning at the intersection of the side of the approach surface with the inner horizontal surface and extending down the side of the approach surface to the inner edge of the approach surface and from there along the length of the strip parallel to the runway centre line; and

b) an upper edge located in the plane of the inner horizontal surface.

4.1.15 The elevation of a point on the lower edge shall be:

a) along the side of the approach surface — equal to the elevation of the approach surface at that point; and

b) along the strip — equal to the elevation of the nearest point on the centre line of the runway or its extension.

Note.— As a result of b) the transitional surface along the strip will be curved if the runway profile is curved, or a plane if the runway profile is a straight line. The intersection of the transitional surface with the inner horizontal surface will also be a curved or a straight line depending on the runway profile.

4.1.16 The slope of the transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway.

Inner transitional surface

Note.— It is intended that the inner transitional surface be the controlling obstacle limitation surface for navigation aids, aircraft and other vehicles that must be near the runway and which is not to be penetrated except for frangible objects. The transitional surface described in 4.1.13 is intended to remain as the controlling obstacle limitation surface for buildings, etc.

4.1.17 *Description.— Inner transitional surface.* A surface similar to the transitional surface but closer to the runway.

4.1.18 *Characteristics.—* The limits of an inner transitional surface shall comprise:

a) a lower edge beginning at the end of the inner approach surface and extending down the side of the inner approach surface to the inner edge of that surface, from there along the strip parallel to the runway centre line to the inner edge of the balked landing surface and from there up the side of the balked landing surface to the point where the side intersects the inner horizontal surface; and

b) an upper edge located in the plane of the inner horizontal surface.

4.1.19 The elevation of a point on the lower edge shall be:

a) along the side of the inner approach surface and balked landing surface — equal to the elevation of the particular surface at that point; and

b) along the strip — equal to the elevation of the nearest point on the centre line of the runway or its extension.

Note.— As a result of b) the inner transitional surface along the strip will be curved if the runway profile is curved or a plane if the runway profile is a straight line. The intersection of the inner transitional surface with the inner horizontal surface will also be a curved or straight line depending on the runway profile.

4.1.20 The slope of the inner transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway.

Balked landing surface

4.1.21 *Description.— Balked landing surface.* An inclined plane located at a specified distance after the threshold, extending between the inner transitional surface.

4.1.22 *Characteristics.—* The limits of the balked landing surface shall comprise:

a) an inner edge horizontal and perpendicular to the centre line of the runway and located at a specified distance after the threshold:

b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the vertical plane containing the centre line of the runway; and

c) an outer edge parallel to the inner edge and located in the plane of the inner horizontal surface.

4.1.23 The elevation of the inner edge shall be equal to the elevation of the runway centre line at the location of the inner edge.

4.1.24 The slope of the balked landing surface shall be measured in the vertical plane containing the centre line of the runway.

Take-off climb surface

4.1.25 *Description.— Take-off climb surface.* An inclined plane or other specified surface beyond the end of a runway or clearway.

4.1.26 *Characteristics.—* The limits of the take-off climb surface shall comprise:

a) an inner edge horizontal and perpendicular to the centre line of the runway and located either at a specified distance beyond the end of the runway or at the end of the clearway when such is provided and its length exceeds the specified distance;

b) two sides originating at the ends of the inner edge, diverging uniformly at a specified rate from the take-off track to a specified final width and continuing thereafter at that width for the remainder of the length of the take-off climb surface; and

c) an outer edge horizontal and perpendicular to the specified take-off track.

4.1.27 The elevation of the inner edge shall be equal to the highest point on the extended runway centre line between the end of the runway and the inner edge, except that when a clearway is provided the elevation shall be equal to the highest point on the ground on the centre line of the clearway.

4.1.28 In the case of a straight take-off flight path, the slope of the take-off climb surface shall be measured in the vertical plane containing the centre line of the runway.

4.1.29 In the case of a take-off flight path involving a turn, the take-off climb surface shall be a complex surface containing the horizontal normals to its centre line, and the slope of the centre line shall be the same as that for a straight take-off flight path.

4.2 Obstacle limitation requirements

Note.— The requirements for obstacle limitation surfaces are specified on the basis of the intended use of a runway, i.e. take-off or landing and type of approach, and are intended to be applied when such use is made of the runway. In cases where operations are conducted to or from both directions of a runway, then the function of certain surfaces may be nullified because of more stringent requirements of another lower surface.

Non-instrument runways

4.2.1 The following obstacle limitation surfaces shall be established for a non-instrument runway:

— conical surface;
— inner horizontal surface;
— approach surface; and
— transitional surfaces.

4.2.2 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1.

4.2.3 New objects or extensions of existing objects shall not be permitted above an approach or transitional surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.4 **Recommendation.—** *New objects or extensions of existing objects should not be permitted above the conical surface or inner horizontal surface except when, in the opinion of the appropriate authority, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

4.2.5 **Recommendation.—** *Existing objects above any of the surfaces required by 4.2.1 should as far as practicable be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note.— Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

4.2.6 **Recommendation.—** *In considering proposed construction, account should be taken of the possible future development of an instrument runway and consequent requirement for more stringent obstacle limitation surfaces.*

Non-precision approach runways

4.2.7 The following obstacle limitation surfaces shall be established for a non-precision approach runway:

— conical surface;
— inner horizontal surface;
— approach surface; and
— transitional surfaces.

4.2.8 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.9).

4.2.9 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

a) a horizontal plane 150 m above the threshold elevation; or

b) the horizontal plane passing through the top of any object that governs the obstacle clearance altitude/height (OCA/H);

whichever is the higher.

Table 4-1. Dimensions and slopes of obstacle limitation surfaces —Approach runways

APPROACH RUNWAYS

	RUNWAY CLASSIFICATION									
	Non-instrument				Non-precision approach			Precision approach category I		Precision approach category II or III
	Code number				Code number			Code number		Code number
Surface and dimensions[a]	1	2	3	4	1,2	3	4	1,2	3,4	3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35 m	55 m	75 m	100 m	60 m	75 m	100 m	60 m	100 m	100 m
INNER HORIZONTAL										
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m
Radius	2 000 m	2 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m	3 500 m	4 000 m	4 000 m
INNER APPROACH										
Width	—	—	—	—	—	—	—	90 m	120 m	120 m
Distance from threshold	—	—	—	—	—	—	—	60 m	60 m	60 m
Length	—	—	—	—	—	—	—	900 m	900 m	900 m
Slope								2.5%	2%	2%
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	150 m	300 m	300 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m[b]	8 400 m[b]	—	8 400 m[b]	8 400 m[b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										
Slope	—	—	—	—	—	—	—	40%	33.3%	33.3%
BALKED LANDING SURFACE										
Length of inner edge	—	—	—	—	—	—	—	90 m	120 m	120 m
Distance from threshold	—	—	—	—	—	—	—	[c]	1 800 m[d]	1 800 m[d]
Divergence (each side)	—	—	—	—	—	—	—	10%	10%	10%
Slope	—	—	—	—	—	—	—	4%	3.33%	3.33%

a. All dimensions are measured horizontally unless specified otherwise.
b. Variable length (see 4.2.9 or 4.2.17).
c. Distance to the end of strip.
d. Or end of runway whichever is less.

4.2.10 New objects or extensions of existing objects shall not be permitted above an approach surface within 3 000 m of the inner edge or above a transitional surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.11 **Recommendation.—** *New objects or extensions of existing objects should not be permitted above the approach surface beyond 3 000 m from the inner edge, the conical surface or inner horizontal surface except when, in the opinion of the appropriate authority, the object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

4.2.12 **Recommendation.—** *Existing objects above any of the surfaces required by 4.2.7 should as far as practicable be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note.— Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

Precision approach runways

Note 1.— See 8.7 for information regarding siting and construction of equipment and installations on operational areas.

Note 2.— Guidance on obstacle limitation surfaces for precision approach runways is given in the Airport Services Manual, *Part 6.*

4.2.13 The following obstacle limitation surfaces shall be established for a precision approach runway category I:

— conical surface;
— inner horizontal surface;
— approach surface; and
— transitional surfaces.

4.2.14 **Recommendation.—** *The following obstacle limitation surfaces should be established for a precision approach runway category I:*

— inner approach surface;
— inner transitional surfaces; and
— balked landing surface.

4.2.15 The following obstacle limitation surfaces shall be established for a precision approach runway category II or III:

— conical surface;
— inner horizontal surface;
— approach surface and inner approach surface;
— transitional surfaces;
— inner transitional surfaces; and
— balked landing surface.

4.2.16 The heights and slopes of the surfaces shall not be greater than, and their other dimensions not less than, those specified in Table 4-1, except in the case of the horizontal section of the approach surface (see 4.2.17).

4.2.17 The approach surface shall be horizontal beyond the point at which the 2.5 per cent slope intersects:

a) a horizontal plane 150 m above the threshold elevation; or

b) the horizontal plane passing through the top of any object that governs the obstacle clearance limit;

whichever is the higher.

4.2.18 Fixed objects shall not be permitted above the inner approach surface, the inner transitional surface or the balked landing surface, except for frangible objects which because of their function must be located on the strip. Mobile objects shall not be permitted above these surfaces during the use of the runway for landing.

4.2.19 New objects or extensions of existing objects shall not be permitted above an approach surface or a transitional surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.20 **Recommendation.—** *New objects or extensions of existing objects should not be permitted above the conical surface and the inner horizontal surface except when, in the opinion of the appropriate authority, an object would be shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

4.2.21 **Recommendation.—** *Existing objects above an approach surface, a transitional surface, the conical surface and inner horizontal surface should as far as practicable be removed except when, in the opinion of the appropriate* *authority, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note.— Because of transverse or longitudinal slopes on a strip, in certain cases the inner edge or portions of the inner edge of the approach surface may be below the corresponding elevation of the strip. It is not intended that the strip be graded to conform with the inner edge of the approach surface, nor is it intended that terrain or objects which are above the approach surface beyond the end of the strip, but below the level of the strip, be removed unless it is considered they may endanger aeroplanes.

Runways meant for take-off

4.2.22 The following obstacle limitation surface shall be established for a runway meant for take-off:

— take-off climb surface.

4.2.23 The dimensions of the surface shall be not less than the dimensions specified in Table 4-2, except that a lesser length may be adopted for the take-off climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of aeroplanes.

4.2.24 **Recommendation.—** *The operational characteristics of aeroplanes for which the runway is intended should be examined to see if it is desirable to reduce the slope specified in Table 4-2 when critical operating conditions are to be catered to. If the specified slope is reduced, corresponding adjustment in the length of take-off climb surface should be made so as to provide protection to a height of 300 m.*

Note.— When local conditions differ widely from sea level standard atmospheric conditions, it may be advisable for the slope specified in Table 4-2 to be reduced. The degree of this reduction depends on the divergence between local conditions and sea level standard atmospheric conditions, and on the performance characteristics and operational requirements of the aeroplanes for which the runway is intended.

4.2.25 New objects or extensions of existing objects shall not be permitted above a take-off climb surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.26 **Recommendation.—** *If no object reaches the 2 per cent (1:50) take-off climb surface, new objects should be limited to preserve the existing obstacle free surface or a surface down to a slope of 1.6 per cent (1:62.5).*

Table 4-2. Dimensions and slopes of obstacle limitation surfaces

RUNWAYS MEANT FOR TAKE-OFF

Surface and dimensions[a]	Code number		
	1	2	3 or 4
(1)	(2)	(3)	(4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

4.2.27 **Recommendation.—** *Existing objects that extend above a take-off climb surface should as far as practicable be removed except when, in the opinion of the appropriate authority, an object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of aeroplanes.*

Note.— Because of transverse slopes on a strip or clearway, in certain cases portions of the inner edge of the take-off climb surface may be below the corresponding elevation of the strip or clearway. It is not intended that the strip or clearway be graded to conform with the inner edge of the take-off climb surface, nor is it intended that terrain or objects which are above the take-off climb surface beyond the end of the strip or clearway, but below the level of the strip or clearway, be removed unless it is considered they may endanger aeroplanes. Similar considerations apply at the junction of a clearway and strip where differences in transverse slopes exist.

4.3 Objects outside the obstacle limitation surfaces

4.3.1 **Recommendation.—** *Arrangements should be made to enable the appropriate authority to be consulted concerning proposed construction beyond the limits of the obstacle limitation surfaces that extend above a height established by that authority, in order to permit an aeronautical study of the effect of such construction on the operation of aeroplanes.*

4.3.2 **Recommendation.—** *In areas beyond the limits of the obstacle limitation surfaces, at least those objects which extend to a height of 150 m or more above ground elevation should be regarded as obstacles, unless a special aeronautical study indicates that they do not constitute a hazard to aeroplanes.*

Note.— This study may have regard to the nature of operations concerned and may distinguish between day and night operations.

4.4 Other objects

4.4.1 **Recommendation.—** *Objects which do not project through the approach surface but which would nevertheless adversely affect the optimum siting or performance of visual or non-visual aids should, as far as practicable, be removed.*

4.4.2 **Recommendation.—** *Anything which may, in the opinion of the appropriate authority after aeronautical study, endanger aeroplanes on the movement area or in the air within the limits of the inner horizontal and conical surfaces should be regarded as an obstacle and should be removed in so far as practicable.*

Note.— In certain circumstances, objects that do not project above any of the surfaces enumerated in 4.1 may constitute a hazard to aeroplanes as, for example, where there are one or more isolated objects in the vicinity of an aerodrome.

CHAPTER 5. VISUAL AIDS FOR NAVIGATION

5.1 Indicators and signalling devices

5.1.1 Wind direction indicators

Application

5.1.1.1 An aerodrome shall be equipped with at least one wind direction indicator.

Location

5.1.1.2 A wind direction indicator shall be located so as to be visible from aircraft in flight or on the movement area and in such a way as to be free from the effects of air disturbances caused by nearby objects.

Characteristics

5.1.1.3 **Recommendation.—** *The wind direction indicator should be in the form of a truncated cone made of fabric and should have a length of not less than 3.6 m and a diameter, at the larger end, of not less than 0.9 m. It should be constructed so that it gives a clear indication of the direction of the surface wind and a general indication of the wind speed. The colour or colours should be so selected as to make the wind direction indicator clearly visible and understandable from a height of at least 300 m, having regard to background. Where practicable, a single colour, preferably white or orange, should be used. Where a combination of two colours is required to give adequate conspicuity against changing backgrounds, they should preferably be orange and white, red and white, or black and white, and should be arranged in five alternate bands, the first and last bands being the darker colour.*

5.1.1.4 **Recommendation.—** *The location of at least one wind direction indicator should be marked by a circular band 15 m in diameter and 1.2 m wide. The band should be centred about the wind direction indicator support and should be in a colour chosen to give adequate conspicuity, preferably white.*

5.1.1.5 **Recommendation.—** *Provision should be made for illuminating at least one wind indicator at an aerodrome intended for use at night.*

5.1.2 Landing direction indicator

Location

5.1.2.1 Where provided, a landing direction indicator shall be located in a conspicuous place on the aerodrome.

Characteristics

5.1.2.2 **Recommendation.—** *The landing direction indicator should be in the form of a "T".*

5.1.2.3 The shape and minimum dimensions of a landing "T" shall be as shown in Figure 5-1. The colour of the landing "T" shall be either white or orange, the choice being dependent on the colour that contrasts best with the background against which the indicator will be viewed. Where required for use at night the landing "T" shall either be illuminated or outlined by white lights.

5.1.3 Signalling lamp

Application

5.1.3.1 A signalling lamp shall be provided at a controlled aerodrome in the aerodrome control tower.

Characteristics

5.1.3.2 **Recommendation.—** *A signalling lamp should be capable of producing red, green and white signals, and of:*

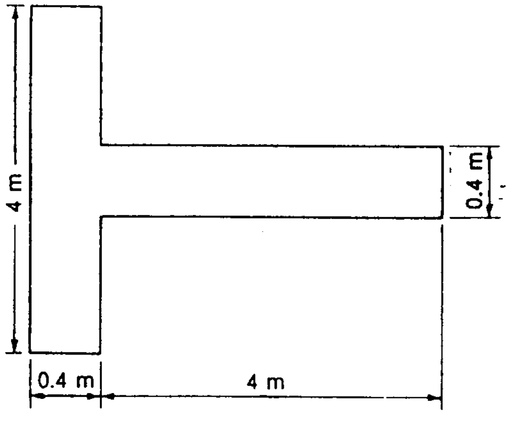


Figure 5-1. Landing direction indicator

a) being aimed manually at any target as required;

b) giving a signal in any one colour followed by a signal in either of the two other colours; and

c) transmitting a message in any one of the three colours by Morse Code up to a speed of at least four words per minute.

When selecting the green light, use should be made of the restricted boundary of green as specified in Appendix 1, 2.1.2.

5.1.3.3 **Recommendation.—** *The beam spread should be not less than 1° nor greater than 3°, with negligible light beyond 3°. When the signalling lamp is intended for use in the daytime the intensity of the coloured light should be not less than 6 000 cd.*

5.1.4 Signal panels and signal area

Note.— The inclusion of detailed specifications for a signal area in this section is not intended to imply that one has to be provided. Attachment A, Section 15 provides guidance on the need to provide ground signals. Annex 2, Appendix 1 specifies the shape, colour and use of visual ground signals. The Aerodrome Design Manual, *Part 4 provides guidance on their design.*

Location of signal area

5.1.4.1 **Recommendation.—** *The signal area should be located so as to be visible for all angles of azimuth above an angle of 10° above the horizontal when viewed from a height of 300 m.*

Characteristics of signal area

5.1.4.2 The signal area shall be an even horizontal surface at least 9 m square.

5.1.4.3 **Recommendation.—** *The colour of the signal area should be chosen to contrast with the colours of the signal panels used, and it should be surrounded by a white border not less than 0.3 m wide.*

5.2 Markings

5.2.1 General

Interruption of runway markings

5.2.1.1 At an intersection of two (or more) runways the markings of the more important runway, except for the runway side stripe marking, shall be displayed and the markings of the other runway(s) shall be interrupted. The runway side stripe marking of the more important runway may be either continued across the intersection or interrupted.

5.2.1.2 **Recommendation.—** *The order of importance of runways for the display of runway markings should be as follows:*

1st — precision approach runway;

2nd — non-precision approach runway; and

3rd — non-instrument runway.

5.2.1.3 At an intersection of a runway and taxiway the markings of the runway shall be displayed and the markings of the taxiway interrupted, except that runway side stripe markings may be interrupted.

Note.— See 5.2.8.5 regarding the manner of connecting runway and taxiway centre line markings.

Colour

5.2.1.4 Runway markings shall be white.

Note 1.— It has been found that, on runway surfaces of light colour, the conspicuity of white markings can be improved by outlining them in black.

Note 2.— It is preferable that the risk of uneven friction characteristics on markings be reduced in so far as practicable by the use of a suitable kind of paint.

Note 3.— Markings may consist of solid areas or a series of longitudinal stripes providing an effect equivalent to the solid areas.

5.2.1.5 Taxiway markings and aircraft stand markings shall be yellow.

5.2.1.6 Apron safety lines shall be of a conspicuous colour which shall contrast with that used for aircraft stand markings.

Unpaved taxiways

5.2.1.7 **Recommendation.—** *An unpaved taxiway should be provided, so far as practicable, with the markings prescribed for paved taxiways.*

5.2.2 Runway designation marking

Application

5.2.2.1 A runway designation marking shall be provided at the thresholds of a paved runway.

5.2.2.2 **Recommendation.—** *A runway designation marking should be provided, so far as practicable, at the thresholds of an unpaved runway.*

Location

5.2.2.3 A runway designation marking shall be located at a threshold as shown in Figure 5-2 as appropriate.

Note.— If the runway threshold is displaced from the extremity of the runway, a sign showing the designation of the runway may be provided for aeroplanes taking off.

Characteristics

5.2.2.4 A runway designation marking shall consist of a two-digit number and on parallel runways shall be supplemented with a letter. On a single runway, dual parallel runways and triple parallel runways the two-digit number shall be the whole number nearest the one-tenth of the magnetic North when viewed from the direction of approach. On four or more parellel runways, one set of adjacent runways shall be numbered to the nearest one-tenth magnetic azimuth and the other set of adjacent runways numbered to the next nearest one-tenth of the magnetic azimuth. When the above rule would give a single digit number, it shall be preceded by a zero.

5.2.2.5 In the case of parallel runways, each runway designation number shall be supplemented by a letter as follows, in the order shown from left to right when viewed from the direction of approach:

— for two parallel runways: "L" "R";

— for three parallel runways: "L" "C" "R";

— for four parallel runways: "L" "R" "L" "R";

— for five parallel runways: "L" "C" "R" "L" "R" or "L" "R" "L" "C" "R"; and

— for six parallel runways: "L" "C" "R" "L" "C" "R".

5.2.2.6 The numbers and letters shall be in the form and proportion shown in Figure 5-3. The dimensions shall be not less than those shown in Figure 5-3, but where the numbers are incorporated in the threshold marking, larger dimensions shall be used in order to fill adequately the gap between the stripes of the threshold marking.

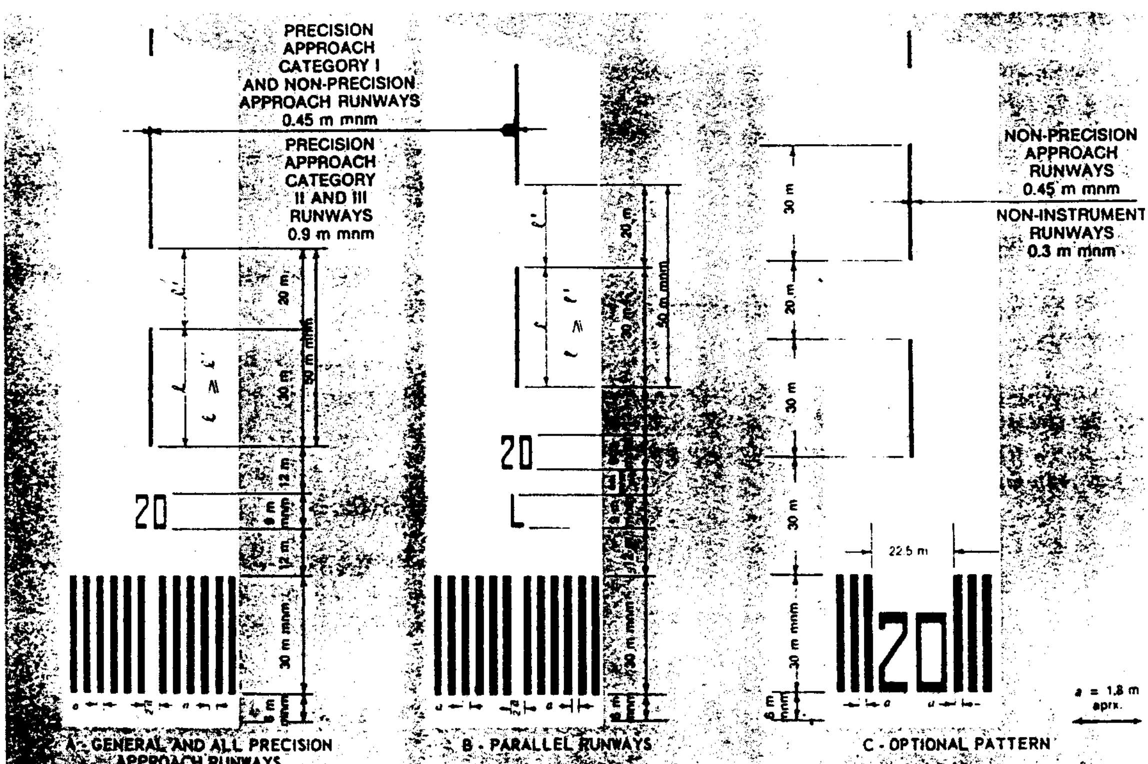
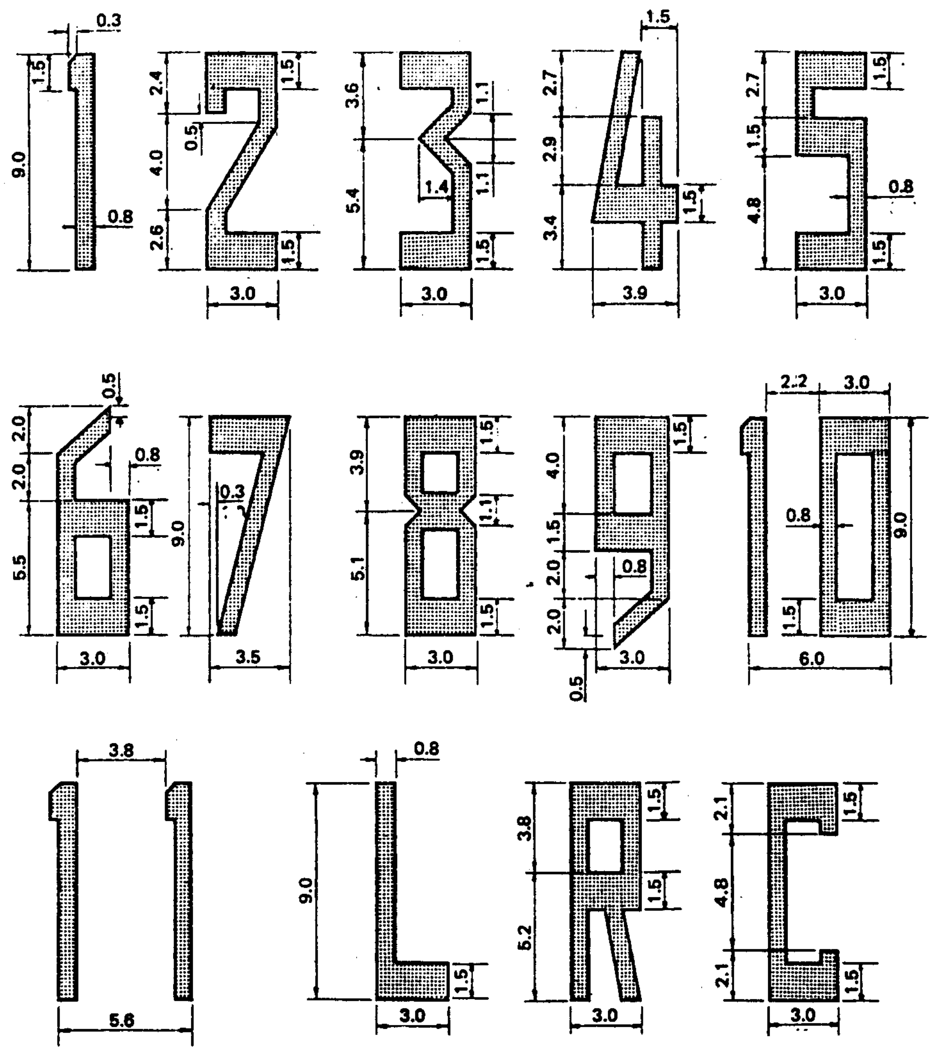


Figure 5-2. Runway designation, centre line and threshold markings



Note.— All units are expressed in metres.

Figure 5-3. Form and proportions of numbers and letters for runway designation markings

5.2.3 Runway centre line marking

Application

5.2.3.1 A runway centre line marking shall be provided on a paved runway.

Location

5.2.3.2 A runway centre line marking shall be located along the centre line of the runway between the runway designation markings as shown in Figure 5-2, except when interrupted in compliance with 5.2.1.1.

Characteristics

5.2.3.3 A runway centre line marking shall consist of a line of uniformly spaced stripes and gaps. The length of a stripe plus a gap shall be not less than 50 m or more than 75 m. The length of each stripe shall be at least equal to the length of the gap or 30 m, whichever is greater.

5.2.3.4 The width of the stripes shall be not less than:

— 0.90 m on precision approach category II and III runways;

— 0.45 m on non-precision approach runways where the code number is 3 or 4, and precision approach category I runways; and

— 0.30 m on non-precision approach runways where the code number is 1 or 2, and on non-instrument runways.

5.2.4 Threshold marking

Application

5.2.4.1 A threshold marking shall be provided at the threshold of a paved instrument runway, and of a paved non-instrument runway where the code number is 3 or 4 and the runway is intended for use by international commercial air transport.

5.2.4.2 **Recommendation.**— *A threshold marking should be provided at the threshold of a paved non-instrument runway where the code number is 3 or 4 and the runway is intended for use by other than international commercial air transport.*

5.2.4.3 **Recommendation.**— *A threshold marking should be provided, so far as practicable, at the thresholds of an unpaved runway.*

Note.— The Aerodrome Design Manual, *Part 4, shows a form of marking which has been found satisfactory for the marking of downward slopes immediately before the threshold.*

Location

5.2.4.4 The stripes of the threshold marking shall commence 6 m from the threshold.

Characteristics

5.2.4.5 A runway threshold marking shall consist of a pattern of longitudinal stripes of uniform dimensions disposed symmetrically about the centre line of a runway as shown in Figure 5-2 (A) and (B) for a runway width of 45 m. The number of stripes shall be in accordance with the runway width as follows:

Runway width	*Number of stripes*
18 m	4
23 m	6
30 m	8
45 m	12
60 m	16

except that on non-precision approach and non-instrument runways 45 m or greater in width, they may be as shown in Figure 5-2 (C).

5.2.4.6 The stripes shall extend laterally to within 3 m of the edge of a runway or to a distance of 27 m on either side of a runway centre line, whichever results in the smaller lateral distance. Where a runway designation marking is placed within a threshold marking there shall be a minimum of three stripes on each side of the centre line of the runway. Where a runway designation marking is placed above a threshold marking, the stripes shall be continued across the runway. The stripes shall be at least 30 m long and approximately 1.80 m wide with spacings of approximately 1.80 m between them except that, where the stripes are continued across a runway, a double spacing shall be used to separate the two stripes nearest the centre line of the runway, and in the case where the designation marking is included within the threshold marking this spacing shall be 22.5 m.

Transverse stripe

5.2.4.7 **Recommendation.**— *Where a threshold is displaced from the extremity of a runway or where the extremity of a runway is not square with the runway centre line, a transverse stripe as shown in Figure 5-4 (B) should be added to the threshold marking.*

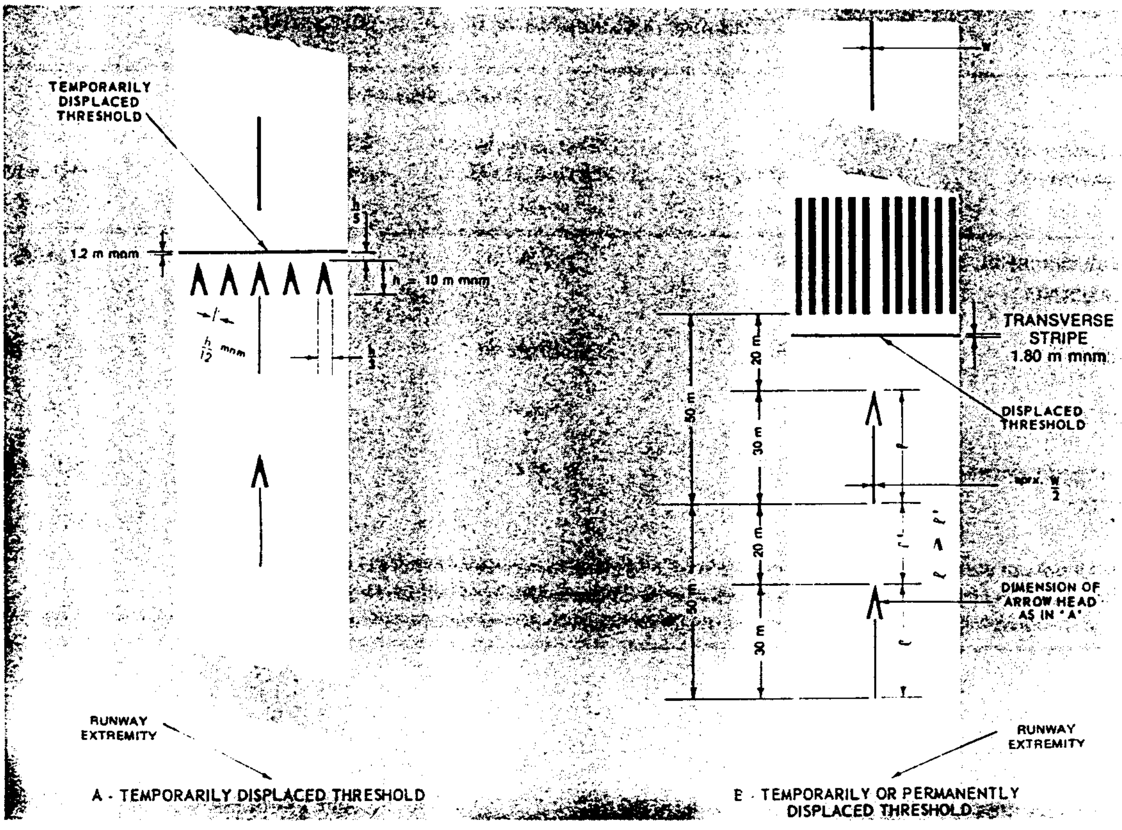
5.2.4.8 A transverse stripe shall be not less than 1.80 m wide.

Arrows

5.2.4.9 Where a runway threshold is permanently displaced, arrows conforming to Figure 5-4 (B) shall be provided on the portion of the runway before the displaced threshold.

5.2.4.10 When a runway threshold is temporarily displaced from the normal position, it shall be marked as shown in Figure 5-4 (A) or 5-4 (B) and all markings prior to the displaced threshold shall be obscured except the runway centre line marking, which shall be converted to arrows.

Note 1.— In the case where a threshold is temporarily displaced for only a short period of time, it has been found satisfactory to use markers in the form and colour of a displaced threshold marking rather than attempting to paint this marking on the runway.



Note.— See 5.2.4.10, Note 2 on the use of unserviceability markings.

Figure 5-4. Displaced threshold markings

Note 2.— When the runway before a displaced threshold is unfit for the surface movement of aircraft, closed markings, as described in 7.1.4, are required to be provided.

5.2.5 Aiming point marking

Application

5.2.5.1 The provisions of Sections 5.2.5 and 5.2.6 shall not require the replacement of existing markings before 1 January 2005.

5.2.5.2 An aiming point marking shall be provided at each approach end of a paved instrument runway where the code number is 2, 3 or 4.

5.2.5.3 **Recommendation.—** *An aiming point marking should be provided at each approach end of:*

a) a paved non-instrument runway where the code number is 3 or 4,

b) a paved instrument runway where the code number is 1,

when additional conspicuity of the aiming point is desirable.

Location

5.2.5.4 The aiming point marking shall commence no closer to the threshold than the distance indicated in the appropriate column of Table 5-1, except that, on a runway equipped with a visual approach slope indicator system, the beginning of the marking shall be coincident with the visual approach slope origin.

5.2.5.5 An aiming point marking shall consist of two conspicuous stripes. The dimensions of the stripes and the lateral spacing between their inner sides shall be in accordance with the provisions of the appropriate column of Table 5-1. Where a touchdown zone marking is provided, the lateral spacing between the markings shall be the same as that of the touchdown zone marking.

5.2.6 Touchdown zone marking

Application

5.2.6.1 A touchdown zone marking shall be provided in the touchdown zone of a paved precision approach runway where the code number is 2, 3 or 4.

Table 5-1. Location and dimensions of aiming point marking

	Landing distance available			
Location and dimensions (1)	Less than 800 m (2)	800 m up to but not including 1 200 m (3)	1 200 m up to but not including 2 400 m (4)	2 400 m and above (5)
Distance from threshold to beginning of marking	150 m	250 m	300 m	400 m
Length of stripe[a]	30-45 m	30-45 m	45-60 m	45-60 m
Width of stripe	4 m	6 m	6-10 m[b]	6-10 m[b]
Lateral spacing between inner sides of stripes	6 m[c]	9 m[c]	18-22.5 m	18-22.5 m

a. The greater dimensions of the specified ranges are intended to be used where increased conspicuity is required.
b. The lateral spacing may be varied within these limits to minimize the contamination of the marking by rubber deposits.
c. These figures were deduced by reference to the outer main gear wheel span which is element 2 of the aerodrome reference code at Chapter 1, Table 1-1.

5.2.6.2 **Recommendation.—** *A touchdown zone marking should be provided in the touchdown zone of a paved non-precision approach or non-instrument runway where the code number is 3 or 4 and additional conspicuity of the touchdown zone is desirable.*

Location and characteristics

5.2.6.3 A touchdown zone marking shall consist of pairs of rectangular markings symmetrically disposed about the runway centre line with the number of such pairs related to the landing distance available and, where the marking is to be displayed at both the approach directions of a runway, the distance between the thresholds, as follows:

Landing distance available or the distance between thresholds	*Pair(s) of markings*
less than 900 m	1
900 m up to but not including 1 200 m	2
1 200 m up to but not including 1 500 m	3
1 500 m up to but not including 2 400 m	4
2 400 m or more	6

5.2.6.4 A touchdown zone marking shall conform to either of the two patterns shown in Figure 5-5. For the pattern shown in Figure 5-5 (A), the markings shall be not less than 22.5 m long and 3 m wide. For the pattern shown in Figure 5-5 (B), each stripe of each marking shall be not less than 22.5 m long and 1.8 m wide with a spacing of 1.5 m between adjacent stripes. The lateral spacing between the inner sides of the rectangles shall be equal to that of the aiming point marking where provided. Where an aiming point marking is not provided, the lateral spacing between the inner sides of the rectangles shall correspond to the lateral spacing specified for the aiming point marking in Table 5-1 (columns 2, 3, 4 or 5, as appropriate). The pairs of markings shall be provided at longitudinal spacings of 150 m beginning from the threshold except that pairs of touchdown zone markings coincident with or located within 50 m of an aiming point marking shall be deleted from the pattern.

5.2.6.5 **Recommendation.—** *On a non-precision approach runway where the code number is 2, an additional pair of touchdown zone marking stripes should be provided 150 m beyond the beginning of the aiming point marking.*

5.2.7 Runway side stripe marking

Application

5.2.7.1 A runway side stripe marking shall be provided between the thresholds of a paved runway where there is a lack of contrast between the runway edges and the shoulders or the surrounding terrain.

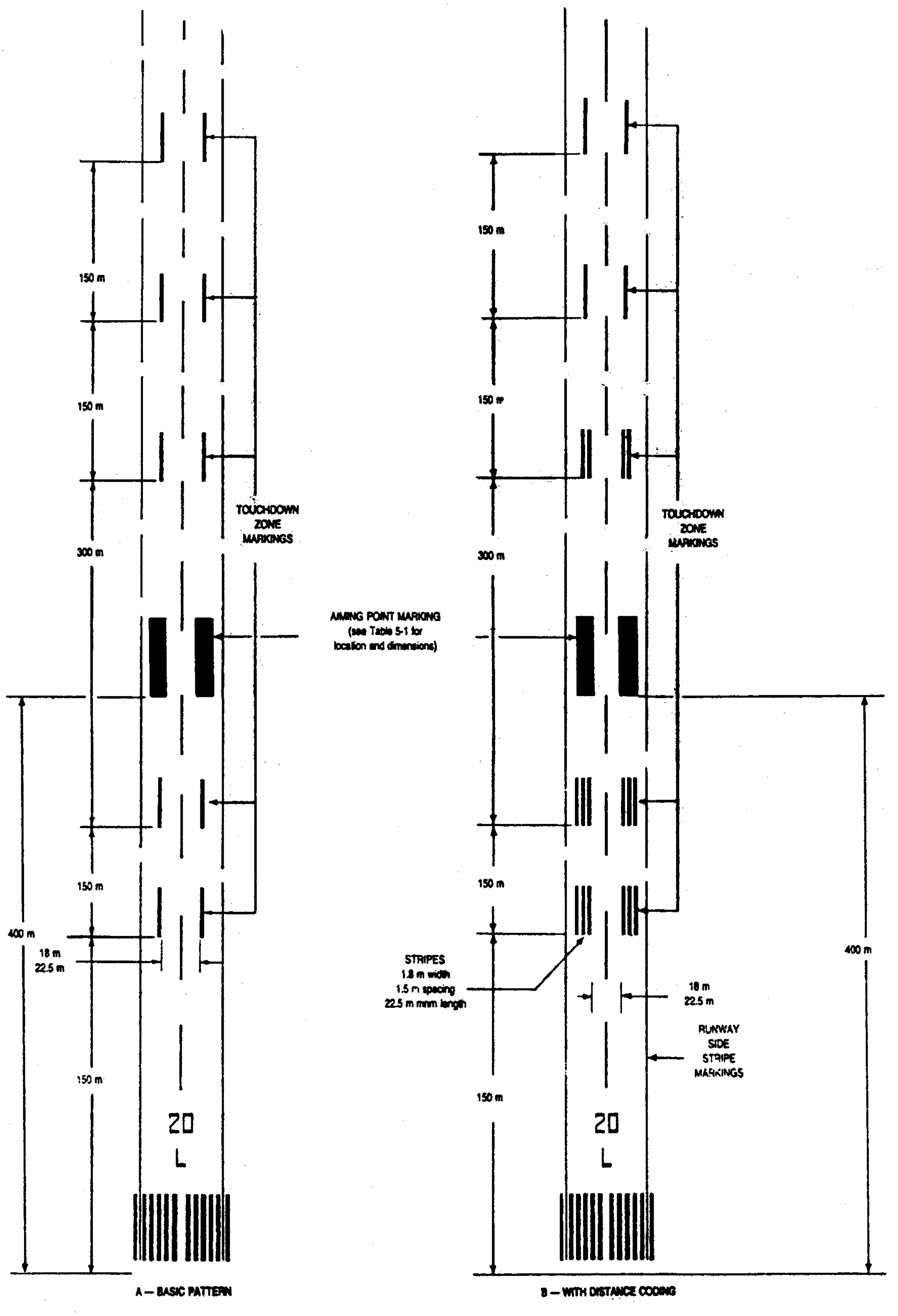


Figure 5-5. Aiming point and touchdown zone markings
(illustrated for a runway with a length of 2 400 m or more)

5.2.7.2 **Recommendation.—** *A runway side stripe marking should be provided on a precision approach runway irrespective of the contrast between the runway edges and the shoulders or the surrounding terrain.*

Location

5.2.7.3 **Recommendation.—** *A runway side stripe marking should consist of two stripes, one placed along each edge of the runway with the outer edge of each stripe approximately on the edge of the runway, except that, where the runway is greater than 60 m in width, the stripes should be located 30 m from the runway centre line.*

Characteristics

5.2.7.4 **Recommendation.—** *A runway side stripe should have an over-all width of at least 0.9 m on runways 30 m or more in width and at least 0.45 m on narrower runways.*

5.2.8 Taxiway centre line marking

Application

5.2.8.1 Taxiway centre line marking shall be provided on a paved taxiway where the code number is 3 or 4 in such a way as to provide guidance from the runway centre line to the point on the apron where aircraft stand markings commence.

5.2.8.2 **Recommendation.—** *Taxiway centre line marking should be provided on a paved taxiway where the code number is 1 or 2 in such a way as to provide guidance from the runway centre line to the point on the apron where aircraft stand markings commence.*

5.2.8.3 Taxiway centre line marking shall be provided on a paved runway when the runway is part of a standard taxi-route and:

a) there is no runway centre line marking; or

b) where the taxiway centre line is not coincident with the runway centre line.

Location

5.2.8.4 **Recommendation.—** *On a straight section of a taxiway the taxiway centre line marking should be located along the taxiway centre line. On a taxiway curve the marking should continue from the straight portion of the taxiway at a constant distance from the outside edge of the curve.*

Note.— See 3.8.5 and Figure 3-1.

5.2.8.5 **Recommendation.—** *At an intersection of a taxiway with a runway where the taxiway serves as an exit from the runway, the taxiway centre line marking should be curved into the runway centre line marking as shown in Figures 5-6 and 5-18. The taxiway centre line marking should be extended parallel to the runway centre line marking for a distance of at least 60 m beyond the point of tangency where the code number is 3 or 4, and for a distance of at least 30 m where the code number is 1 or 2.*

5.2.8.6 **Recommendation.—** *Where taxiway centre line marking is provided on a runway in accordance with 5.2.8.3, the marking should be located on the centre line of the designated taxiway.*

Characteristics

5.2.8.7 A taxiway centre line marking shall be at least 15 cm in width and continuous in length except where it intersects a taxi-holding position marking as shown in Figure 5-6.

5.2.9 Taxi-holding position marking

Application and location

5.2.9.1 A taxi-holding position marking shall be displayed along a taxi-holding position.

Note.— See 5.4.2 concerning the provision of a holding position sign.

Characteristics

5.2.9.2 At an intersection of a taxiway and a non-instrument, non-precision approach or take-off runway, the taxi-holding position marking shall be as shown in Figure 5-6, pattern A.

5.2.9.3 Where a single taxi-holding position is provided at an intersection of a taxiway and a precision approach category I, II or III runway, the taxi-holding position marking shall be as shown in Figure 5-6, pattern A. Where two or three taxi-holding positions are provided at such an intersection, the taxi-holding position marking closer (closest) to the runway shall be as shown in Figure 5-6, pattern A and the markings farther from the runway shall be as shown in Figure 5-6, pattern B.

5.2.9.4 The taxi-holding position marking displayed at a taxi-holding position established in accordance with 3.11.3 shall be as shown in Figure 5-6, pattern A.

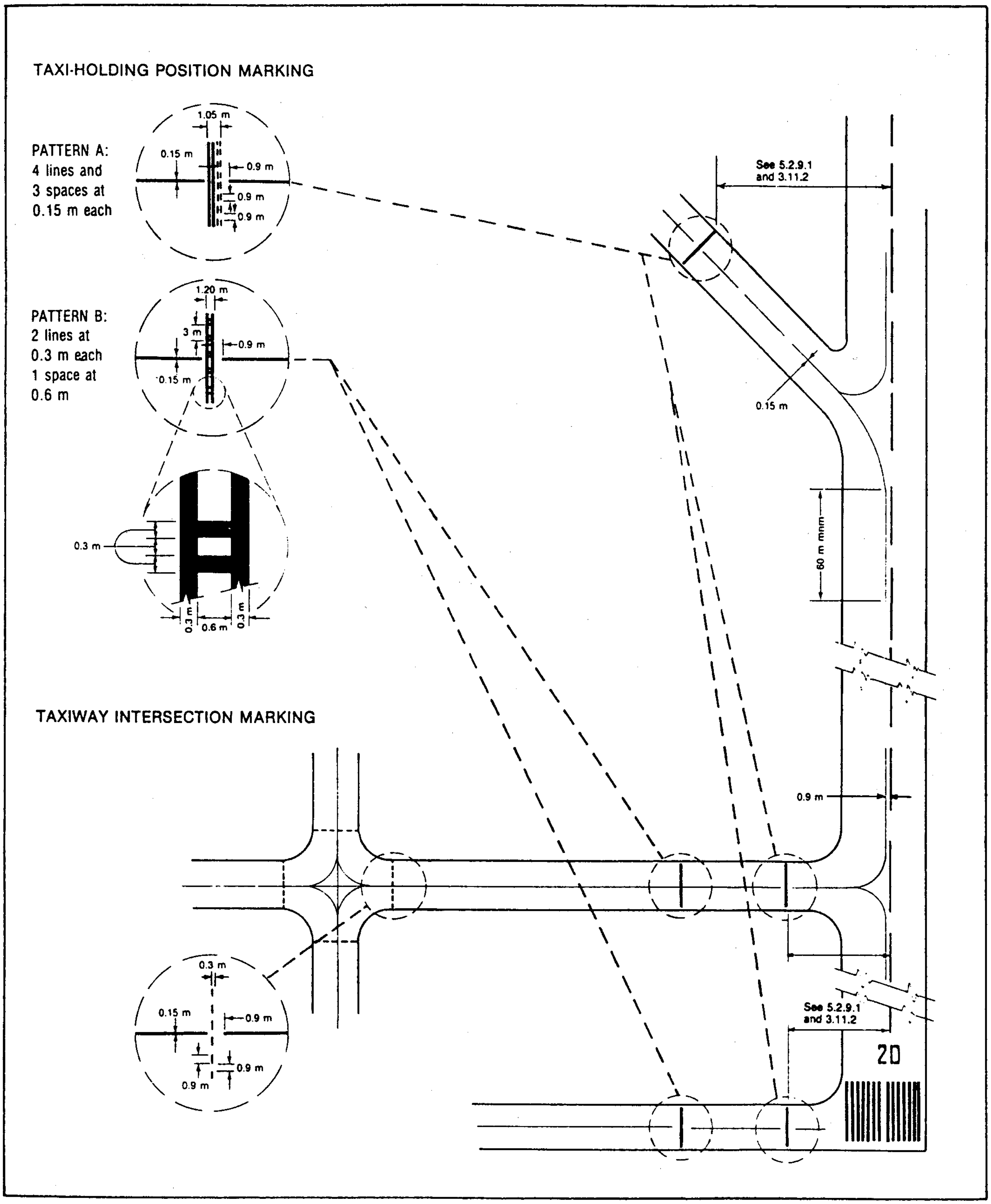


Figure 5-6. Taxiway markings
(shown with basic runway markings)

5.2.9.5 **Recommendation.**— *Where a pattern B taxi-holding position marking is located on an area where it would exceed 60 m in length, the term "CAT II" or "CAT III" as appropriate should be marked on the surface at the ends of the taxi-holding position marking and at equal intervals of 45 m maximum between successive marks. The letters should be not less than 1.8 m high and should be placed not more than 0.9 m beyond the holding position marking.*

5.2.9.6 The taxi-holding position marking displayed at a runway/runway intersection shall be perpendicular to the centre line of the runway forming part of the standard taxi-route. The pattern of the marking shall conform to that shown in Figure 5-6, pattern A.

5.2.10 Taxiway intersection marking

Application

5.2.10.1 **Recommendation.**— *A taxiway intersection marking should be displayed at an intersection of two paved taxiways where it is desired to designate a specific holding limit.*

Location

5.2.10.2 **Recommendation.**— *A taxiway intersection marking should be located across a taxiway at sufficient distance from the near edge of an intersecting taxiway to ensure safe clearance between taxiing aircraft. It should be coincident with a stop bar or clearance bar, where provided.*

Characteristics

5.2.10.3 A taxiway intersection marking shall consist of a single broken line as shown in Figure 5-6.

5.2.11 VOR aerodrome check-point marking

Application

5.2.11.1 When a VOR aerodrome check-point is established, it shall be indicated by a VOR aerodrome check-point marking and sign.

Note.— See 5.4.4 for VOR aerodrome check-point sign.

5.2.11.2 *Site selection*

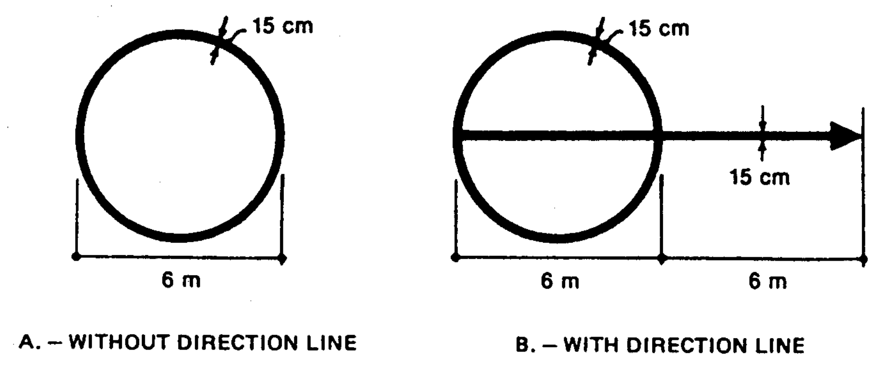
Note.— Guidance on the selection of sites for VOR aerodrome check-points is given in Annex 10, Volume I, Attachment E to Part I.

Location

5.2.11.3 A VOR aerodrome check-point marking shall be centred on the spot at which an aircraft is to be parked to receive the correct VOR signal.

Characteristics

5.2.11.4 A VOR aerodrome check-point marking shall consist of a circle 6 m in diameter and have a line width of 15 cm (see Figure 5-7 (A)).



Note.— A direction line need only be provided when an aircraft must be aligned in a specific direction.

Figure 5-7. VOR aerodrome check-point marking

5.2.11.5 **Recommendation.—** *When it is preferable for an aircraft to be aligned in a specific direction, a line should be provided that passes through the centre of the circle on the desired azimuth. The line should extend 6 m outside the circle in the desired direction of heading and terminate in an arrowhead. The width of the line should be 15 cm (see Figure 5-7 (B)).*

5.2.11.6 **Recommendation.—** *A VOR aerodrome check-point marking should preferably be white in colour but should differ from the colour used for the taxiway markings.*

Note.— To provide contrast, markings may be bordered with black.

5.2.12 Aircraft stand markings

Note.— Guidance on the layout of aircraft stand markings is contained in the Aerodrome Design Manual, *Part 4.*

Application

5.2.12.1 **Recommendation.—** *Aircraft stand markings should be provided for designated parking positions on a paved apron.*

Location

5.2.12.2 **Recommendation.—** *Aircraft stand markings should be located so as to provide the clearances specified in 3.12.6 when the nose wheel follows the stand marking.*

Characteristics

5.2.12.3 **Recommendation.—** *Aircraft stand markings should include such elements as stand identification, lead-in line, turn bar, turning line, alignment bar, stop line and lead-out line, as are required by the parking configuration and to complement other parking aids.*

5.2.12.4 **Recommendation.—** *An aircraft stand identification (letter and/or number) should be included in the lead-in line a short distance after the beginning of the lead-in line. The height of the identification should be adequate to be readable from the cockpit of aircraft using the stand.*

5.2.12.5 **Recommendation.—** *Where two sets of aircraft stand markings are superimposed on each other in order to permit more flexible use of the apron and it is difficult to identify which stand marking should be followed, or safety would be impaired if the wrong marking was followed, then identification of the aircraft for which each set of markings is intended should be added to the stand identification.*

Note.— Example: 2A-B747, 2B-F28.

5.2.12.6 **Recommendation.—** *Lead-in, turning and lead-out lines should normally be continuous in length and have a width of not less than 15 cm. Where one or more sets of stand markings are superimposed on a stand marking, the lines should be continuous for the most demanding aircraft and broken for other aircraft.*

5.2.12.7 **Recommendation.—** *The curved portions of lead-in, turning and lead-out lines should have radii appropriate to the most demanding aircraft type for which the markings are intended.*

5.2.12.8 **Recommendation.—** *Where it is intended that an aircraft proceed in one direction only, arrows pointing in the direction to be followed should be added as part of the lead-in and lead-out lines.*

5.2.12.9 **Recommendation.—** *A turn bar should be located at right angles to the lead-in line, abeam the left pilot position at the point of initiation of any intended turn. It should have a length and width of not less than 6 m and 15 cm, respectively, and include an arrowhead to indicate the direction of turn.*

Note.— The distances to be maintained between the turn bar and the lead-in line may vary according to different aircraft types, taking into account the pilot's field of view.

5.2.12.10 **Recommendation.—** *If more than one turn bar and/or stop line is required, they should be coded.*

5.2.12.11 **Recommendation.—** *An alignment bar should be placed so as to be coincident with the extended centre line of the aircraft in the specified parking position and visible to the pilot during the final part of the parking manoeuvre. It should have a width of not less than 15 cm.*

5.2.12.12 **Recommendation.—** *A stop line should be located at right angles to the alignment bar, abeam the left pilot position at the intended point of stop. It should have a length and width of not less than 6 m and 15 cm, respectively.*

Note.— The distances to be maintained between the stop line and the lead-in line may vary according to different aircraft types, taking into account the pilot's field of view.

5.2.13 Apron safety lines

Note.— Guidance on apron safety lines is contained in the Aerodrome Design Manual, *Part 4.*

Application

5.2.13.1 **Recommendation.—** *Apron safety lines should be provided on a paved apron as required by the parking configurations and ground facilities.*

Location

5.2.13.2 Apron safety lines shall be located so as to define the areas intended for use by ground vehicles and other aircraft servicing equipment, etc., to provide safe separation from aircraft.

Characteristics

5.2.13.3 **Recommendation.—** *Apron safety lines should include such elements as wing tip clearance lines and service road boundary lines as required by the parking configurations and ground facilities.*

5.2.13.4 **Recommendation.—** *An apron safety line should be continuous in length and at least 10 cm in width.*

5.2.14 Road-holding position marking

Application

5.2.14.1 A road-holding position marking shall be provided at all road entrances to a runway.

Location

5.2.14.2 The road-holding position marking shall be located across the road at the holding position.

Characteristics

5.2.14.3 The road-holding position marking shall be in accordance with the local road traffic regulations.

5.2.15 Information marking

Note.— Guidance on information marking is contained in the Aerodrome Design Manual, *Part 4.*

Application

5.2.15.1 Where an information sign would normally be installed and it is physically impossible to install a sign, an information marking shall be displayed on the surface of the pavement.

5.2.15.2 **Recommendation.—** *Where operationally required an information sign should be supplemented by an information marking.*

Location

5.2.15.3 **Recommendation.—** *The information marking should be displayed across the surface of the taxiway or apron where necessary and positioned so as to be legible from the cockpit of an approaching aircraft.*

Characteristics

5.2.15.4 An information marking shall consist of:

a) an inscription in yellow, when it replaces or supplements a location sign; and

b) an inscription in black, when it replaces or supplements a direction or destination sign.

5.2.15.5 Where there is insufficient contrast between the marking and the pavement surface, the marking shall include:

a) a black background where the inscriptions are in yellow; and

b) a yellow background where the inscriptions are in black.

5.2.15.6 **Recommendation.—** *The character height should be 4 m. The inscriptions should be in the form and proportions shown in Appendix 3.*

5.3 Lights

5.3.1 General

Lights which may endanger the safety of aircraft

5.3.1.1 A non-aeronautical ground light near an aerodrome which might endanger the safety of aircraft shall be extinguished, screened or otherwise modified so as to eliminate the source of danger.

Lights which may cause confusion

5.3.1.2 **Recommendation.—** *A non-aeronautical ground light which, by reason of its intensity, configuration or colour, might prevent, or cause confusion in, the clear interpretation of aeronautical ground lights should be extinguished, screened or otherwise modified so as to eliminate such a possibility. In particular, attention should be directed to a non-aeronautical ground light visible from the air within the areas described hereunder:*

a) Instrument runway — code number 4:

within the areas before the threshold and beyond the end of the runway extending at least 4 500 m in length from the threshold and runway end and 750 m either side of the extended runway centre line in width.

b) Instrument runway — code number 2 or 3:

as in a), except that the length should be at least 3 000 m.

c) Instrument runway — code number 1; and non-instrument runway:

within the approach area.

Aeronautical ground lights which may cause confusion to mariners

Note.— In the case of aeronautical ground lights near navigable waters, consideration needs to be given to ensuring that the lights do not cause confusion to mariners.

Light fixtures and supporting structures

Note.— See 8.7 for information regarding siting and construction of equipment and installations on operational areas, and the Aerodrome Design Manual, *Part 6 (in preparation) for guidance on frangibility of light fixtures and supporting structures.*

Elevated approach lights

5.3.1.3 Elevated approach lights and their supporting structures shall be frangible except that, in that portion of the approach lighting system beyond 300 m from the threshold:

a) where the height of a supporting structure exceeds 12 m, the frangibility requirement shall apply to the top 12 m only; and

b) where a supporting structure is surrounded by non-frangible objects, only that part of the structure that extends above the surrounding objects shall be frangible.

5.3.1.4 The provisions of 5.3.1.3 shall not require the replacement of existing installations before 1 January 2005.

5.3.1.5 When an approach light fixture or supporting structure is not in itself sufficiently conspicuous, it shall be suitably marked.

Elevated lights

5.3.1.6 Elevated runway, stopway and taxiway lights shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

Surface lights

5.3.1.7 Light fixtures inset in the surface of runways, stopways, taxiways and aprons shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the lights themselves.

5.3.1.8 **Recommendation.—** *The temperature produced by conduction or radiation at the interface between an installed inset light and an aircraft tire should not exceed 160°C during a 10-minute period of exposure.*

Note.— Guidance on measuring the temperature of inset lights is given in the Aerodrome Design Manual, *Part 4.*

Light intensity and control

Note.— In dusk or poor visibility conditions by day, lighting can be more effective than marking. For lights to be effective in such conditions or in poor visibility by night, they must be of adequate intensity. To obtain the required intensity, it will usually be necessary to make the light directional, in which case the arcs over which the light shows will have to be adequate and so orientated as to meet the operational requirements. The runway lighting system will have to be considered as a whole, to ensure that the relative light intensities are suitably matched to the same end. (See Attachment A, Section 14, and the Aerodrome Design Manual, *Part 4.)*

5.3.1.9 The intensity of runway lighting shall be adequate for the minimum conditions of visibility and ambient light in which use of the runway is intended, and compatible with that of the nearest section of the approach lighting system when provided.

Note.— While the lights of an approach lighting system may be of higher intensity than the runway lighting, it is good practice to avoid abrupt changes in intensity as these could give a pilot a false impression that the visibility is changing during approach.

5.3.1.10 Where a high-intensity lighting system is provided, a suitable intensity control shall be incorporated to allow for adjustment of the light intensity to meet the prevailing conditions. Separate intensity controls or other suitable methods shall be provided to ensure that the following systems, when installed, can be operated at compatible intensities:

— approach lighting system;

— runway edge lights;

— runway threshold lights;

— runway end lights;

— runway centre line lights;

— runway touchdown zone lights; and

— taxiway centre line lights.

5.3.1.11 On the perimeter of and within the ellipse defining the main beam in Appendix 2, Figures 2.1 to 2.11, the maximum light intensity value shall not be greater than three times the minimum light intensity value measured in accordance with Appendix 2, collective notes for Figures 2.1 to 2.12, Note 2.

5.3.1.12 On the perimeter of and within the rectangle defining the main beam in Appendix 2, Figures 2.13 to 2.17, the maximum light intensity value shall not be greater than three times the minimum light intensity value measured in accordance with Appendix 2, collective notes for Figures 2.13 to 2.18, Note 2.

5.3.2 Emergency lighting

Application

5.3.2.1 **Recommendation.**— *At an aerodrome provided with runway lighting and without a secondary power supply, sufficient emergency lights should be conveniently available for installation on at least the primary runway in the event of failure of the normal lighting system.*

Note.— Emergency lighting may also be useful to mark obstacles or delineate taxiways and apron areas.

Location

5.3.2.2 **Recommendation.**— *When installed on a runway the emergency lights should, as a minimum, conform to the configuration required for a non-instrument runway.*

Characteristics

5.3.2.3 **Recommendation.**— *The colour of the emergency lights should conform to the colour requirements for runway lighting, except that, where the provision of coloured lights at the threshold and the runway end is not practicable, all lights may be variable white or as close to variable white as practicable.*

5.3.3 Aeronautical beacons

Application

5.3.3.1 Where operationally necessary an aerodrome beacon or an identification beacon shall be provided at each aerodrome intended for use at night.

5.3.3.2 The operational requirement shall be determined having regard to the requirements of the air traffic using the aerodrome, the conspicuity of the aerodrome features in relation to its surroundings and the installation of other visual and non-visual aids useful in locating the aerodrome.

Aerodrome beacon

5.3.3.3 An aerodrome beacon shall be provided at an aerodrome intended for use at night if one or more of the following conditions exist:

a) aircraft navigate predominantly by visual means;

b) reduced visibilities are frequent; or

c) it is difficult to locate the aerodrome from the air due to surrounding lights or terrain.

Location

5.3.3.4 The aerodrome beacon shall be located on or adjacent to the aerodrome in an area of low ambient background lighting.

5.3.3.5 **Recommendation.**— *The location of the beacon should be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.*

Characteristics

5.3.3.6 The aerodrome beacon shall show either coloured flashes alternating with white flashes, or white flashes only. The frequency of total flashes shall be from 20 to 30 per minute. Where used, the coloured flashes emitted by beacons at land aerodromes shall be green and coloured flashes emitted by beacons at water aerodromes shall be yellow. In the case of a combined water and land aerodrome, coloured flashes, if used, shall have the colour characteristics of whichever section of the aerodrome is designated as the principal facility.

5.3.3.7 The light from the beacon shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used and the effective intensity of the flash shall be not less than 2 000 cd.

Note.— At locations where a high ambient background lighting level cannot be avoided, the effective intensity of the flash may be required to be increased by a factor up to a value of 10.

Identification beacon

Application

5.3.3.8 An identification beacon shall be provided at an aerodrome which is intended for use at night and cannot be easily identified from the air by other means.

Location

5.3.3.9 The identification beacon shall be located on the aerodrome in an area of low ambient background lighting.

5.3.3.10 **Recommendation.—** *The location of the beacon should be such that the beacon is not shielded by objects in significant directions and does not dazzle a pilot approaching to land.*

Characteristics

5.3.3.11 An identification beacon at a land aerodrome shall show at all angles of azimuth. The vertical light distribution shall extend upwards from an elevation of not more than 1° to an elevation determined by the appropriate authority to be sufficient to provide guidance at the maximum elevation at which the beacon is intended to be used and the effective intensity of the flash shall be not less than 2 000 cd.

Note.— At locations where a high ambient background lighting level cannot be avoided, the effective intensity of the flash may be required to be increased by a factor up to a value of 10.

5.3.3.12 An identification beacon shall show flashing-green at a land aerodrome and flashing-yellow at a water aerodrome.

5.3.3.13 The identification characters shall be transmitted in the International Morse Code.

5.3.3.14 **Recommendation.—** *The speed of transmission should be between six and eight words per minute, the corresponding range of duration of the Morse dots being from 0.15 to 0.2 seconds per dot.*

5.3.4 Approach lighting systems

Note.— It is intended that existing lighting systems not conforming to the specifications in 5.3.4.19, 5.3.4.35, 5.3.9.10, 5.3.10.10, 5.3.10.11, 5.3.11.5, 5.3.12.8, 5.3.13.6 and 5.3.15.6 be replaced not later than 1 January 2005.

Application

5.3.4.1 *Application*

A.— Non-instrument runway

Recommendation.— *Where physically practicable, a simple approach lighting system as specified in 5.3.4.2 to 5.3.4.9 should be provided to serve a non-instrument runway where the code number is 3 or 4 and intended for use at night, except when the runway is used only in conditions of good visibility, and sufficient guidance is provided by other visual aids.*

Note.— A simple approach lighting system can also provide visual guidance by day.

B.— Non-precision approach runway

Where physically practicable, a simple approach lighting system as specified in 5.3.4.2 to 5.3.4.9 shall be provided to serve a non-precision approach runway, except when the runway is used only in conditions of good visibility or sufficient guidance is provided by other visual aids.

Note.— It is advisable to give consideration to the installation of a precision approach category I lighting system or to the addition of a runway lead-in lighting system.

C.— Precision approach runway category I

Where physically practicable, a precision approach category I lighting system as specified in 5.3.4.10 to 5.3.4.19 shall be provided to serve a precision approach runway category I.

D.— Precision approach runway categories II and III

A precision approach category II and III lighting system as specified in 5.3.4.20 to 5.3.4.35 shall be provided to serve a precision approach runway category II or III.

Simple approach lighting system

Location

5.3.4.2 A simple approach lighting system shall consist of a row of lights on the extended centre line of the runway extending, whenever possible, over a distance of not less than 420 m from the threshold with a row of lights forming a crossbar 18 m or 30 m in length at a distance of 300 m from the threshold.

5.3.4.3 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights of the crossbar shall be spaced so as to produce a linear effect, except that, when a crossbar of 30 m is used, gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

Note 1.— Spacings for the crossbar lights between 1 m and 4 m are in use. Gaps on each side of the centre line may improve directional guidance when approaches are made with a lateral error, and facilitate the movement of rescue and fire fighting vehicles.

Note 2.— See Attachment A, Section 11 for guidance on installation tolerances.

5.3.4.4 The lights forming the centre line shall be placed at longitudinal intervals of 60 m, except that, when it is desired to improve the guidance, an interval of 30 m may be used. The innermost light shall be located either 60 m or 30 m from the threshold, depending on the longitudinal interval selected for the centre line lights.

5.3.4.5 **Recommendation.—** *If it is not physically possible to provide a centre line extending for a distance of 420 m from the threshold, it should be extended to 300 m so as to include the crossbar. If this is not possible, the centre line lights should be extended as far as practicable, and each centre line light should then consist of a barrette at least 3 m in length. Subject to the approach system having a crossbar at 300 m from the threshold, an additional crossbar may be provided at 150 m from the threshold.*

5.3.4.6 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and

b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.7 The lights of a simple approach lighting system shall be fixed lights and the colour of the lights shall be such as to ensure that the system is readily distinguishable from other aeronautical ground lights, and from extraneous lighting if present. Each centre line light shall consist of either:

a) a single source; or

b) a barrette at least 3 m in length.

Note 1.— When the barrette as in b) is composed of lights approximating to point sources, a spacing of 1.5 m between adjacent lights in the barrette has been found satisfactory.

Note 2.— It may be advisable to use barrettes 4 m in length if it is anticipated that the simple approach lighting system will be developed into a precision approach lighting system.

Note 3.— At locations where identification of the simple approach lighting system is difficult at night due to surrounding lights, sequence flashing lights installed in the outer portion of the system may resolve this problem.

5.3.4.8 **Recommendation.—** *Where provided for a non-instrument runway, the lights should show at all angles in azimuth necessary to a pilot on base leg and final approach. The intensity of the lights should be adequate for all conditions of visibility and ambient light for which the system has been provided.*

5.3.4.9 **Recommendation.—** *Where provided for a non-precision approach runway, the lights should show at all angles in azimuth necessary to the pilot of an aircraft which on final approach does not deviate by an abnormal amount from the path defined by the non-visual aid. The lights should be designed to provide guidance during both day and night in the most adverse conditions of visibility and ambient light for which it is intended that the system should remain usable.*

Precision approach category I lighting system

Location

5.3.4.10 A precision approach category I lighting system shall consist of a row of lights on the extended centre line of the runway extending, wherever possible, over a distance of 900 m from the runway threshold with a row of lights forming a crossbar 30 m in length at a distance of 300 m from the runway threshold.

Note.— The installation of an approach lighting system of less than 900 m in length may result in operational limitations on the use of the runway. See Attachment A, Section 11.

5.3.4.11 The lights forming the crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights of the crossbar shall be spaced so as to produce a linear effect, except that gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

Note 1.— Spacings for the crossbar lights between 1 m and 4 m are in use. Gaps on each side of the centre line may improve directional guidance when approaches are made with a lateral error, and facilitate the movement of rescue and fire fighting vehicles.

Note 2.— See Attachment A, Section 11 for guidance on installation tolerances.

5.3.4.12 The lights forming the centre line shall be placed at longitudinal intervals of 30 m with the innermost light located 30 m from the threshold.

5.3.4.13 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and

b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.14 The centre line and crossbar lights of a precision approach category I lighting system shall be fixed lights showing variable white. Each centre line light shall consist of either:

a) a single light source in the innermost 300 m of the centre line, two light sources in the central 300 m of the centre line and three light sources in the outer 300 m of the centre line to provide distance information; or

b) a barrette at least 4 m in length.

Note.— When the barrette as in b) is composed of lights approximating to point sources, a spacing of 1.5 m between adjacent lights in the barrette has been found satisfactory.

5.3.4.15 **Recommendation.—** *If the centre line consists of barrettes as described in 5.3.4.14 b), each barrette should be supplemented by a capacitor discharge light, except where such lighting is considered unnecessary taking into account the characteristics of the system and the nature of the meteorological conditions.*

5.3.4.16 Each capacitor discharge light as described in 5.3.4.15 shall be flashed twice a second in sequence, beginning with the outermost light and progressing toward the threshold to the innermost light of the system. The design of the electrical circuit shall be such that these lights can be operated independently of the other lights of the approach lighting system.

5.3.4.17 If the centre line consists of lights as described in 5.3.4.14 a), additional crossbars of lights to the crossbar provided at 300 m from the threshold shall be provided at 150 m, 450 m, 600 m and 750 m from the threshold. The lights forming each crossbar shall be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights. The lights shall be spaced so as to produce a linear effect, except that gaps may be left on each side of the centre line. These gaps shall be kept to a minimum to meet local requirements and each shall not exceed 6 m.

Note.— See Attachment A, Section 11 for detailed configuration.

5.3.4.18 Where the additional crossbars described in 5.3.4.17 are incorporated in the system, the outer ends of the crossbars shall lie on two straight lines that either are parallel to the line of the centre line lights or converge to meet the runway centre line 300 m from threshold.

5.3.4.19 The lights shall be in accordance with the specifications of Appendix 2, Figure 2.1 or 2.2.

Note.— The flight path envelopes used in the design of these lights are given in Attachment A, Figure A-4.

Precision approach category II and III lighting system

Location

5.3.4.20 The approach lighting system shall consist of a row of lights on the extended centre line of the runway, extending, wherever possible, over a distance of 900 m from the runway threshold. In addition, the system shall have two side rows of lights, extending 270 m from the threshold, and two crossbars, one at 150 m and one at 300 m from the threshold, all as shown in Figure 5-8.

Note.— The length of 900 m is based on providing guidance for operations under category I, II and III conditions. Reduced lengths may support category II and III operations but may impose limitations on category I operations. See Attachment A, Section 11.

5.3.4.21 The lights forming the centre line shall be placed at longitudinal intervals of 30 m with the innermost lights located 30 m from the threshold.

5.3.4.22 The lights forming the side rows shall be placed on each side of the centre line, at a longitudinal spacing equal to that of the centre line lights and with the first light located 30 m from the threshold. The lateral spacing (or gauge) between the innermost lights of the side row shall be not less than 18 m nor more than 22.5 m, and preferably 18 m, but in any event shall be equal to that of the touchdown zone lights.

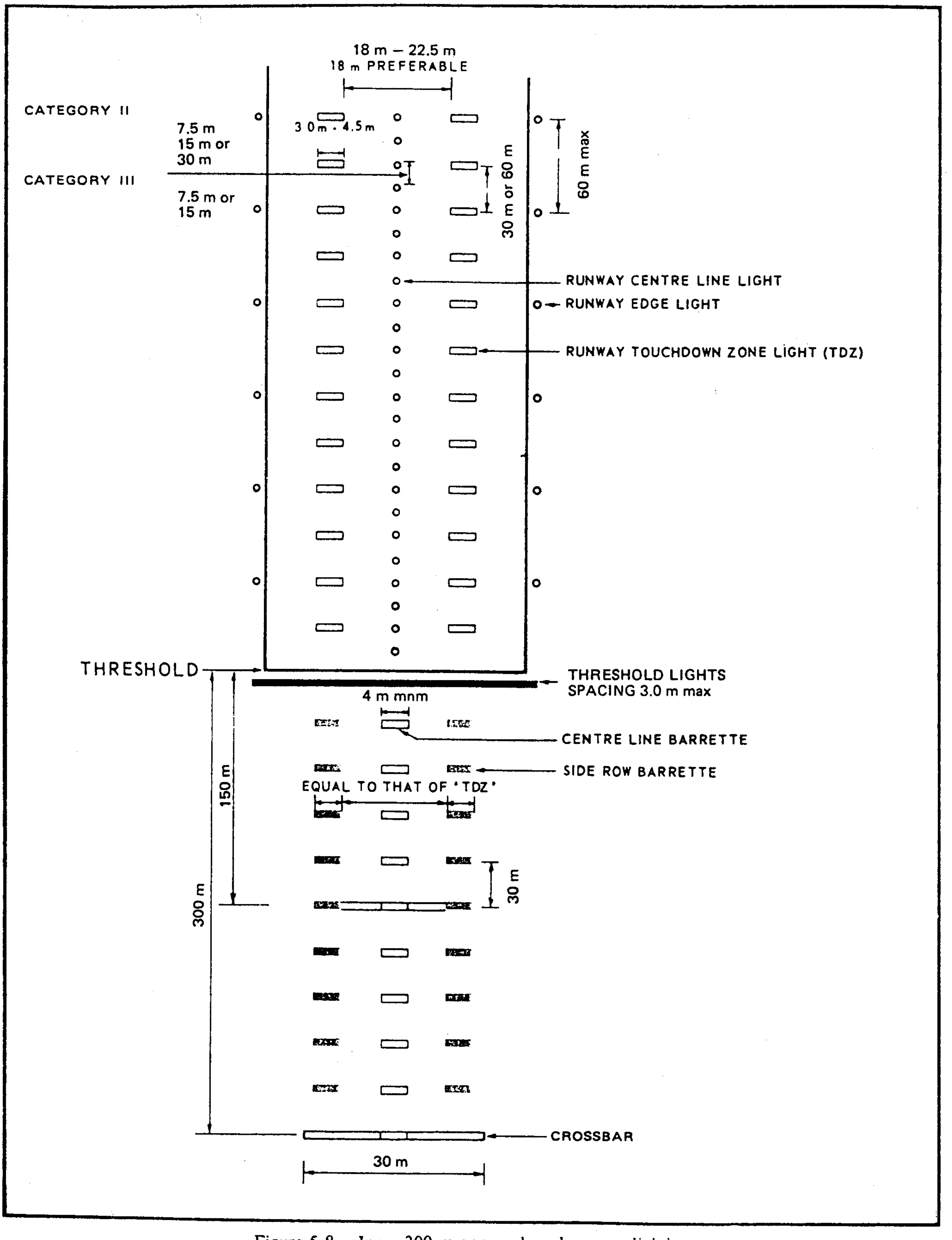


Figure 5-8. Inner 300 m approach and runway lighting for precision approach runways categories II and III

5.3.4.23 The crossbar provided at 150 m from the threshold shall fill in the gaps between the centre line and side row lights.

5.3.4.24 The crossbar provided at 300 m from the threshold shall extend on both sides of the centre line lights to a distance of 15 m from the centre line.

5.3.4.25 If the centre line beyond a distance of 300 m from the threshold consists of lights as described in 5.3.4.29 b), additional crossbars of lights shall be provided at 450 m, 600 m and 750 m from the threshold.

5.3.4.26 Where the additional crossbars described in 5.3.4.25 are incorporated in the system, the outer ends of these crossbars shall lie on two straight lines that either are parallel to the centre line or converge to meet the runway centre line 300 m from the threshold.

5.3.4.27 The system shall lie as nearly as practicable in the horizontal plane passing through the threshold, provided that:

a) no object other than an ILS or MLS azimuth antenna shall protrude through the plane of the approach lights within a distance of 60 m from the centre line of the system; and

b) no light other than a light located within the central part of a crossbar or a centre line barrette (not their extremities) shall be screened from an approaching aircraft.

Any ILS or MLS azimuth antenna protruding through the plane of the lights shall be treated as an obstacle and marked and lighted accordingly.

Characteristics

5.3.4.28 The centre line of a precision approach category II and III lighting system for the first 300 m from the threshold shall consist of barrettes showing variable white, except that, where the threshold is displaced 300 m or more, the centre line may consist of single light sources showing variable white. The barrettes shall be at least 4 m in length. When barrettes are composed of lights approximating to point sources, the lights shall be uniformly spaced at intervals of not more than 1.5 m.

5.3.4.29 Beyond 300 m from the threshold each centre line light shall consist of either:

a) a barrette as used on the inner 300 m; or

b) two light sources in the central 300 m of the centre line and three light sources in the outer 300 m of the centre line;

all of which shall show variable white.

5.3.4.30 **Recommendation.—** *If the centre line beyond 300 m from the threshold consists of barrettes as described in 5.3.4.29 a), each barrette beyond 300 m should be supplemented by a capacitor discharge light, except where such lighting is considered unnecessary taking into account the characteristics of the system and the nature of the meteorological conditions.*

5.3.4.31 Each capacitor discharge light shall be flashed twice a second in sequence, beginning with the outermost light and progressing toward the threshold to the innermost light of the system. The design of the electrical circuit shall be such that these lights can be operated independently of the other lights of the approach lighting system.

5.3.4.32 The side row shall consist of barrettes showing red. The length of a side row barrette and the spacing of its lights shall be equal to those of the touchdown zone light barrettes.

5.3.4.33 The lights forming the crossbars shall be fixed lights showing variable white. The lights shall be uniformly spaced at intervals of not more than 2.7 m.

5.3.4.34 The intensity of the red lights shall be compatible with the intensity of the white lights.

5.3.4.35 The lights shall be in accordance with the specifications of Appendix 2, Figure 2.1 or 2.2.

Note.— The flight path envelopes used in the design of these lights are given in Attachment A, Figure A-4.

5.3.5 Visual approach slope indicator systems

Application

5.3.5.1 A visual approach slope indicator system shall be provided to serve the approach to a runway whether or not the runway is served by other visual approach aids or by non-visual aids, where one or more of the following conditions exist:

a) the runway is used by turbojet or other aeroplanes with similar approach guidance requirements;

b) the pilot of any type of aeroplane may have difficulty in judging the approach due to:

1) inadequate visual guidance such as is experienced during an approach over water or featureless terrain by day or in the absence of sufficient extraneous lights in the approach area by night, or

2) misleading information such as is produced by deceptive surrounding terrain or runway slopes;

c) the presence of objects in the approach area may involve serious hazard if an aeroplane descends below the normal approach path, particularly if there are no non-visual or other visual aids to give warning of such objects;

d) physical conditions at either end of the runway present a serious hazard in the event of an aeroplane undershooting or overrunning the runway; and

e) terrain or prevalent meteorological conditions are such that the aeroplane may be subjected to unusual turbulence during approach.

Note.— Guidance on the priority of installation of visual approach slope indicator systems is contained in Attachment A, Section 12.

5.3.5.2 The standard visual approach slope indicator systems shall consist of the following:

a) T-VASIS and AT-VASIS conforming to the specifications contained in 5.3.5.6 to 5.3.5.22 inclusive;

b) PAPI and APAPI systems conforming to the specifications contained in 5.3.5.23 to 5.3.5.40 inclusive;

as shown in Figure 5-9.

5.3.5.3 PAPI, T-VASIS or AT-VASIS shall be provided where the code number is 3 or 4 when one or more of the conditions specified in 5.3.5.1 exist.

5.3.5.4 PAPI or APAPI shall be provided where the code number is 1 or 2 when one or more of the conditions specified in 5.3.5.1 exist.

5.3.5.5 **Recommendation.—** *Where a runway threshold is temporarily displaced from the normal position and one or more of the conditions specified in 5.3.5.1 exist, a PAPI should be provided except that where the code number is 1 or 2 an APAPI may be provided.*

T-VASIS and AT-VASIS

Description

5.3.5.6 The T-VASIS shall consist of twenty light units symmetrically disposed about the runway centre line in the form of two wing bars of four light units each, with bisecting longitudinal lines of six lights, as shown in Figure 5-10.

5.3.5.7 The AT-VASIS shall consist of ten light units arranged on one side of the runway in the form of a single wing bar of four light units with a bisecting longitudinal line of six lights.

5.3.5.8 The light units shall be constructed and arranged in such a manner that the pilot of an aeroplane during an approach will:

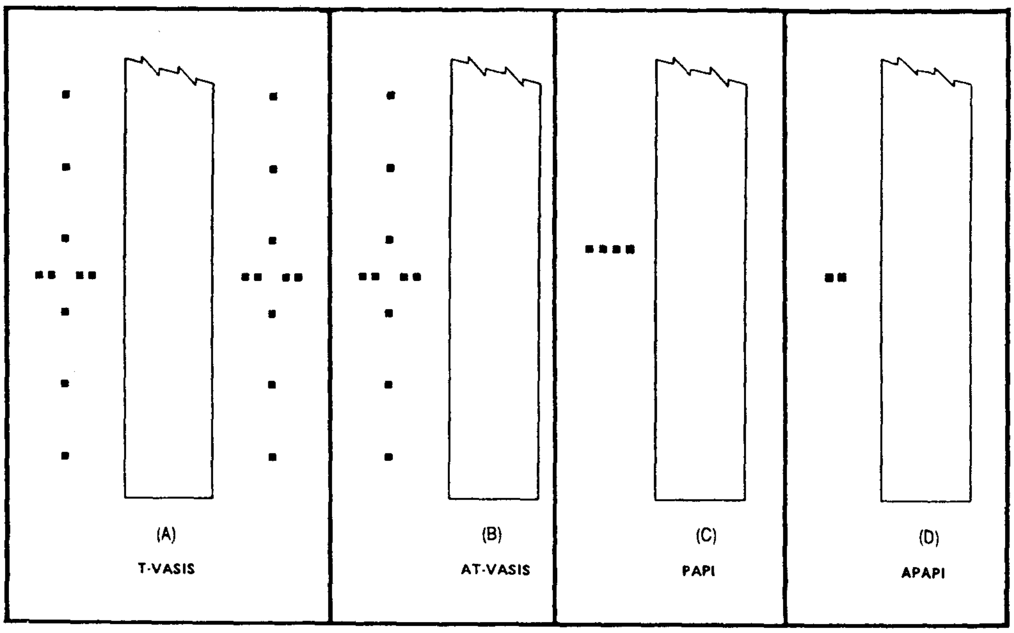
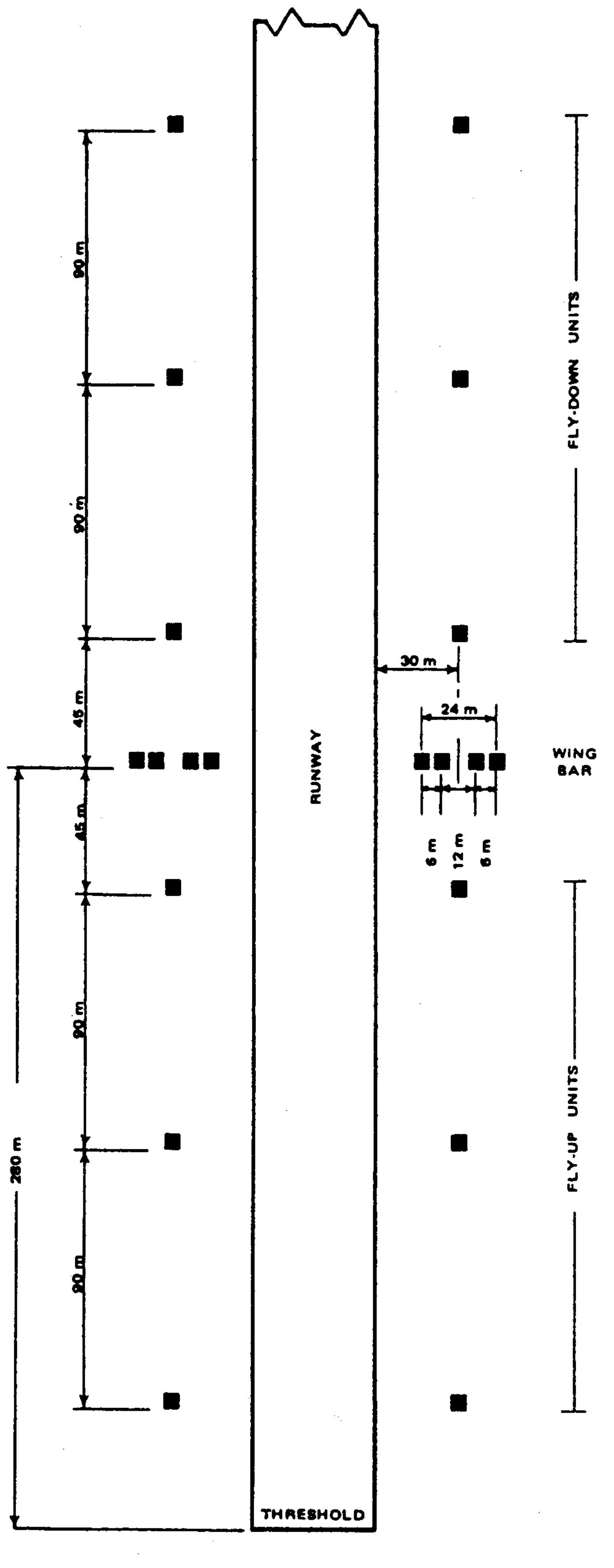


Figure 5-9. Visual approach slope indicator systems



INSTALLATION TOLERANCES

The appropriate authority may:

a) vary the nominal eye height over the threshold of the on-slope signal between the limits of 12 m and 16 m, except in cases where a standard ILS glide path and/or MLS minimum glide path is available; the height over threshold should be varied to avoid any conflict between the visual approach slope indications and the usable portion of the ILS glide path and/or MLS minimum glide path indications;

b) vary the longitudinal distance between individual light units or the over-all length of the system by not more than 10 per cent;

c) vary the lateral displacement of the system from the runway edge by not more than ±3 m;

Note.— The system must be symmetrically displaced about the runway centre line.

d) where there is a longitudinal slope of the ground, adjust the longitudinal distance of a light unit to compensate for its difference in level from that of the threshold; and

e) where there is a transverse slope in the ground, adjust the longitudinal distance of two light units or two wing bars to compensate for the difference in level between them as necessary to meet the requirements of 5.3.5.16.

The distance between the wing bar and the threshold is based on an approach slope of 3° to a level runway with a nominal eye height over the threshold of 15 m. In practice, the threshold to wing bar distance is determined by:

a) the selected approach slope;

b) the longitudinal slope of the runway; and

c) the selected nominal eye height over the threshold.

Figure 5-10. Siting of light units for T-VASIS

a) when above the approach slope, see the wing bar(s) white, and one, two or three fly-down lights, the more fly-down lights being visible the higher the pilot is above the approach slope;

b) when on the approach slope, see the wing bar(s) white; and

c) when below the approach slope, see the wing bar(s) and one, two or three fly-up lights white, the more fly-up lights being visible the lower the pilot is below the approach slope; and when well below the approach slope, see the wing bar(s) and the three fly-up lights red.

When on or above the approach slope, no light shall be visible from the fly-up light units; when on or below the approach slope, no light shall be visible from the fly-down light units.

Siting

5.3.5.9 The light units shall be located as shown in Figure 5-10, subject to the installation tolerances given therein.

Note.— The siting of T-VASIS will provide, for a 3° slope and a nominal eye height over the threshold of 15 m (see 5.3.5.6 and 5.3.5.19), a pilot's eye height over threshold of 13 m to 17 m when only the wing bar lights are visible. If increased eye height at the threshold is required (to provide adequate wheel clearance), then the approaches may be flown with one or more fly-down lights visible. The pilot's eye height over the threshold is then of the following order:

Wing bar lights and one fly-down light visible	*17 m to 22 m*
Wing bar lights and two fly-down lights visible	*22 m to 28 m*
Wing bar lights and three fly-down lights visible	*28 m to 54 m*

Characteristics of the light units

5.3.5.10 The systems shall be suitable for both day and night operations.

5.3.5.11 The light distribution of the beam of each light unit shall be of fan shape showing over a wide arc in azimuth in the approach direction. The wing bar light units shall produce a beam of white light from 1°54′ vertical angle up to 6° vertical angle and a beam of red light from 0° to 1°54′ vertical angle. The fly-down light units shall produce a white beam extending from an elevation of 6° down to approximately the approach slope, where it shall have a sharp cut-off. The fly-up light units shall produce a white beam from approximately the approach slope down to 1°54′ vertical angle and a red beam below a 1°54′ vertical angle. The angle of the top of the red beam in the wing bar units and fly-up units may be increased to comply with 5.3.5.21.

5.3.5.12 The light intensity distribution of the fly-down, wing bar and fly-up light units shall be as shown in Appendix 2, Figure 2.19.

5.3.5.13 The colour transition from red to white in the vertical plane shall be such as to appear to an observer, at a distance of not less than 300 m, to occur over a vertical angle of not more than 15′.

5.3.5.14 At full intensity the red light shall have a Y coordinate not exceeding 0.320.

5.3.5.15 A suitable intensity control shall be provided to allow adjustments to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

5.3.5.16 The light units forming the wing bars, or the light units forming a fly-down or a fly-up matched pair, shall be mounted so as to appear to the pilot of an approaching aeroplane to be substantially in a horizontal line. The light units shall be mounted as low as possible and shall be frangible.

5.3.5.17 The light units shall be so designed that deposits of condensation, dirt, etc., on optically transmitting or reflecting surfaces shall interfere to the least possible extent with the light signals and shall in no way affect the elevation of the beams or the contrast between the red and white signals. The construction of the light units shall be such as to minimize the probability of the slots being wholly or partially blocked by snow or ice where these conditions are likely to be encountered.

Approach slope and elevation setting of light beams

5.3.5.18 The approach slope shall be appropriate for use by the aeroplanes using the approach.

5.3.5.19 When the runway on which a T-VASIS is provided is equipped with an ILS and/or MLS, the siting and elevations of the light units shall be such that the visual approach slope conforms as closely as possible with the glide path of the ILS and/or the minimum glide path of the MLS, as appropriate.

5.3.5.20 The elevation of the beams of the wing bar light units on both sides of the runway shall be the same. The elevation of the top of the beam of the fly-up light unit nearest to each wing bar, and that of the bottom of the beam of the fly-down light unit nearest to each wing bar, shall be equal and shall correspond to the approach slope. The cut-off angle of the top of the beams of successive fly-up light units shall decrease by 5′ of arc in angle of elevation at each successive unit away from the wing bar. The cut-in angle of the bottom of the beam of the fly-down light units shall increase by 7′ of arc at each successive unit away from the wing bar (see Figure 5-11).

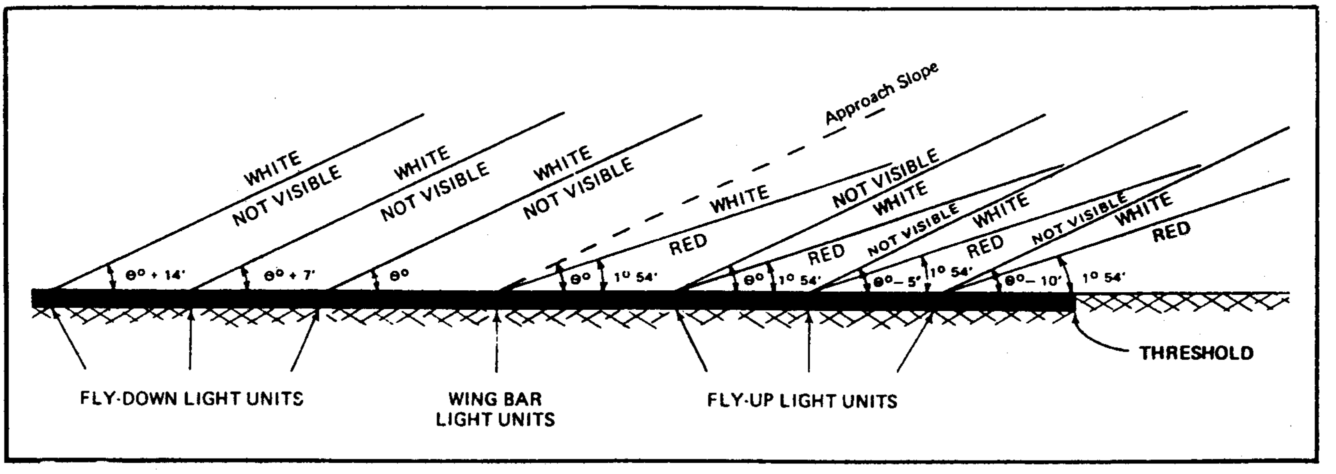


Figure 5-11. Light beams and elevation settings of T-VASIS and AT-VASIS

5.3.5.21 The elevation setting of the top of the red light beams of the wing bar and fly-up light units shall be such that, during an approach, the pilot of an aeroplane to whom the wing bar and three fly-up light units are visible would clear all objects in the approach area by a safe margin if any such light did not appear red.

5.3.5.22 The azimuth spread of the light beam shall be suitably restricted where an object located outside the obstacle protection surface of the system, but within the lateral limits of its light beam, is found to extend above the plane of the obstacle protection surface and an aeronautical study indicates that the object could adversely affect the safety of operations. The extent of the restriction shall be such that the object remains outside the confines of the light beam.

Note.— See 5.3.5.41 to 5.3.5.45 concerning the related obstacle protection surface.

PAPI and APAPI

Description

5.3.5.23 The PAPI system shall consist of a wing bar of 4 sharp transition multi-lamp (or paired single lamp) units equally spaced. The system shall be located on the left side of the runway unless it is physically impracticable to do so.

Note.— Where a runway is used by aircraft requiring visual roll guidance which is not provided by other external means, then a second wing bar may be provided on the opposite side of the runway.

5.3.5.24 The APAPI system shall consist of a wing bar of 2 sharp transition multi-lamp (or paired single lamp) units. The system shall be located on the left side of the runway unless it is physically impracticable to do so.

Note.— Where a runway is used by aircraft requiring visual roll guidance which is not provided by other external means, then a second wing bar may be provided on the opposite side of the runway.

5.3.5.25 The wing bar of a PAPI shall be constructed and arranged in such a manner that a pilot making an approach will:

a) when on or close to the approach slope, see the two units nearest the runway as red and the two units farthest from the runway as white;

b) when above the approach slope, see the one unit nearest the runway as red and the three units farthest from the runway as white; and when further above the approach slope, see all the units as white; and

c) when below the approach slope, see the three units nearest the runway as red and the unit farthest from the runway as white; and when further below the approach slope, see all the units as red.

5.3.5.26 The wing bar of an APAPI shall be constructed and arranged in such a manner that a pilot making an approach will:

a) when on or close to the approach slope, see the unit nearer the runway as red and the unit farther from the runway as white;

b) when above the approach slope, see both the units as white; and

c) when below the approach slope, see both the units as red.

Siting

5.3.5.27 The light units shall be located as in the basic configuration illustrated in Figure 5-12, subject to the installation tolerances given therein. The units forming a wing bar shall be mounted so as to appear to the pilot of an approaching aeroplane to be substantially in a horizontal line. The light units shall be mounted as low as possible and shall be frangible.

Characteristics of the light units

5.3.5.28 The system shall be suitable for both day and night operations.

5.3.5.29 The colour transition from red to white in the vertical plane shall be such as to appear to an observer, at a distance of not less than 300 m, to occur within a vertical angle of not more than 3′.

5.3.5.30 At full intensity the red light shall have a Y coordinate not exceeding 0.320.

5.3.5.31 The light intensity distribution of the light units shall be as shown in Appendix 2, Figure 2.20.

Note.— See the Aerodrome Design Manual, *Part 4 for additional guidance on the characteristics of light units.*

5.3.5.32 Suitable intensity control shall be provided so as to allow adjustment to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

5.3.5.33 Each light unit shall be capable of adjustment in elevation so that the lower limit of the white part of the beam may be fixed at any desired angle of elevation between 1°30′ and at least 4°30′ above the horizontal.

5.3.5.34 The light units shall be so designed that deposits of condensation, snow, ice, dirt, etc., on optically transmitting or reflecting surfaces shall interfere to the least possible extent with the light signals and shall not affect the contrast between the red and white signals and the elevation of the transition sector.

Approach slope and elevation setting of light units

5.3.5.35 The approach slope as defined in Figure 5-13 shall be appropriate for use by the aeroplanes using the approach.

5.3.5.36 When the runway is equipped with an ILS and/or MLS, the siting and the angle of elevation of the light units shall be such that the visual approach slope conforms as closely as possible with the glide path of the ILS and/or the minimum glide path of the MLS, as appropriate.

5.3.5.37 The angle of elevation settings of the light units in a PAPI wing bar shall be such that, during an approach, the pilot of an aeroplane observing a signal of one white and three reds will clear all objects in the approach area by a safe margin.

5.3.5.38 The angle of elevation settings of the light units in an APAPI wing bar shall be such that, during an approach, the pilot of an aeroplane observing the lowest onslope signal, i.e. one white and one red, will clear all objects in the approach area by a safe margin.

5.3.5.39 The azimuth spread of the light beam shall be suitably restricted where an object located outside the obstacle protection surface of the PAPI or APAPI system, but within the lateral limits of its light beam, is found to extend above the plane of the obstacle protection surface and an aeronautical study indicates that the object could adversely affect the safety of operations. The extent of the restriction shall be such that the object remains outside the confines of the light beam.

Note.— See 5.3.5.41 to 5.3.5.45 concerning the related obstacle protection surface.

5.3.5.40 Where wing bars are installed on each side of the runway to provide roll guidance, corresponding units shall be set at the same angle so that the signals of each wing bar change symmetrically at the same time.

Obstacle protection surface

Note.— The following specifications apply to T-VASIS, AT-VASIS, PAPI and APAPI.

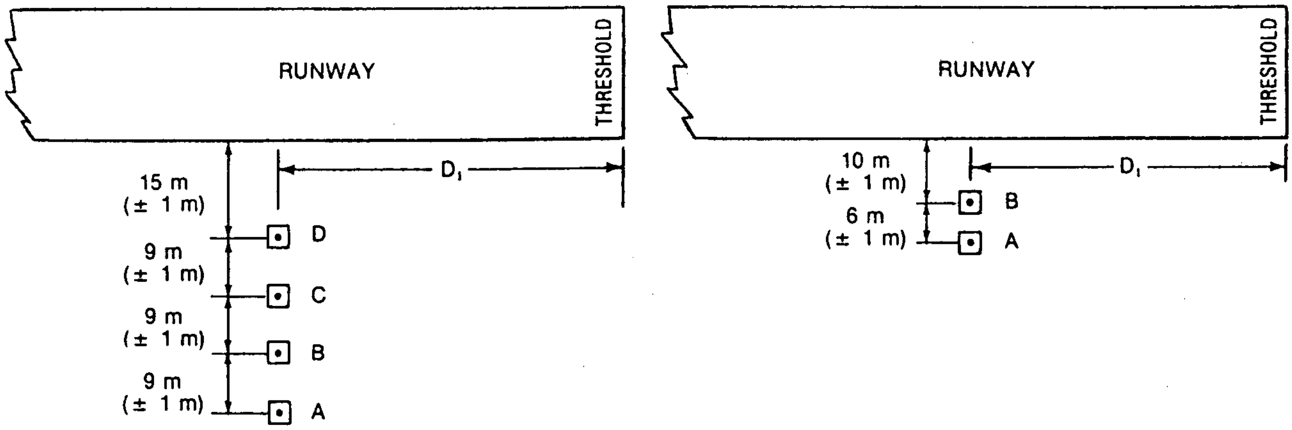
5.3.5.41 An obstacle protection surface shall be established when it is intended to provide a visual approach slope indicator system.

5.3.5.42 The characteristics of the obstacle protection surface, i.e. origin, divergence, length and slope shall correspond to those specified in the relevant column of Table 5-3 and in Figure 5-14.

5.3.5.43 New objects or extensions of existing objects shall not be permitted above an obstacle protection surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

5.3.5.44 Existing objects above an obstacle protection surface shall be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety of operations of aeroplanes.



TYPICAL PAPI WING BAR

TYPICAL APAPI WING BAR

INSTALLATION TOLERANCES

a) *Where a PAPI or APAPI is installed on a runway not equipped with an ILS or MLS, the distance D_1 shall be calculated to ensure that the lowest height at which a pilot will see a correct approach path indication (Figure 5-13, angle B for a PAPI and angle A for an APAPI) provides the wheel clearance over the threshold specified in Table 5-2 for the most demanding amongst aeroplanes regularly using the runway.*

b) *Where a PAPI or APAPI is installed on a runway equipped with an ILS and/or MLS, the distance D_1 shall be calculated to provide the optimum compatibility between the visual and non-visual aids for the range of eye-to-antenna heights of the aeroplanes regularly using the runway. The distance shall be equal to that between the threshold and the effective origin of the ILS glide path or MLS minimum glide path, as appropriate, plus a correction factor for the variation of eye-to-antenna heights of the aeroplanes concerned. The correction factor is obtained by multiplying the average eye-to-antenna height of those aeroplanes by the cotangent of the approach angle. However, the distance shall be such that in no case will the wheel clearance over the threshold be lower than that specified in column (3) of Table 5-2.*

Note.— See Section 5.2.5 for specifications on aiming point marking. Guidance on the harmonization of PAPI, ILS and/or MLS signals is contained in the *Aerodrome Design Manual*, Part 4.

c) *If a wheel clearance, greater than that specified in a) above is required for specific aircraft, this can be achieved by increasing D_1.*

d) *Distance D_1 shall be adjusted to compensate for differences in elevation between the lens centres of the light units and the threshold.*

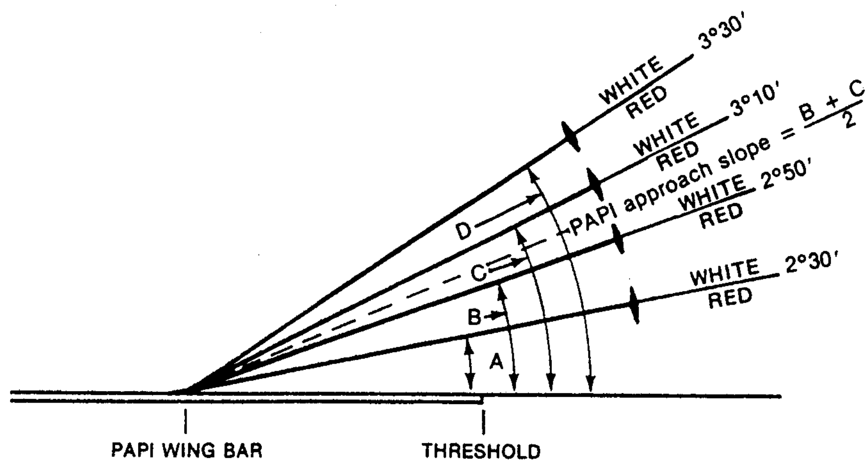
e) *To ensure that units are mounted as low as possible and to allow for any transverse slope, small height adjustments of up to 5 cm between units are acceptable. A lateral gradient not greater than 1.25 per cent can be accepted provided it is uniformly applied across the units.*

f) *A spacing of 6 m (± 1 m) between PAPI units should be used on code numbers 1 and 2. In such an event, the inner PAPI unit shall be located not less than 10 m (± 1 m) from the runway edge.*

Note.— Reducing the spacing between light units results in a reduction in usable range of the system.

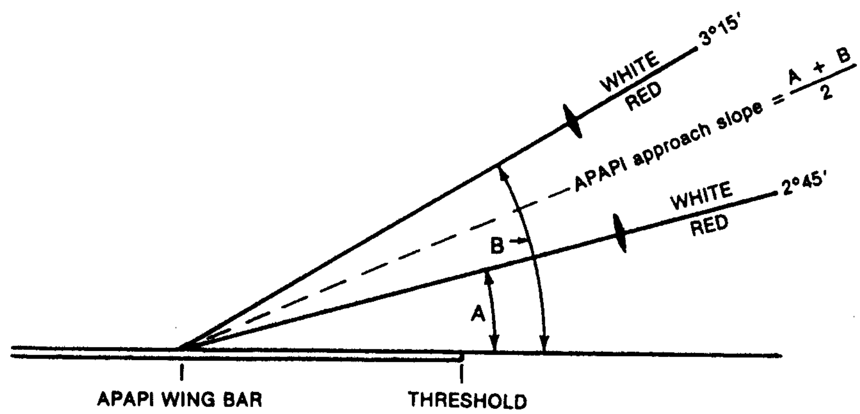
g) *The lateral spacing between APAPI units may be increased to 9 m (± 1 m) if greater range is required or later conversion to a full PAPI is anticipated. In the latter case, the inner APAPI unit shall be located 15 m (± 1 m) from the runway edge.*

Figure 5-12. Siting of PAPI and APAPI



The height of the pilot's eye above the aircraft's ILS glide path/MLS antenna varies with the type of aeroplane and approach attitude. Harmonization of the PAPI signal and ILS glide path and/or MLS minimum glide path to a point closer to the threshold may be achieved by increasing the on-course sector from 20′ to 30′. The setting angles for a 3° glide slope would then be 2°25′, 2°45′, 3°15′ and 3°35′.

A — 3° PAPI ILLUSTRATED



B — 3° APAPI ILLUSTRATED

Figure 5-13. Light beams and angle of elevation setting of PAPI and APAPI

Table 5-2. Wheel clearance over threshold for PAPI and APAPI

Eye-to-wheel height of aeroplane in the approach configuration[a] (1)	Desired wheel clearance (metres)[b,c] (2)	Minimum wheel clearance (metres)[d] (3)
up to but not including 3 m	6	3[e]
3 m up to but not including 5 m	9	4
5 m up to but not including 8 m	9	5
8 m up to but not including 14 m	9	6

a. In selecting the eye-to-wheel height group, only aeroplanes meant to use the system on a regular basis shall be considered. The most demanding amongst such aeroplanes shall determine the eye-to-wheel height group.

b. Where practicable the desired wheel clearances shown in column (2) shall be provided.

c. The wheel clearances in column (2) may be reduced to no less than those in column (3) where an aeronautical study indicates that such reduced wheel clearances are acceptable.

d. When a reduced wheel clearance is provided at a displaced threshold it shall be ensured that the corresponding desired wheel clearance specified in column (2) will be available when an aeroplane at the top end of the eye-to-wheel height group chosen overflies the extremity of the runway.

e. This wheel clearance may be reduced to 1.5 m on runways used mainly by light-weight non-turbo-jet aeroplanes.

Table 5-3. Dimensions and slopes of the obstacle protection surface

	Runway type/code number							
	Non-instrument Code number				Instrument Code number			
Surface dimensions	1	2	3	4	1	2	3	4
Length of inner edge	60 m	80 m[a]	150 m	150 m	150 m	150 m	300 m	300 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%
Total length	7 500 m	7 500 m[b]	15 000 m	15 000 m	7 500 m	7 500 m[b]	15 000 m	15 000 m
Slope								
a) T-VASIS and AT-VASIS	–[c]	1.9°	1.9°	1.9°	–	1.9°	1.9°	1.9°
b) PAPI[d]	–	A–0.57°	A–0.57°	A–0.57°	A–0.57°	A–0.57°	A–0.57°	A–0.57°
c) APAPI[d]	A–0.9°	A–0.9°	–	–	A–0.9°	A–0.9°	–	–

a. This length is to be increased to 150 m for a T-VASIS or AT-VASIS.
b. This length is to be increased to 15 000 m for a T-VASIS or AT-VASIS.
c. No slope has been specified if a system is unlikely to be used on runway type/code number indicated.
d. Angles as indicated in Figure 5-13.

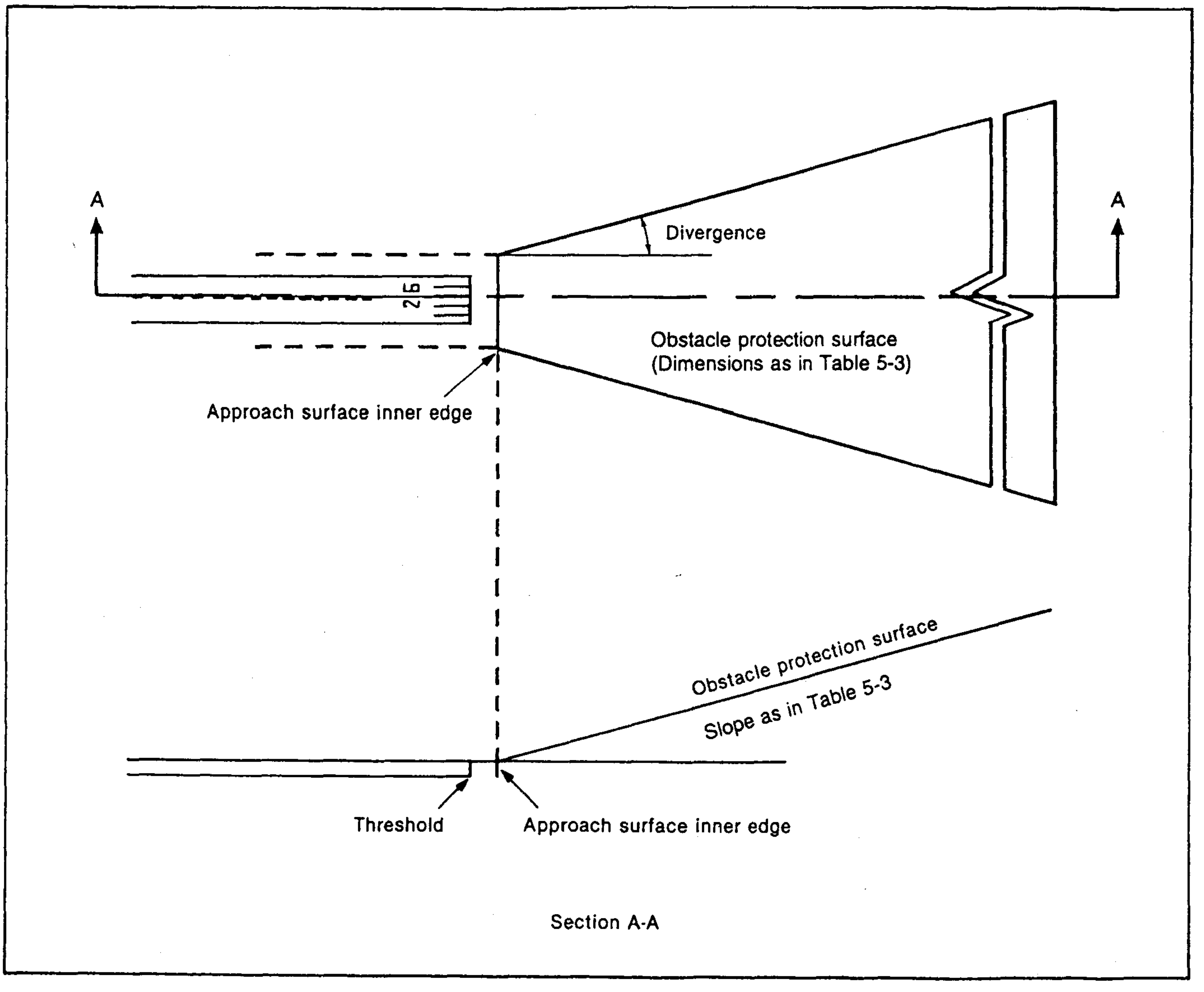


Figure 5-14. Obstacle protection surface for visual approach slope indicator systems

5.3.5.45 Where an aeronautical study indicates that an existing object extending above an obstacle protection surface could adversely affect the safety of operations of aeroplanes one or more of the following measures shall be taken:

a) suitably raise the approach slope of the system;

b) reduce the azimuth spread of the system so that the object is outside the confines of the beam;

c) displace the axis of the system and its associated obstacle protection surface by no more than 5°;

d) suitably displace the threshold; and

e) where d) is found to be impracticable, suitably displace the system upwind of the threshold to provide an increase in threshold crossing height equal to the height of the object penetration.

Note.— Guidance on this issue is contained in the Aerodrome Design Manual, *Part 4.*

5.3.6 Circling guidance lights

Application

5.3.6.1 **Recommendation.—** *Circling guidance lights should be provided when existing approach and runway lighting systems do not satisfactorily permit identification of the runway and/or approach area to a circling aircraft in the conditions for which it is intended the runway be used for circling approaches.*

Location

5.3.6.2 **Recommendation.—** *The location and number of circling guidance lights should be adequate to enable a pilot, as appropriate, to:*

a) join the downwind leg or align and adjust the aircraft's track to the runway at a required distance from it and to distinguish the threshold in passing; and

b) keep in sight the runway threshold and/or other features which will make it possible to judge the turn on to base leg and final approach, taking into account the guidance provided by other visual aids.

5.3.6.3 **Recommendation.—** *Circling guidance lights should consist of:*

a) lights indicating the extended centre line of the runway and/or parts of any approach lighting system; or

b) lights indicating the position of the runway threshold; or

c) lights indicating the direction or location of the runway;

or a combination of such lights as is appropriate to the runway under consideration.

Note.— Guidance on installation of circling guidance lights is given in the Aerodrome Design Manual, *Part 4.*

Characteristics

5.3.6.4 **Recommendation.—** *Circling guidance lights should be fixed or flashing lights of an intensity and beam spread adequate for the conditions of visibility and ambient light in which it is intended to make visual circling approaches. The flashing lights should be white, and the steady lights either white or gaseous discharge lights.*

5.3.6.5 **Recommendation.—** *The lights should be designed and be installed in such a manner that they will not dazzle or confuse a pilot when approaching to land, taking off or taxiing.*

5.3.7 Runway lead-in lighting systems

Application

5.3.7.1 **Recommendation.—** *A runway lead-in lighting system should be provided where it is desired to provide visual guidance along a specific approach path, for reasons such as avoiding hazardous terrain or for purposes of noise abatement.*

Note.— Guidance on providing lead-in lighting systems is given in the Aerodrome Design Manual, *Part 4.*

Location

5.3.7.2 **Recommendation.—** *A runway lead-in lighting system should consist of groups of lights positioned so as to define the desired approach path and so that one group may be sighted from the preceding group. The interval between adjacent groups should not exceed approximately 1 600 m.*

Note.— Runway lead-in lighting systems may be curved, straight or a combination thereof.

5.3.7.3 **Recommendation.—** *A runway lead-in lighting system should extend from a point as determined by the appropriate authority, up to a point where the approach lighting system, if provided, or the runway or the runway lighting system is in view.*

Characteristics

5.3.7.4 **Recommendation.—** *Each group of lights of a runway lead-in lighting system should consist of at least three flashing lights in a linear or cluster configuration. The system may be augmented by steady burning lights where such lights would assist in identifying the system.*

5.3.7.5 **Recommendation.—** *The flashing lights should be white, and the steady burning lights gaseous discharge lights.*

5.3.7.6 **Recommendation.—** *Where practicable, the flashing lights in each group should flash in sequence towards the runway.*

5.3.8 Runway threshold identification lights

Application

5.3.8.1 **Recommendation.—** *Runway threshold identification lights should be installed:*

a) at the threshold of a non-precision approach runway when additional threshold conspicuity is necessary or where it is not practicable to provide other approach lighting aids; and

b) where a runway threshold is permanently displaced from the runway extremity or temporarily displaced from the normal position and additional threshold conspicuity is necessary.

Location

5.3.8.2 Runway threshold identification lights shall be located symmetrically about the runway centre line, in line with the threshold and approximately 10 m outside each line of runway edge lights.

Characteristics

5.3.8.3 **Recommendation.—** *Runway threshold identification lights should be flashing white lights with a flash frequency between 60 and 120 per minute.*

5.3.8.4 The lights shall be visible only in the direction of approach to the runway.

5.3.9 Runway edge lights

Application

5.3.9.1 Runway edge lights shall be provided for a runway intended for use at night or for a precision approach runway intended for use by day or night.

5.3.9.2 **Recommendation.—** *Runway edge lights should be provided on a runway intended for take-off with an operating minimum below an RVR of the order of 800 m by day.*

Location

5.3.9.3 Runway edge lights shall be placed along the full length of the runway and shall be in two parallel rows equidistant from the centre line.

5.3.9.4 Runway edge lights shall be placed along the edges of the area declared for use as the runway or outside the edges of the area at a distance of not more than 3 m.

5.3.9.5 **Recommendation.—** *Where the width of the area which could be declared as runway exceeds 60 m, the distance between the rows of lights should be determined taking into account the nature of the operations, the light distribution characteristics of the runway edge lights, and other visual aids serving the runway.*

5.3.9.6 The lights shall be uniformly spaced in rows at intervals of not more than 60 m for an instrument runway, and at intervals of not more than 100 m for a non-instrument runway. The lights on opposite sides of the runway axis shall be on lines at right angles to that axis. At intersections of runways, lights may be spaced irregularly or omitted, provided that adequate guidance remains available to the pilot.

Characteristics

5.3.9.7 Runway edge lights shall be fixed lights showing variable white, except that:

a) in the case of a displaced threshold, the lights between the beginning of the runway and the displaced threshold shall show red in the approach direction; and

b) a section of the lights 600 m or one-third of the runway length, whichever is the less, at the remote end of the runway from the end at which the take-off run is started, may show yellow.

5.3.9.8 The runway edge lights shall show at all angles in azimuth necessary to provide guidance to a pilot landing or taking off in either direction. When the runway edge lights are intended to provide circling guidance, they shall show at all angles in azimuth (see 5.3.6.1).

5.3.9.9 In all angles of azimuth required in 5.3.9.8, runway edge lights shall show at angles up to 15° above the horizontal with an intensity adequate for the conditions of visibility and ambient light in which use of the runway for take-off or landing is intended. In any case, the intensity shall be at least 50 cd except that at an aerodrome without extraneous lighting the intensity of the lights may be reduced to not less than 25 cd to avoid dazzling the pilot.

5.3.9.10 Runway edge lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure 2.10 or 2.11.

5.3.10 Runway threshold and wing bar lights (see Figure 5-15)

Application of runway threshold lights

5.3.10.1 Runway threshold lights shall be provided for a runway equipped with runway edge lights except on a non-instrument or non-precision approach runway where the threshold is displaced and wing bar lights are provided.

Location of runway threshold lights

5.3.10.2 When a threshold is at the extremity of a runway, the threshold lights shall be placed in a row at right angles to the runway axis as near to the extremity of the runway as possible and, in any case, not more than 3 m outside the extremity.

5.3.10.3 When a threshold is displaced from the extremity of a runway, threshold lights shall be placed in a row at right angles to the runway axis at the displaced threshold.

5.3.10.4 Threshold lighting shall consist of:

a) on a non-instrument or non-precision approach runway, at least six lights;

b) on a precision approach runway category I, at least the number of lights that would be required if the lights were uniformly spaced at intervals of 3 m between the rows of runway edge lights; and

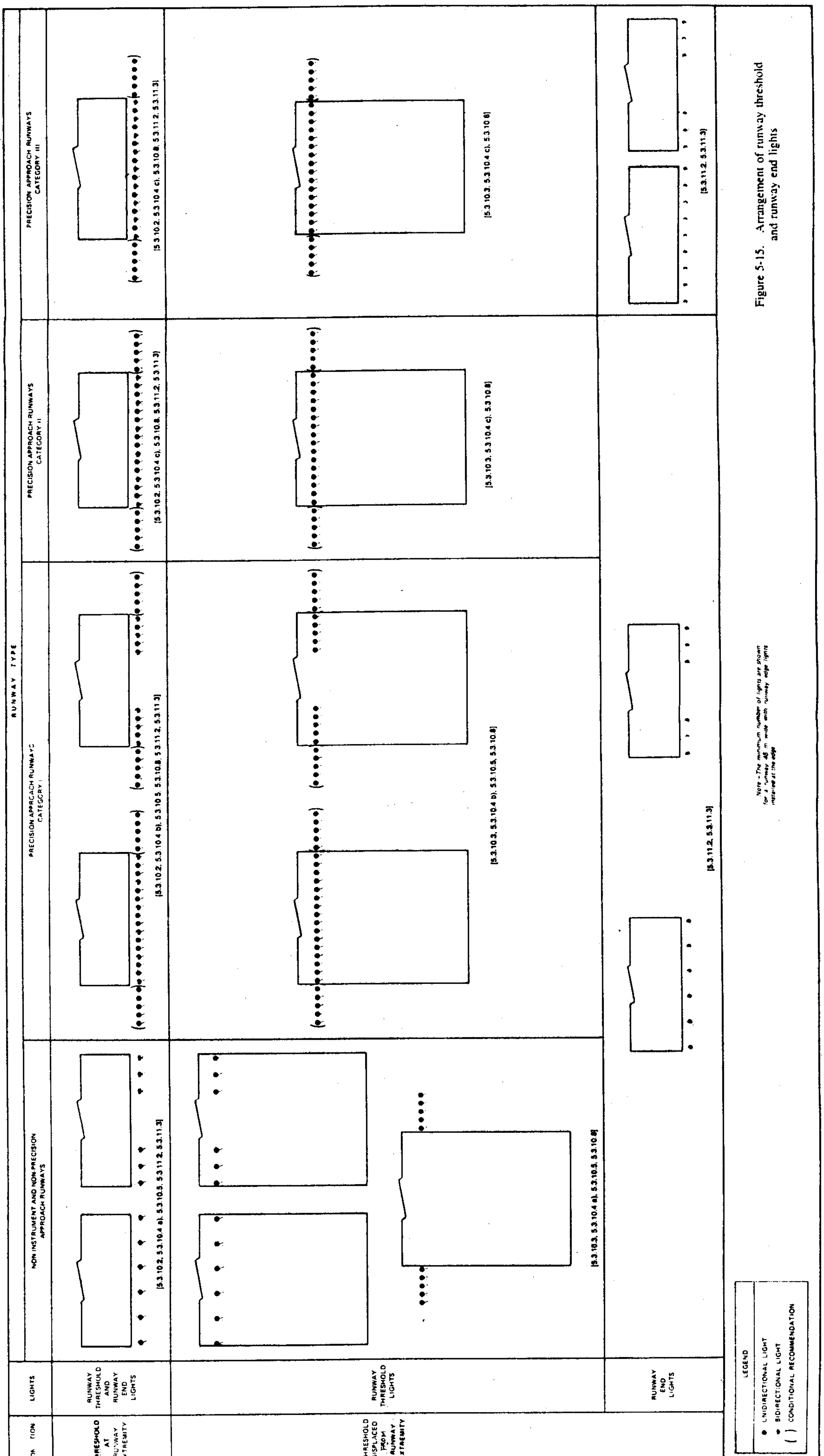


Figure 5-15. Arrangement of runway threshold and runway end lights

c) on a precision approach runway category II or III, lights uniformly spaced between the rows of runway edge lights at intervals of not more than 3 m.

5.3.10.5 **Recommendation.—** *The lights prescribed in 5.3.10.4 a) and b) should be either:*

a) equally spaced between the rows of runway edge lights, or

b) symmetrically disposed about the runway centre line in two groups, with the lights uniformly spaced in each group and with a gap between the groups equal to the gauge of the touchdown zone marking or lighting, where such is provided, or otherwise not more than half the distance between the rows of runway edge lights.

Application of wing bar lights

5.3.10.6 **Recommendation.—** *Wing bar lights should be provided on a precision approach runway when additional conspicuity is considered desirable.*

5.3.10.7 Wing bar lights shall be provided on a non-instrument or non-precision approach runway where the threshold is displaced and runway threshold lights are required, but are not provided.

Location of wing bar lights

5.3.10.8 Wing bar lights shall be symmetrically disposed about the runway centre line at the threshold in two groups, i.e. wing bars. Each wing bar shall be formed by at least five lights extending at least 10 m outward from, and at right angles to, the line of the runway edge lights, with the innermost light of each wing bar in the line of the runway edge lights.

Characteristics of runway threshold and wing bar lights

5.3.10.9 Runway threshold and wing bar lights shall be fixed unidirectional lights showing green in the direction of approach to the runway. The intensity and beam spread of the lights shall be adequate for the conditions of visibility and ambient light in which use of the runway is intended.

5.3.10.10 Runway threshold lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure 2.3.

5.3.10.11 Threshold wing bar lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure 2.4.

5.3.11 Runway end lights
(see Figure 5-15)

Application

5.3.11.1 Runway end lights shall be provided for a runway equipped with runway edge lights.

Note.— When the threshold is at the runway extremity, fittings serving as threshold lights may be used as runway end lights.

Location

5.3.11.2 Runway end lights shall be placed on a line at right angles to the runway axis as near to the end of the runway as possible and, in any case, not more than 3 m outside the end.

5.3.11.3 **Recommendation.—** *Runway end lighting should consist of at least six lights. The lights should be either:*

a) equally spaced between the rows of runway edge lights, or

b) symmetrically disposed about the runway centre line in two groups with the lights uniformly spaced in each group and with a gap between the groups of not more than half the distance between the rows of runway edge lights.

For a precision approach runway category III, the spacing between runway end lights, except between the two innermost lights if a gap is used, should not exceed 6 m.

Characteristics

5.3.11.4 Runway end lights shall be fixed unidirectional lights showing red in the direction of the runway. The intensity and beam spread of the lights shall be adequate for the conditions of visibility and ambient light in which use of the runway is intended.

5.3.11.5 Runway end lights on a precision approach runway shall be in accordance with the specifications of Appendix 2, Figure 2.9.

5.3.12 Runway centre line lights

Application

5.3.12.1 Runway centre line lights shall be provided on a precision approach runway category II or III.

5.3.12.2 **Recommendation.—** *Runway centre line lights should be provided on a precision approach runway category I, particularly when the runway is used by aircraft with high landing speeds or where the width between the runway edge lights is greater than 50 m.*

5.3.12.3 Runway centre line lights shall be provided on a runway intended to be used for take-off with an operating minimum below an RVR of the order of 400 m.

5.3.12.4 **Recommendation.—** *Runway centre line lights should be provided on a runway intended to be used for take-off with an operating minimum of an RVR of the order of 400 m or higher when used by aeroplanes with a very high take-off speed, particularly where the width between the runway edge lights is greater than 50 m.*

Location

5.3.12.5 Runway centre line lights shall be located along the centre line of the runway, except that the lights may be uniformly offset to the same side of the runway centre line by not more than 60 cm where it is not practicable to locate them along the centre line. The lights shall be located from the threshold to the end at a longitudinal spacing of approximately:

— 7.5 m or 15 m on a precision approach runway category III; and

— 7.5 m, 15 m or 30 m on a precision approach runway category II or other runway on which the lights are provided.

5.3.12.6 **Recommendation.—** *Centre line guidance for take-off from the beginning of a runway to a displaced threshold should be provided by:*

a) an approach lighting system if its characteristics and intensity settings afford the guidance required during take-off and it does not dazzle the pilot of an aircraft taking off; or

b) runway centre line lights; or

c) barrettes of at least 3 m length and spaced at uniform intervals of 30 m, as shown in Figure 5-16, designed so that their photometric characteristics and intensity setting afford the guidance required during take-off without dazzling the pilot of an aircraft taking off.

Where necessary, provision should be made to extinguish those centre line lights specified in b) or reset the intensity of the approach lighting system or barrettes when the runway is being used for landing. In no case should only the single source runway centre line lights show from the beginning of the runway to a displaced threshold when the runway is being used for landing.

Characteristics

5.3.12.7 Runway centre line lights shall be fixed lights showing variable white from the threshold to the point 900 m from the runway end; alternate red and variable white from 900 m to 300 m from the runway end; and red from 300 m to the runway end, except that:

a) where the runway centre line lights are spaced at 7.5 m intervals, alternate pairs of red and variable white lights shall be used on the section from 900 m to 300 m from the runway end; and

b) for runways less than 1 800 m in length, the alternate red and variable white lights shall extend from the mid-point of the runway usable for landing to 300 m from the runway end.

Note.— Care is required in the design of the electrical system to ensure that failure of part of the electrical system will not result in a false indication of the runway distance remaining.

5.3.12.8 Runway centre line lights shall be in accordance with the specifications of Appendix 2, Figure 2.6, 2.7 or 2.8.

5.3.13 Runway touchdown zone lights

Application

5.3.13.1 Touchdown zone lights shall be provided in the touchdown zone of a precision approach runway category II or III.

Location

5.3.13.2 Touchdown zone lights shall extend from the threshold for a longitudinal distance of 900 m, except that, on runways less than 1 800 m in length, the system shall be shortened so that it does not extend beyond the midpoint of the runway. The pattern shall be formed by pairs of barrettes symmetrically located about the runway centre line. The lateral spacing between the innermost lights of a pair of barrettes shall be equal to the lateral spacing selected for the touchdown zone marking. The longitudinal spacing between pairs of barrettes shall be either 30 m or 60 m.

Note.— To allow for operations at lower visibility minima, it may be advisable to use a 30 m longitudinal spacing between barrettes.

Characteristics

5.3.13.3 A barrette shall be composed of at least three lights with a spacing between the lights of not more than 1.5 m.

5.3.13.4 **Recommendation.**— *A barrette should be not less than 3 m nor more than 4.5 m in length.*

5.3.13.5 Touchdown zone lights shall be fixed unidirectional lights showing variable white.

5.3.13.6 Touchdown zone lights shall be in accordance with the specifications of Appendix 2, Figure 2.5.

5.3.14 Stopway lights

Application

5.3.14.1 Stopway lights shall be provided for a stopway intended for use at night.

Location

5.3.14.2 Stopway lights shall be placed along the full length of the stopway and shall be in two parallel rows that are equidistant from the centre line and coincident with the rows of the runway edge lights. Stopway lights shall also be provided across the end of a stopway on a line at right angles to the stopway axis as near to the end of the stopway as possible and, in any case, not more than 3 m outside the end.

Characteristics

5.3.14.3 Stopway lights shall be fixed unidirectional lights showing red in the direction of the runway.

5.3.15 Taxiway centre line lights

Application

5.3.15.1 Taxiway centre line lights shall be provided on an exit taxiway, taxiway and apron intended for use in runway visual range conditions less than a value of 350 m in such a manner as to provide continuous guidance from the runway centre line to the point on the apron where aircraft commence manoeuvring for parking, except that these lights need not be provided where there is a low volume of traffic and taxiway edge lights and centre line marking provide adequate guidance.

5.3.15.2 **Recommendation.**— *Taxiway centre line lights should be provided on a taxiway intended for use at night in runway visual range conditions of 350 m or greater, and particularly on complex taxiway intersections and exit taxiways, except that these lights need not be provided where there is a low volume of traffic and taxiway edge lights and centre line marking provide adequate guidance.*

Note.— Where there may be a need to delineate the edges of a taxiway, e.g. on a rapid exit taxiway, narrow taxiway or in snow conditions, this may be done with taxiway edge lights or markers.

5.3.15.3 Taxiway centre line lights shall be provided on a runway forming part of a standard taxi-route and intended for taxiing in runway visual range conditions less than a value of 350 m, except that these lights need not be provided where there is a low volume of traffic and taxiway edge lights and centre line marking provide adequate guidance.

Note.— See 8.2.3 for provisions concerning the interlocking of runway and taxiway lighting systems.

Characteristics

5.3.15.4 Taxiway centre line lights on a taxiway other than an exit taxiway and on a runway forming part of a standard taxi-route shall be fixed lights showing green with beam dimensions such that the light is visible only from aeroplanes on or in the vicinity of the taxiway.

5.3.15.5 Taxiway centre line lights on an exit taxiway shall be fixed lights. Alternate taxiway centre line lights shall show green and yellow from their beginning near the runway centre line to the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface, whichever is farthest from the runway; and thereafter all lights shall show green (Figure 5-17). The light nearest to the perimeter shall always show yellow. Where aircraft may follow the same centre line in both directions, all the centre line lights shall show green to aircraft approaching the runway.

Note 1.— Care is necessary to limit the light distribution of green lights on or near a runway so as to avoid possible confusion with threshold lights.

Note 2.— For yellow filter characteristics see Appendix 1, 2.2.

Note 3.— The size of the ILS/MLS critical/sensitive area depends on the characteristics of the associated ILS/MLS and other factors. Guidance is provided in Annex 10, Volume I, Attachments C and G to Part I.

Note 4.— See 5.4.3 for specifications on runway vacated signs.

5.3.15.6 Taxiway centre line lights shall be in accordance with the specifications of:

a) Appendix 2, Figure 2.13, 2.14 or 2.15 for taxiways intended for use in runway visual range conditions of less than a value of 350 m; and

b) Appendix 2, Figure 2.16 or 2.17 for other taxiways.

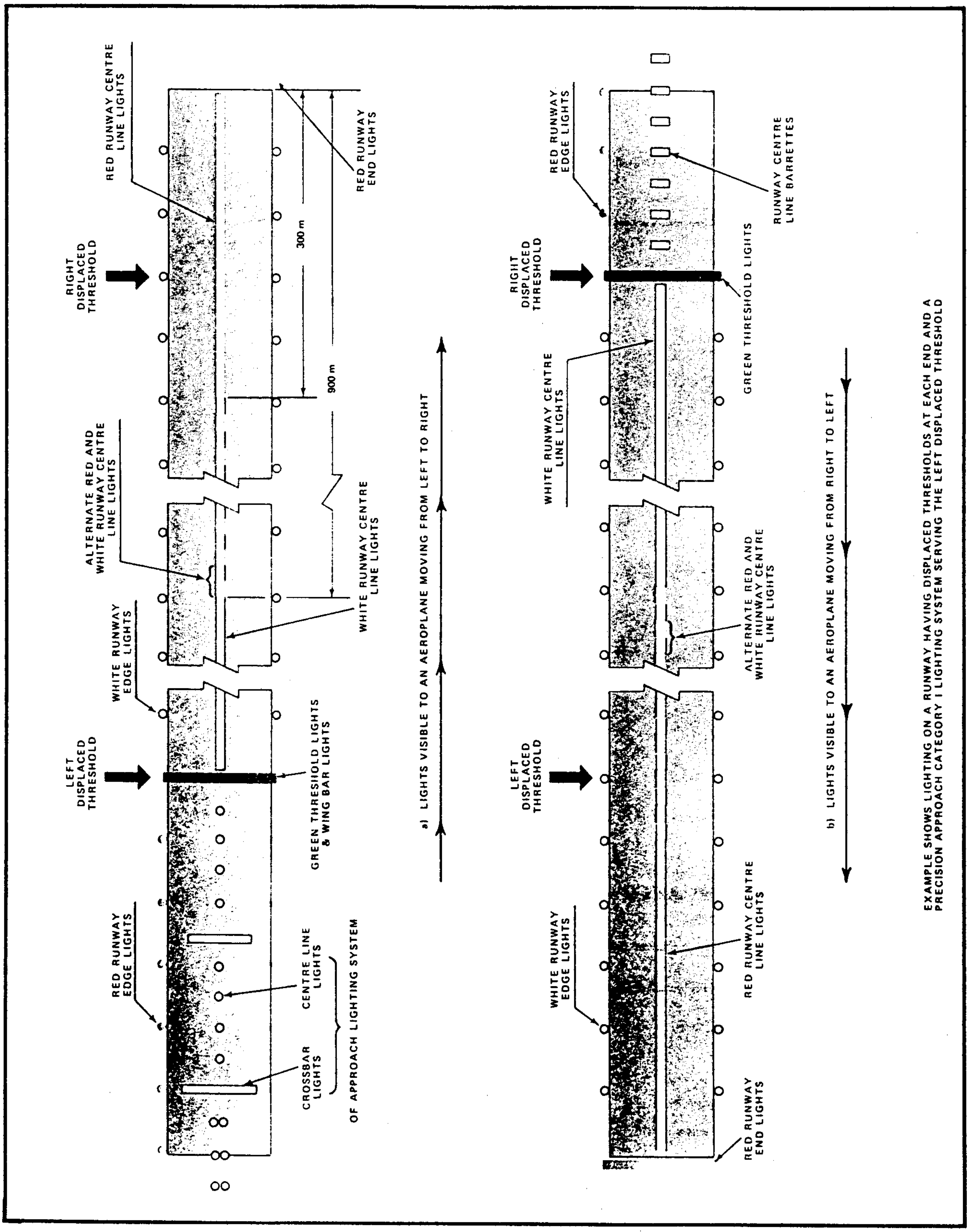


Figure 5-16. Example of approach and runway lighting for runways with displaced thresholds

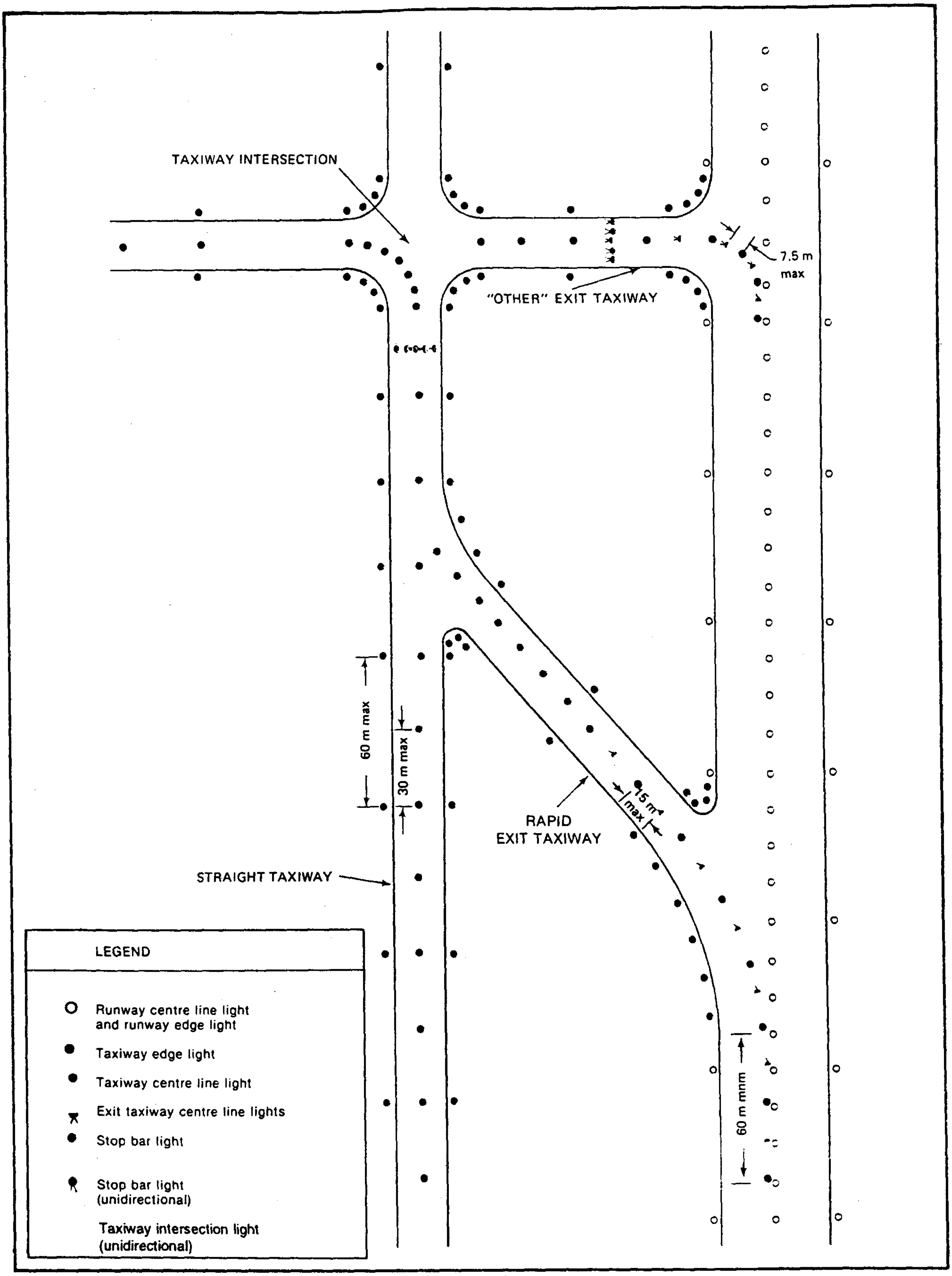


Figure 5-17. Taxiway lighting

Location

5.3.15.7 **Recommendation.**— *Taxiway centre line lights should normally be located on the taxiway centre line marking, except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.*

Taxiway centre line lights on taxiways

Location

5.3.15.8 **Recommendation.**— *Taxiway centre line lights on a straight section of a taxiway should be spaced at longitudinal intervals of not more than 30 m, except that:*

a) larger intervals not exceeding 60 m may be used where, because of the prevailing meteorological conditions, adequate guidance is provided by such spacing;

b) intervals less than 30 m should be provided on short straight sections; and

c) on a taxiway intended for use in RVR conditions of less than a value of 350 m, the longitudinal spacing should not exceed 15 m.

5.3.15.9 **Recommendation.**— *Taxiway centre line lights on a taxiway curve should continue from the straight portion of the taxiway at a constant distance from the outside edge of the taxiway curve. The lights should be spaced at intervals such that a clear indication of the curve is provided.*

5.3.15.10 **Recommendation.**— *On a taxiway intended for use in RVR conditions of less than a value of 350 m, the lights on a curve should not exceed a spacing of 15 m and on a curve of less than 400 m radius the lights should be spaced at intervals of not greater than 7.5 m. This spacing should extend for 60 m before and after the curve.*

Note 1.— Spacings on curves that have been found suitable for a taxiway intended for use in RVR conditions of 350 m or greater are:

Curve radius	Light spacing
up to 400 m	*7.5 m*
401 m to 899 m	*15 m*
900 m or greater	*30 m*

Note 2.— See 3.8.5 and Figure 3-1.

Taxiway centre line lights on rapid exit taxiways

Location

5.3.15.11 **Recommendation.**— *Taxiway centre line lights on a rapid exit taxiway should commence at a point at least 60 m before the beginning of the taxiway centre line curve and continue beyond the end of the curve to a point on the centre line of the taxiway where an aeroplane can be expected to reach normal taxiing speed. The lights on that portion parallel to the runway centre line should always be at least 60 cm from any row of runway centre line lights, as shown in Figure 5-18.*

5.3.15.12 **Recommendation.**— *The lights should be spaced at longitudinal intervals of not more than 15 m, except that, where runway centre line lights are not provided, a greater interval not exceeding 30 m may be used.*

Taxiway centre line lights on other exit taxiways

Location

5.3.15.13 **Recommendation.**— *Taxiway centre line lights on exit taxiways other than rapid exit taxiways should commence at the point where the taxiway centre line marking begins to curve from the runway centre line, and follow the curved taxiway centre line marking at least to the point where the marking leaves the runway. The first light should be at least 60 cm from any row of runway centre line lights, as shown in Figure 5-18.*

5.3.15.14 **Recommendation.**— *The lights should be spaced at longitudinal intervals of not more than 7.5 m.*

Taxiway centre line lights on runways

Location

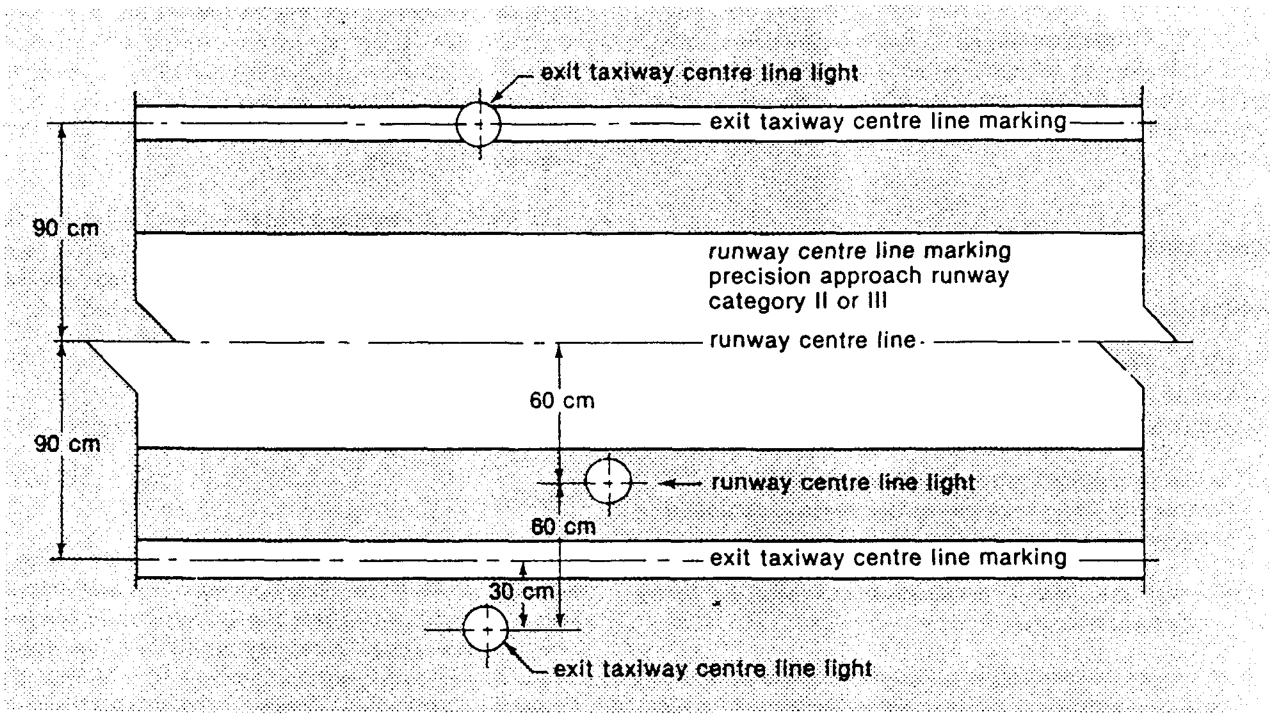
5.3.15.15 **Recommendation.**— *Taxiway centre line lights on a runway forming part of a standard taxi-route and intended for taxiing in runway visual range conditions less than a value of 350 m should be spaced at longitudinal intervals not exceeding 15 m.*

5.3.16 Taxiway edge lights

Application

5.3.16.1 Taxiway edge lights shall be provided on a holding bay, apron, etc. intended for use at night and on a taxiway not provided with taxiway centre line lights and intended for use at night, except that taxiway edge lights need not be provided where, considering the nature of the operations, adequate guidance can be achieved by surface illumination or other means.

Note.— See 5.5.5 for taxiway edge markers.



Tolerances for offset runway centre line lights and
taxiway centre line lights to maintain 60 cm separation.

Figure 5-18. Offset runway and taxiway centre line lights

5.3.16.2 Taxiway edge lights shall be provided on a runway forming part of a standard taxi-route and intended for taxiing at night where the runway is not provided with taxiway centre line lights.

Note.— See 8.2.3 for provisions concerning the interlocking of runway and taxiway lighting systems.

Location

5.3.16.3 **Recommendation.—** *Taxiway edge lights on a straight section of a taxiway and on a runway forming part of a standard taxi-route should be spaced at uniform longitudinal intervals of not more than 60 m. The lights on a curve should be spaced at intervals less than 60 m so that a clear indication of the curve is provided.*

5.3.16.4 **Recommendation.—** *The lights should be located as near as practicable to the edges of the taxiway, holding bay, apron or runway, etc. or outside the edges at a distance of not more than 3 m.*

Characteristics

5.3.16.5 Taxiway edge lights shall be fixed lights showing blue. The lights shall show up to at least 30° above the horizontal and at all angles in azimuth necessary to provide guidance to a pilot taxiing in either direction. At an intersection, exit or curve the lights shall be shielded as far as practicable so that they cannot be seen in angles of azimuth in which they may be confused with other lights.

5.3.17 Stop bars

Application

Note.— The provision of stop bars requires their control by air traffic services.

5.3.17.1 A stop bar shall be provided at every taxi-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions less than a value of 350 m, except where:

a) appropriate aids and procedures are available to assist in preventing inadvertent incursions of aircraft and vehicles onto the runway; or

b) operational procedures exist to limit, in runway visual range conditions less than a value of 550 m, the number of:

1) aircraft on the manoeuvring area to one at a time; and

2) vehicles on the manoeuvring area to the essential minimum.

5.3.17.2 **Recommendation.—** *A stop bar should be provided at every taxi-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions of values between 350 m and 550 m, except where:*

a) appropriate aids and procedures are available to assist in preventing inadvertent incursions of aircraft and vehicles onto the runway; or

b) operational procedures exist to limit, in runway visual range conditions less than a value of 550 m, the number of:

1) aircraft on the manoeuvring area to one at a time; and

2) vehicles on the manoeuvring area to the essential minimum.

5.3.17.3 The provisions of 5.3.17.2 shall apply as a Standard as of 1 January 2001.

5.3.17.4 **Recommendation.—** *One or more stop bars, as appropriate, should be provided at a taxiway intersection or taxi-holding position when it is desired to supplement markings with lights and to provide traffic control by visual means.*

5.3.17.5 **Recommendation.—** *Where the normal stop bar lights might be obscured (from a pilot's view), for example, by snow or rain, or where a pilot may be required to stop the aircraft in a position so close to the lights that they are blocked from view by the structure of the aircraft, then a pair of elevated lights should be added to each end of the stop bar.*

Location

5.3.17.6 Stop bars shall be located across the taxiway at the point where it is desired that traffic stop. Where the additional lights specified in 5.3.17.5 are provided, these lights shall be located not less than 3 m from the taxiway edge.

Characteristics

5.3.17.7 Stop bars shall consist of lights spaced at intervals of 3 m across the taxiway, showing red in the intended direction(s) of approach to the intersection or taxi-holding position.

5.3.17.8 Stop bars installed at a taxi-holding position shall be unidirectional and shall show red in the direction of approach to the runway.

5.3.17.9 Where the additional lights specified in 5.3.17.5 are provided, these lights shall have the same characteristics as the lights in the stop bar, but shall be visible to approaching aircraft up to the stop bar position.

5.3.17.10 Selectively switchable stop bars shall be installed in conjunction with at least three taxiway centre line lights (extending for a distance of at least 90 m from the stop bar) in the direction that it is intended for an aircraft to proceed from the stop bar.

Note.— See 5.3.15.8 for provisions concerning the spacing of taxiway centre line lights.

5.3.17.11 **Recommendation.—** *The intensity in red light and beam spreads of stop bar lights should be in accordance with the specifications in Appendix 2, Figures 2.13 through 2.17, as appropriate.*

5.3.17.12 The lighting circuit shall be designed so that:

a) stop bars located across entrance taxiways are selectively switchable;

b) stop bars located across taxiways intended to be used only as exit taxiways are switchable selectively or in groups;

c) when a stop bar is illuminated, any taxiway centre line lights installed beyond the stop bar shall be extinguished for a distance of at least 90 m; and

d) stop bars shall be interlocked with the taxiway centre line lights so that when the centre line lights beyond the stop bar are illuminated the stop bar is extinguished and vice versa.

Note 1.— A stop bar is switched on to indicate that traffic stop and switched off to indicate that traffic proceed.

Note 2.— Care is required in the design of the electrical system to ensure that all of the lights of a stop bar will not fail at the same time. Guidance on this issue is given in the Aerodrome Design Manual, *Part 5.*

5.3.18 Taxiway intersection lights

Note.— See 5.2.10 for specifications on taxiway intersection marking.

Application

5.3.18.1 **Recommendation.—** *Taxiway intersection lights should be provided at a taxiway intersection where it is desirable to define a specific aeroplane holding limit and there is no need for stop-and-go signals as provided by a stop bar.*

Location

5.3.18.2 Taxiway intersection lights shall be located at a point between 30 m to 60 m from the near edge of the intersecting taxiway.

Characteristics

5.3.18.3 Taxiway intersection lights shall consist of at least three fixed unidirectional lights showing yellow in the direction of approach to the intersection with a light distribution similar to taxiway centre line lights if provided. The lights shall be disposed symmetrically about, and at 90° to, the taxiway centre line, with individual lights spaced 1.5 m apart.

5.3.19 Runway guard lights

Note.— There are two standard configurations of runway guard lights as illustrated in Figure 5-19.

Application

5.3.19.1 Runway guard lights, Configuration A, shall be provided at each taxiway/runway intersection associated with a runway intended for use in:

a) runway visual range conditions less than a value of 550 m where a stop bar is not installed; and

b) runway visual range conditions of values between 550 m and 1 200 m where the traffic density is high.

Note.— See the Manual of Surface Movement Guidance and Control Systems (SMGCS) *for the definition of traffic conditions.*

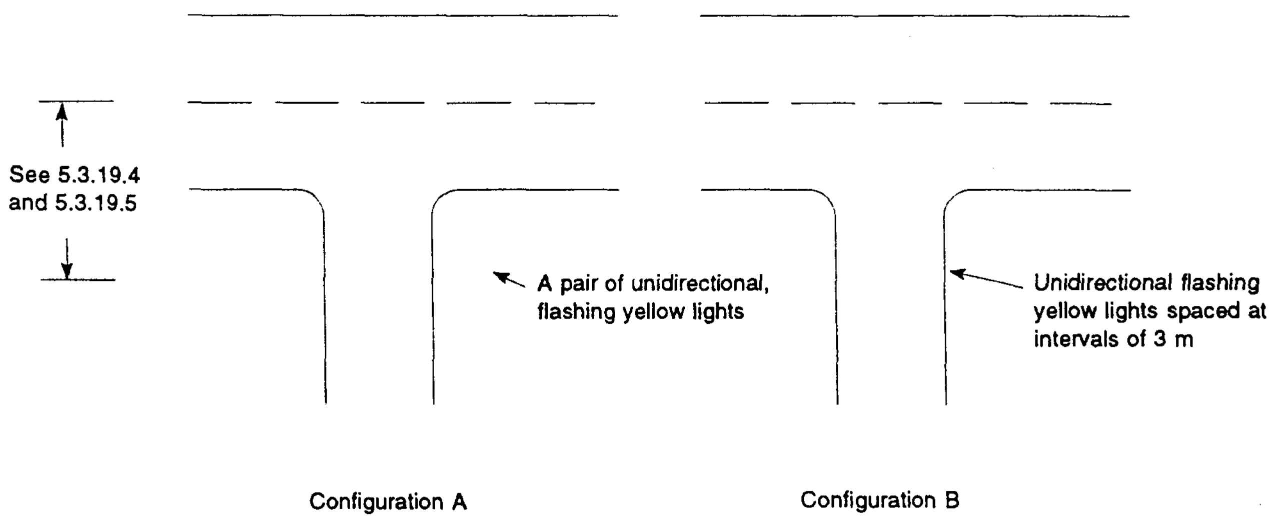


Figure 5-19. Runway guard lights

5.3.19.2 **Recommendation.—** *Runway guard lights, Configuration A, should be provided at each taxiway/runway intersection associated with a runway intended for use in:*

a) runway visual range conditions of values less than a value of 550 m where a stop bar is installed; and

b) runway visual range conditions of values between 550 m and 1 200 m where the traffic density is medium or low.

5.3.19.3 **Recommendation.—** *Runway guard lights, Configuration A or Configuration B or both, should be provided at each taxiway/runway intersection where enhanced conspicuity of the taxiway/runway intersection is needed, such as on a wide-throat taxiway, except that Configuration B should not be collocated with a stop bar.*

Location

5.3.19.4 Runway guard lights, Configuration A, shall be located at each side of the taxiway at a distance from the runway centre line not less than that specified for a take-off runway in Table 3-2.

5.3.19.5 Runway guard lights, Configuration B, shall be located across the taxiway at a distance from the runway centre line not less than that specified for a take-off runway in Table 3-2.

Characteristics

5.3.19.6 Runway guard lights, Configuration A, shall consist of two pairs of yellow lights.

5.3.19.7 Runway guard lights, Configuration B, shall consist of yellow lights spaced at intervals of 3 m across the taxiway.

5.3.19.8 The light beam shall be unidirectional and aligned so as to be visible to the pilot of an aeroplane taxiing to the holding position.

5.3.19.9 **Recommendation.—** *The effective intensity in yellow light and beam spreads of lights of Configuration A should be in accordance with the specifications in Appendix 2, Figure 2.21.*

5.3.19.10 **Recommendation.—** *The intensity in yellow light and beam spreads of lights of Configuration B should be in accordance with the specifications in Appendix 2, Figure 2.13.*

5.3.19.11 The lights in each unit of Configuration A shall be illuminated alternately.

5.3.19.12 For Configuration B, adjacent lights shall be alternately illuminated and alternative lights shall be illuminated in unison.

5.3.19.13 The lights shall be illuminated between 30 and 60 cycles per minute and the light suppression and illumination periods shall be equal and opposite in each light.

5.3.20 Apron floodlighting
(see also 5.3.15.1 and 5.3.16.1)

Application

5.3.20.1 **Recommendation.—** *Apron floodlighting should be provided on an apron, and on a designated isolated aircraft parking position, intended to be used at night.*

Note 1.— The designation of an isolated aircraft parking position is specified in 3.13.

Note 2.— Guidance on apron floodlighting is given in the Aerodrome Design Manual, *Part 4.*

Location

5.3.20.2 **Recommendation.—** *Apron floodlights should be located so as to provide adequate illumination on all apron service areas, with a minimum of glare to pilots of aircraft in flight and on the ground, aerodrome and apron controllers, and personnel on the apron. The arrangement and aiming of floodlights should be such that an aircraft stand receives light from two or more directions to minimize shadows.*

Characteristics

5.3.20.3 The spectral distribution of apron floodlights shall be such that the colours used for aircraft marking connected with routine servicing, and for surface and obstacle marking, can be correctly identified.

5.3.20.4 **Recommendation.—** *The average illuminance should be at least the following:*

Aircraft stand:

— horizontal illuminance — 20 lux with a uniformity ratio (average to minimum) of not more than 4 to 1; and

— vertical illuminance — 20 lux at a height of 2 m above the apron in relevant directions.

Other apron areas:

— horizontal illuminance — 50 per cent of the average illuminance on the aircraft stands with a uniformity ratio (average to minimum) of not more than 4 to 1.

5.3.21 Visual docking guidance system

Application

5.3.21.1 A visual docking guidance system shall be provided when it is intended to indicate, by a visual aid, the precise positioning of an aircraft on an aircraft stand and other alternative means, such as marshallers, are not practicable.

Note.— The factors to be considered in evaluating the need for a visual docking guidance system are in particular: the number and type(s) of aircraft using the aircraft stand, weather conditions, space available on the apron and the precision required for manoeuvring into the parking position due to aircraft servicing installation, passenger loading bridges, etc. See the Aerodrome Design Manual, *Part 4 —* Visual Aids *(Doc 9157) for guidance on the selection of suitable systems.*

5.3.21.2 The provisions of 5.3.21.3 to 5.3.21.7, 5.3.21.9, 5.3.21.10, 5.3.21.12 to 5.3.21.15, 5.3.21.17, 5.3.21.18 and 5.3.21.20 shall not require the replacement of existing installations before 1 January 2005.

Characteristics

5.3.21.3 The system shall provide both azimuth and stopping guidance.

5.3.21.4 The azimuth guidance unit and the stopping position indicator shall be adequate for use in all weather, visibility, background lighting and pavement conditions for which the system is intended both by day and night, but shall not dazzle the pilot.

Note.— Care is required in both the design and on-site installation of the system to ensure that reflection of sunlight, or other light in the vicinity, does not degrade the clarity and conspicuity of the visual cues provided by the system.

5.3.21.5 The azimuth guidance unit and the stopping position indicator shall be of a design such that:

a) a clear indication of malfunction of either or both is available to the pilot; and

b) they can be turned off.

5.3.21.6 The azimuth guidance unit and the stopping position indicator shall be located in such a way that there is continuity of guidance between the aircraft stand markings, the aircraft stand manoeuvring guidance lights, if present, and the visual docking guidance system.

5.3.21.7 The accuracy of the system shall be adequate for the type of loading bridge and fixed aircraft servicing installations with which it is to be used.

5.3.21.8 **Recommendation.—** *The system should be usable by all types of aircraft for which the aircraft stand is intended, preferably without selective operation.*

5.3.21.9 If selective operation is required to prepare the system for use by a particular type of aircraft, then the system shall provide an identification of the selected aircraft type to both the pilot and the system operator as a means of ensuring that the system has been set properly.

Azimuth guidance unit

Location

5.3.21.10 The azimuth guidance unit shall be located on or close to the extension of the stand centre line ahead of the aircraft so that its signals are visible from the cockpit of an aircraft throughout the docking manoeuvre and aligned for use at least by the pilot occupying the left seat.

5.3.21.11 **Recommendation.—** *The azimuth guidance unit should be aligned for use by the pilots occupying both the left and right seats.*

Characteristics

5.3.21.12 The azimuth guidance unit shall provide unambiguous left/right guidance which enables the pilot to acquire and maintain the lead-in line without overcontrolling.

5.3.21.13 When azimuth guidance is indicated by colour change, green shall be used to identify the centre line and red for deviations from the centre line.

Stopping position indicator

Location

5.3.21.14 The stopping position indicator shall be located in conjunction with, or sufficiently close to, the azimuth guidance unit so that a pilot can observe both the azimuth and stop signals without turning the head.

5.3.21.15 The stopping position indicator shall be usable at least by the pilot occupying the left seat.

5.3.21.16 **Recommendation.—** *The stopping position indicator should be usable by the pilots occupying both the left and right seats.*

Characteristics

5.3.21.17 The stopping position information provided by the indicator for a particular aircraft type shall account for the anticipated range of variations in pilot eye height and/or viewing angle.

5.3.21.18 The stopping position indicator shall show the stopping position for the aircraft for which guidance is being provided, and shall provide closing rate information to enable the pilot to gradually decelerate the aircraft to a full stop at the intended stopping position.

5.3.21.19 **Recommendation.—** *The stopping position indicator should provide closing rate information over a distance of at least 10 m.*

5.3.21.20 When stopping guidance is indicated by colour change, green shall be used to show that the aircraft can proceed and red to show that the stop point has been reached except that for a short distance prior to the stop point a third colour may be used to warn that the stopping point is close.

5.3.22 Aircraft stand manoeuvring guidance lights

Application

5.3.22.1 **Recommendation.—** *Aircraft stand manoeuvring guidance lights should be provided to facilitate the positioning of an aircraft on an aircraft stand intended for use in poor visibility conditions, unless adequate guidance is provided by other means.*

Location

5.3.22.2 Aircraft stand manoeuvring guidance lights shall be collocated with the aircraft stand markings.

Characteristics

5.3.22.3 Aircraft stand manoeuvring guidance lights, other than those indicating a stop position, shall be fixed yellow lights, visible throughout the segments within which they are intended to provide guidance.

5.3.22.4 **Recommendation.—** *The lights used to delineate lead-in, turning and lead-out lines should be spaced at intervals of not more than 7.5 m on curves and 15 m on straight sections.*

5.3.22.5 The lights indicating a stop position shall be fixed, unidirectional lights, showing red.

5.3.22.6 **Recommendation.—** *The intensity of the lights should be adequate for the condition of visibility and ambient light in which the use of the aircraft stand is intended.*

5.3.22.7 **Recommendation.—** *The lighting circuit should be designed so that the lights may be switched on to indicate that an aircraft stand is to be used and switched off to indicate that it is not to be used.*

5.3.23 Road-holding position light

Application

5.3.23.1 A road-holding position light shall be provided at each road-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions less than a value of 350 m.

5.3.23.2 **Recommendation.—** *A road-holding position light should be provided at each road-holding position serving a runway when it is intended that the runway will be used in runway visual range conditions of values between 350 m and 550 m.*

Location

5.3.23.3 A road-holding position light shall be located adjacent to the holding position marking 1.5 m (± 0.5 m) from one edge of the road, i.e. left or right as appropriate to the local traffic regulations.

Note.— See 8.7.2 to 8.7.4 for the mass and height limitations and frangibility requirements of navigation aids located on runway strips.

Characteristics

5.3.23.4 The road-holding position light shall comprise:

a) a controllable red (stop)/green (go) traffic light; or

b) a flashing-red light.

Note.— It is intended that the lights specified in subparagraph a) be controlled by the air traffic services.

5.3.23.5 The road-holding position light beam shall be unidirectional and aligned so as to be visible to the driver of a vehicle approaching the holding position.

5.3.23.6 The intensity of the light beam shall be adequate for the conditions of visibility and ambient light in which the use of the holding position is intended, but shall not dazzle the driver.

Note.— The commonly used traffic lights are likely to meet the requirements in 5.3.23.5 and 5.3.23.6.

5.3.23.7 The flash frequency of the flashing-red light shall be between 30 and 60 per minute.

5.4 Signs

5.4.1 General

Note.— Guidance on signs is contained in the Aerodrome Design Manual, *Part 4.*

Application

5.4.1.1 Signs shall be provided to convey a mandatory instruction, information on a specific location or destination on a movement area or to provide other information to meet the requirements of 8.9.1.

Note.— See 5.2.15 for specifications on information marking.

Characteristics

5.4.1.2 Signs shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and the engine pods of jet aircraft. The installed height of the sign shall not exceed the dimension shown in the appropriate column of Table 5-4.

5.4.1.3 Signs shall be rectangular, as shown in Figures 5-20 and 5-21 with the longer side horizontal.

5.4.1.4 The only signs on the movement area utilizing red shall be mandatory instruction signs.

5.4.1.5 The inscriptions on a sign shall be in accordance with the provisions of Appendix 4.

5.4.1.6 Signs shall be illuminated in accordance with the provisions of Appendix 4 when intended for use:

a) in runway visual range conditions less than a value of 800 m; or

b) at night in association with instrument runways; or

c) at night in association with non-instrument runways where the code number is 3 or 4.

5.4.1.7 Signs shall be retroreflective and/or illuminated in accordance with the provisions of Appendix 4 when intended for use at night in association with non-instrument runways where the code number is 1 or 2.

5.4.2 Mandatory instruction signs

Note.— See Figure 5-20 for pictorial representation of mandatory instruction signs and Figure 5-22 for examples of locating signs at taxiway/runway intersections.

Application

5.4.2.1 A mandatory instruction sign shall be provided to identify a location beyond which an aircraft taxiing or vehicle shall not proceed unless authorized by the aerodrome control tower.

5.4.2.2 Mandatory instruction signs shall include runway designation signs, category I, II or III holding position signs, taxi-holding position signs, road-holding position signs and NO ENTRY signs.

Note.— See 5.4.7 for specifications on road-holding position signs.

5.4.2.3 A pattern "A" taxi-holding position marking shall be supplemented at a taxiway/runway intersection or a runway/runway intersection with a runway designation sign.

5.4.2.4 A pattern "B" taxi-holding position marking shall be supplemented with a category I, II or III holding position sign.

Note.— See 5.2.9 for taxi-holding position marking.

5.4.2.5 **Recommendation.—** *A runway designation sign at a taxiway/runway intersection should be supplemented with a location sign in the outboard (farthest from the taxiway) position, as appropriate.*

Note.— See 5.4.3 for characteristics of location signs.

5.4.2.6 A NO ENTRY sign shall be provided when entry into an area is prohibited.

Location

5.4.2.7 A runway designation sign at a taxiway/runway intersection shall be located at least on the left side of a taxiway facing the direction of approach to the runway. Where practicable a runway designation sign shall be located on each side of the taxiway.

5.4.2.8 A NO ENTRY sign shall be located at the beginning of the area to which entrance is prohibited at least on the left-hand side of the taxiway as viewed by the pilot. Where practicable, a NO ENTRY sign shall be located on each side of the taxiway.

5.4.2.9 A category I, II or III holding position sign shall be located on each side of the holding position marking facing the direction of the approach to the critical area.

5.4.2.10 A taxi-holding position sign shall be located at least on the left-side of the taxi-holding position established in accordance with 3.11.3, facing the approach to the obstacle limitation surface or ILS/MLS critical/sensitive area, as appropriate. Where practicable, a holding position sign shall be located on each side of the taxi-holding position.

Table 5-4. Location distances for taxiing guidance signs including runway exit signs

Code number	Sign height (mm) Legend	Face (min.)	Installed (max.)	Perpendicular distance from defined taxiway pavement edge to near side of sign	Perpendicular distance from defined runway pavement edge to near side of sign
1 or 2	200	400	700	5-11 m	3-10 m
1 or 2	300	600	900	5-11 m	3-10 m
3 or 4	300	600	900	11-21 m	8-15 m
3 or 4	400	800	1 100	11-21 m	8-15 m

Characteristics

5.4.2.11 A mandatory instruction sign shall consist of an inscription in white on a red background.

5.4.2.12 The inscription on a runway designation sign shall consist of the runway designations of the intersecting runway properly oriented with respect to the viewing position of the sign, except that a runway designation sign installed in the vicinity of a runway extremity may show the runway designation of the concerned runway extremity only.

5.4.2.13 The inscription on a NO ENTRY sign shall be in accordance with Figure 5-20.

5.4.2.14 The inscription on a category I, II, III or joint II/III holding position sign shall consist of the runway designator followed by CAT I, CAT II, CAT III or CAT II/III, as appropriate.

5.4.2.15 The inscription on a taxi-holding position sign established in accordance with 3.11.3 shall consist of the taxiway designation and a number.

5.4.2.16 Where appropriate, the following inscriptions/symbol shall be used:

Inscription/ symbol	*Use*
25 CAT I (Example)	To indicate a category I taxi-holding position at the threshold of runway 25
25 CAT II (Example)	To indicate a category II taxi-holding position at the threshold of runway 25
25 CAT III (Example)	To indicate a category III taxi-holding position at the threshold of runway 25
25 CAT II/III (Example)	To indicate a joint category II/III taxi-holding position at the threshold of runway 25
NO ENTRY symbol	To indicate that entry to an area is prohibited
Runway designation of a runway extremity	To indicate a taxi-holding position at a runway extremity
OR	
Runway designation of both extremities of a runway	To indicate a taxi-holding position located at other taxiway/runway intersections or runway/runway intersections
B2 (Example)	To indicate a taxi-holding position located at other than a taxiway/runway, runway/runway or taxiway/taxiway intersections

5.4.3 Information signs

Note.— See Figure 5-21 for pictorial representations of information signs.

5.4.3.1 The following specifications shall not require the replacement of existing information signs before 1 January 2001. However, any signs installed after 9 November 1995 shall conform to the specifications.

5.4.3.2 An information sign shall be provided where there is an operational need to identify by a sign, a specific location, or routing (direction or destination) information.

5.4.3.3 Information signs shall include: direction signs, location signs, destination signs, runway exit signs and runway vacated signs.

5.4.3.4 A runway exit sign shall be provided where there is an operational need to identify a runway exit.

5.4.3.5 A runway vacated sign shall be provided where the exit taxiway is not provided with taxiway centre line lights and there is a need to indicate to a pilot leaving a runway the perimeter of the ILS/MLS critical/sensitive area or the lower edge of the inner transitional surface whichever is farther from the runway centre line.

Note.— See 5.3.15 for specifications on colour coding taxiway centre line lights.

5.4.3.6 **Recommendation.—** *Where necessary, a destination sign should be provided to indicate the direction to a specific destination on the aerodrome, such as cargo area, general aviation, etc.*

5.4.3.7 A combined location and direction sign shall be provided when it is intended to indicate routing information prior to a taxiway intersection.

5.4.3.8 A direction sign shall be provided when there is an operational need to identify the designation and direction of taxiways at an intersection.

5.4.3.9 A location sign shall be provided in conjunction with a runway designation sign except at a runway/runway intersection.

5.4.3.10 A location sign shall be provided in conjunction with a direction sign, except that it may be omitted where an aeronautical study indicates that it is not needed.

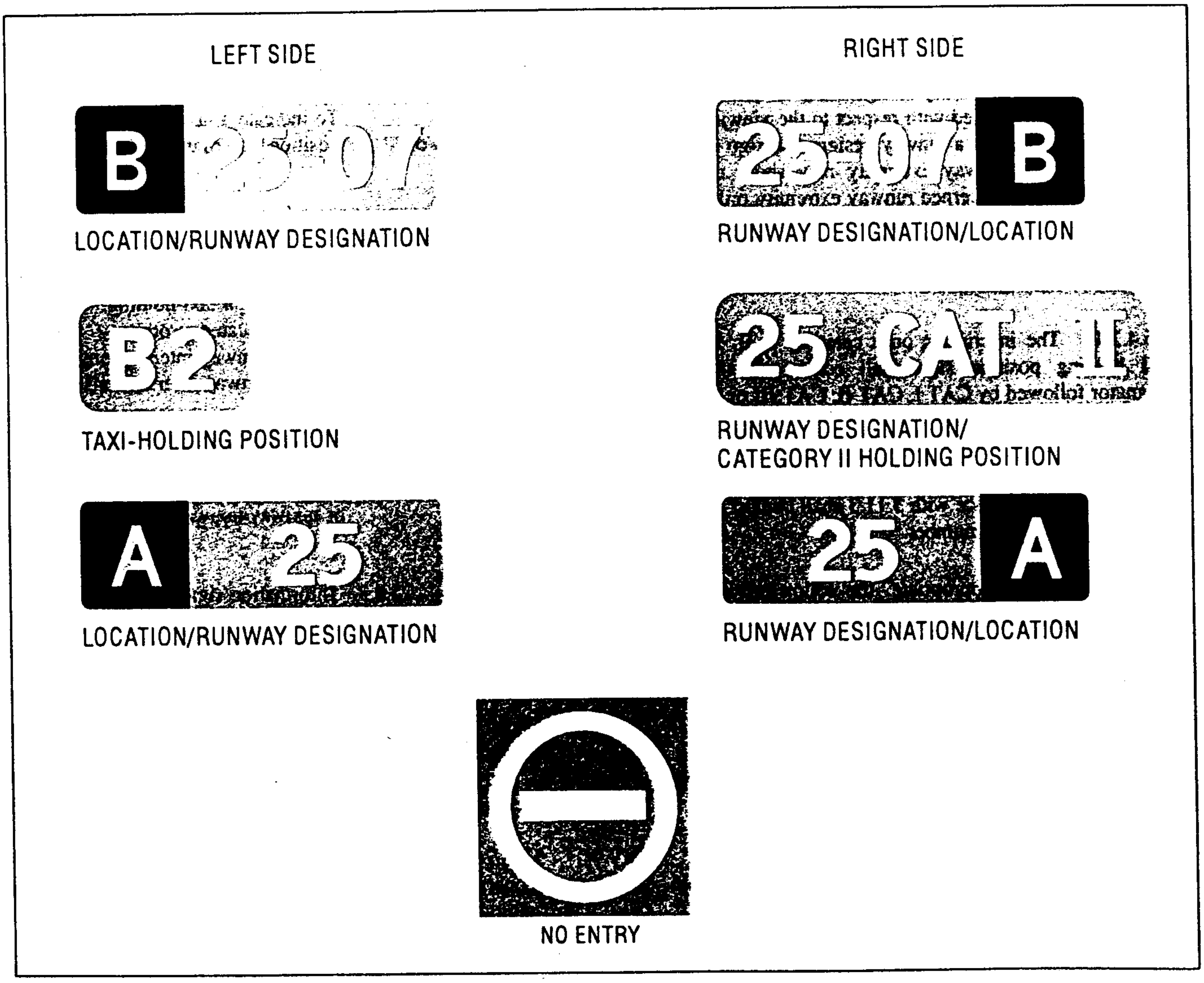


Figure 5-20. Mandatory instruction signs

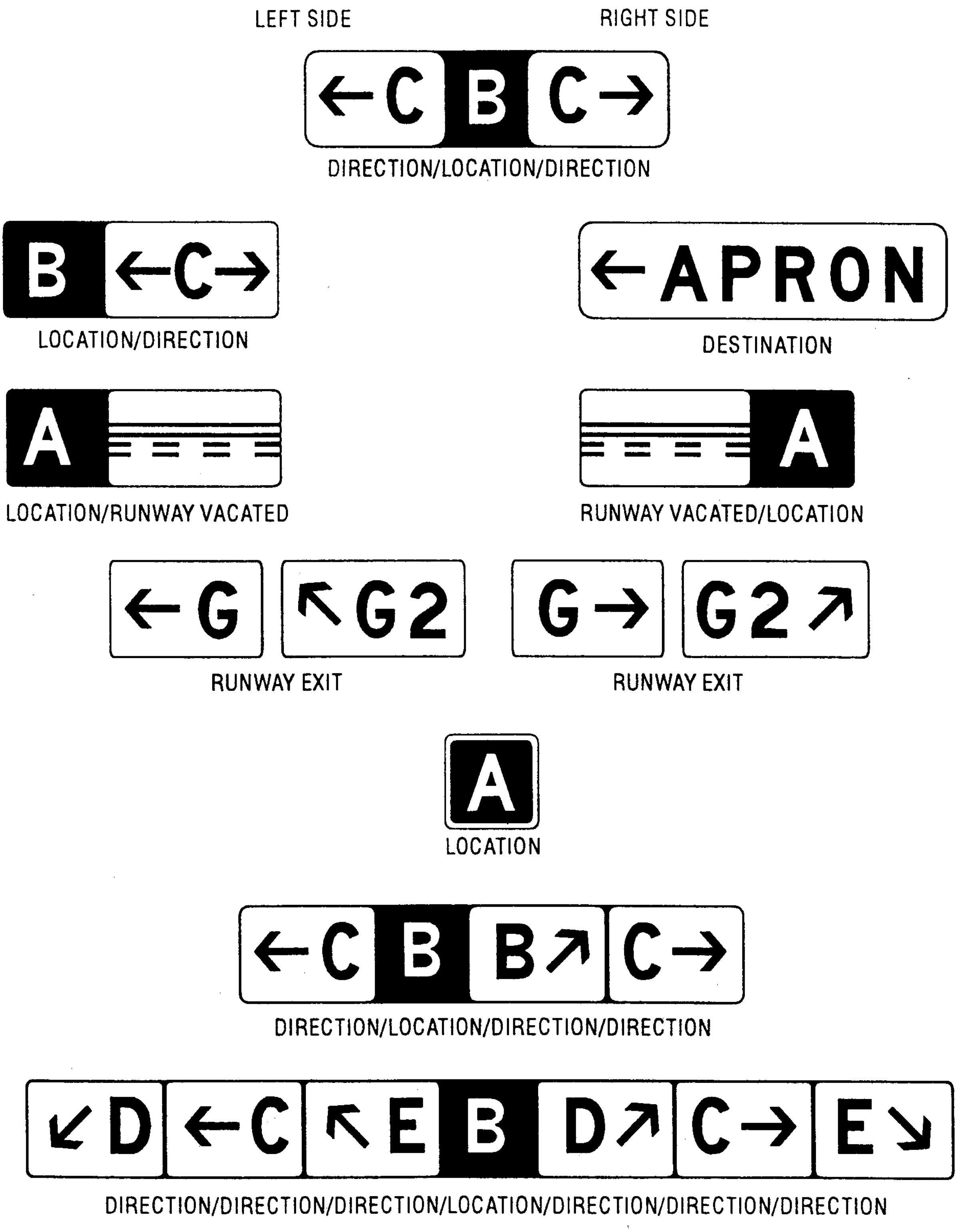
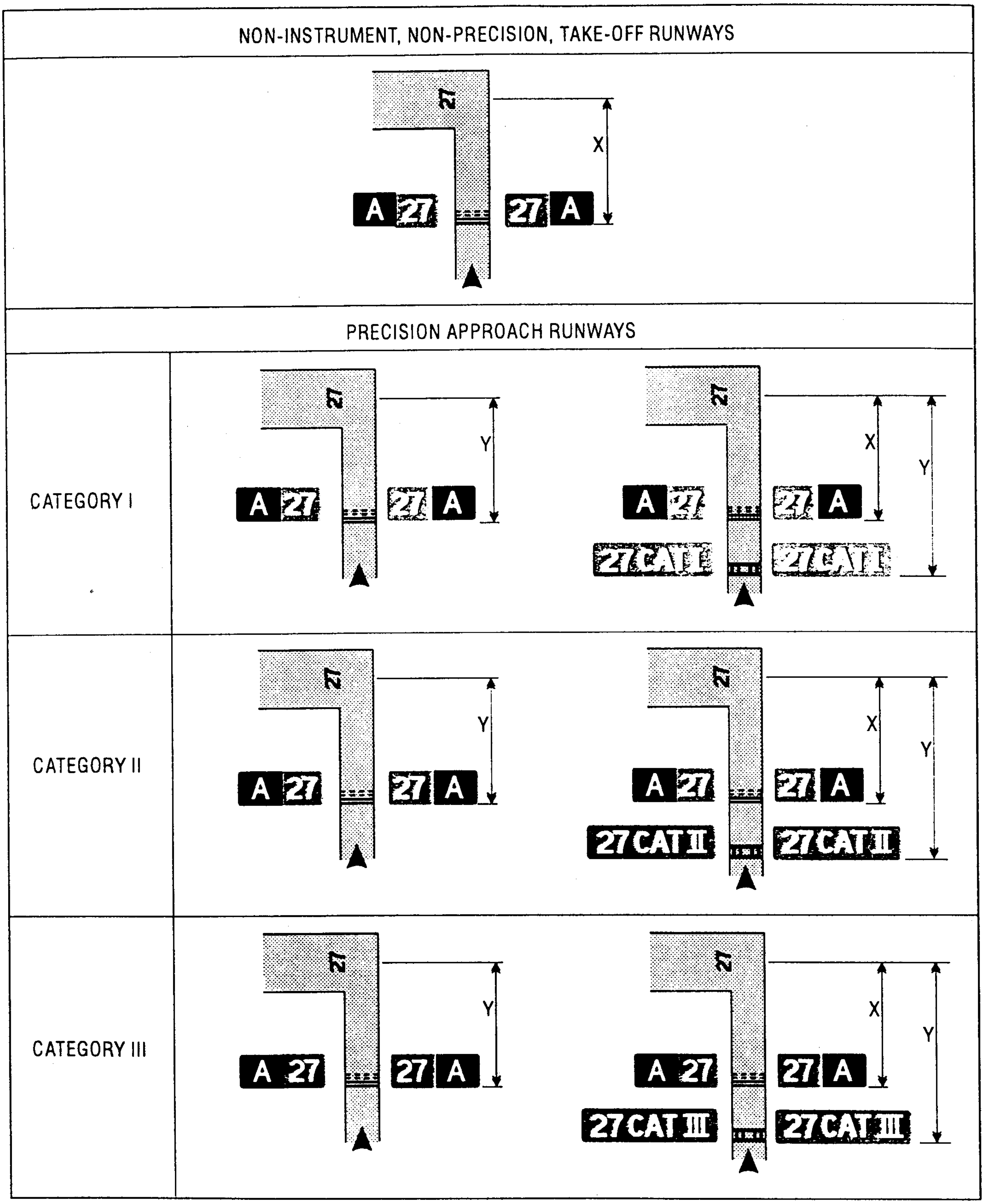


Figure 5-21. Information signs



Note: Distance X is established in accordance with Table 3-2. Distance Y is established at the edge of the ILS/MLS critical/sensitive area.

Figure 5-22. Examples of sign positions at taxiway/runway intersections

5.4.3.11 **Recommendation.—** *Where necessary, a location sign should be provided to identify taxiways exiting an apron or taxiways beyond an intersection.*

5.4.3.12 **Recommendation.—** *Where a taxiway ends at an intersection such as a "T" and it is necessary to identify this, a barricade, direction sign and/or other appropriate visual aid should be used.*

Location

5.4.3.13 Except as specified in 5.4.3.15 and 5.4.3.22 information signs shall, wherever practicable, be located on the left-hand side of the taxiway in accordance with Table 5-4.

5.4.3.14 At a taxiway intersection, information signs shall be located prior to the intersection and in line with the taxiway intersection marking. Where there is no taxiway intersection marking, the signs shall be installed at least 60 m from the centre line of the intersecting taxiway where the code number is 3 or 4 and at least 40 m where the code number is 1 or 2.

Note.— A location sign installed beyond a taxiway intersection may be installed on either side of a taxiway.

5.4.3.15 A runway exit sign shall be located on the same side of the runway as the exit is located (i.e. left or right) and positioned in accordance with Table 5-4.

5.4.3.16 A runway exit sign shall be located prior to the runway exit point in line with a position at least 60 m prior to the point of tangency where the code number is 3 or 4, and at least 30 m where the code number is 1 or 2.

5.4.3.17 A runway vacated sign shall be located at least on one side of the taxiway. The distance between the sign and the centre line of a runway shall be not less than the greater of the following:

a) the distance between the centre line of the runway and the perimeter of the ILS/MLS critical/sensitive area; or

b) the distance between the centre line of the runway and the lower edge of the inner transitional surface.

5.4.3.18 Where provided in conjunction with a runway vacated sign, the taxiway location sign shall be positioned outboard of the runway vacated sign.

5.4.3.19 A taxiway location sign installed in conjunction with a runway designation sign shall be positioned outboard of the runway designation sign.

5.4.3.20 **Recommendation.—** *A destination sign should not normally be collocated with a location or direction sign.*

5.4.3.21 An information sign other than a location sign shall not be collocated with a mandatory instruction sign.

5.4.3.22 **Recommendation.—** *A direction sign, barricade and/or other appropriate visual aid used to identify a "T" intersection should be located on the opposite side of the intersection facing the taxiway.*

Characteristics

5.4.3.23 An information sign other than a location sign shall consist of an inscription in black on a yellow background.

5.4.3.24 A location sign shall consist of an inscription in yellow on a black background and where it is a stand-alone sign shall have a yellow border.

5.4.3.25 The inscription on a runway exit sign shall consist of the designator of the exit taxiway and an arrow indicating the direction to follow.

5.4.3.26 The inscription on a runway vacated sign shall depict the pattern A taxi-holding position marking as shown in Figure 5-21.

5.4.3.27 The inscription on a destination sign shall comprise an alpha, alphanumerical or numerical message identifying the destination plus an arrow indicating the direction to proceed as shown in Figure 5-21.

5.4.3.28 The inscription on a direction sign shall comprise an alpha or alphanumerical message identifying the taxiway(s) plus an arrow or arrows appropriately oriented as shown in Figure 5-21.

5.4.3.29 The inscription on a location sign shall comprise the designation of the location taxiway, runway or other pavement the aircraft is on or is entering and shall not contain arrows.

5.4.3.30 **Recommendation.—** *Where it is necessary to identify each of a series of taxi-holding positions on the same taxiway, the location sign should consist of the taxiway designation and a number.*

5.4.3.31 Where a location sign and direction signs are used in combination:

a) all direction signs related to left turns shall be placed on the left side of the location sign and all direction signs related to right turns shall be placed on the right side of the location sign, except that where the junction consists of one intersecting taxiway, the location sign may alternatively be placed on the left hand side;

b) the direction signs shall be placed such that the direction of the arrows departs increasingly from the vertical with increasing deviation of the corresponding taxiway;

c) an appropriate direction sign shall be placed next to the location sign where the direction of the location taxiway changes significantly beyond the intersection; and

d) adjacent direction signs shall be delineated by a vertical black line as shown in Figure 5-21.

5.4.3.32 A taxiway shall be identified by a designator comprising a letter, letters or a combination of a letter or letters followed by a number.

5.4.3.33 **Recommendation.—** *When designating taxiways, the use of the letters I, O or X and the use of words such as inner and outer should be avoided wherever possible to avoid confusion with the numerals 1, 0 and closed marking.*

5.4.3.34 The use of numbers alone on the manoeuvring area shall be reserved for the designation of runways.

5.4.4 VOR aerodrome check-point sign

Application

5.4.4.1 When a VOR aerodrome check-point is established, it shall be indicated by a VOR aerodrome check-point marking and sign.

Note.— See 5.2.11 for VOR aerodrome check-point marking.

Location

5.4.4.2 A VOR aerodrome check-point sign shall be located as near as possible to the check-point and so that the inscriptions are visible from the cockpit of an aircraft properly positioned on the VOR aerodrome check-point marking.

Characteristics

5.4.4.3 A VOR aerodrome check-point sign shall consist of an inscription in black on a yellow background.

5.4.4.4 **Recommendation.—** *The inscriptions on a VOR check-point sign should be in accordance with one of the alternatives shown in Figure 5-23 in which:*

VOR — *is an abbreviation identifying this as a VOR check-point;*

116.3 — *is an example of the radio frequency of the VOR concerned;*

147° — *is an example of the VOR bearing, to the nearest degree, which should be indicated at the VOR check-point; and*

4.3 NM — *is an example of the distance in nautical miles to a DME collocated with the VOR concerned.*

Note.— Tolerances for the bearing value shown on the sign are given in Annex 10, Volume I, Attachment E to Part I. It will be noted that a check-point can only be used operationally when periodic checks show it to be consistently within ±2 degrees of the stated bearing.

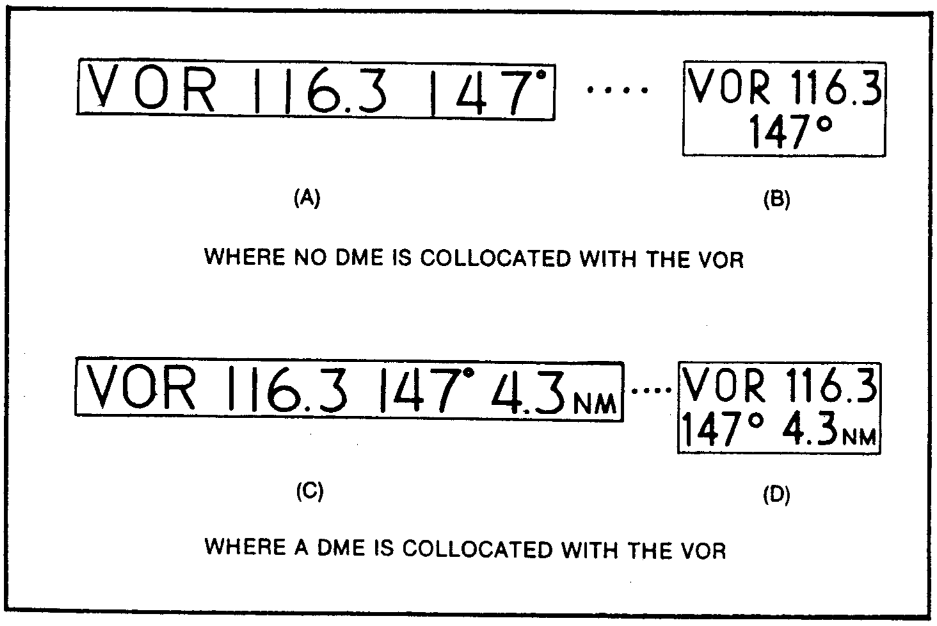


Figure 5-23. VOR aerodrome check-point sign

5.4.5 Aerodrome identification sign

Application

5.4.5.1 **Recommendation.—** *An aerodrome identification sign should be provided at an aerodrome where there is insufficient alternative means of visual identification.*

Location

5.4.5.2 **Recommendation.—** *The aerodrome identification sign should be placed on the aerodrome so as to be legible, in so far as is practicable, at all angles above the horizontal.*

Characteristics

5.4.5.3 The aerodrome identification sign shall consist of the name of the aerodrome.

5.4.5.4 **Recommendation.—** *The colour selected for the sign should give adequate conspicuity when viewed against its background.*

5.4.5.5 **Recommendation.—** *The characters should have a height of not less than 3 m.*

5.4.6 Aircraft stand identification signs

Application

5.4.6.1 **Recommendation.—** *An aircraft stand identification marking should be supplemented with an aircraft stand identification sign where feasible.*

Location

5.4.6.2 **Recommendation.—** *An aircraft stand identification sign should be located so as to be clearly visible from the cockpit of an aircraft prior to entering the aircraft stand.*

Characteristics

5.4.6.3 **Recommendation.—** *An aircraft stand identification sign should consist of an inscription in black on a yellow background.*

5.4.7 Road-holding position sign

5.4.7.1 A road-holding position sign shall be provided at all road entrances to a runway.

Location

5.4.7.2 The road-holding position sign shall be located 1.5 m from one edge of the road (left or right as appropriate to the local traffic regulations) at the holding position.

Characteristics

5.4.7.3 A road-holding position sign shall consist of an inscription in white on a red background.

5.4.7.4 The inscription on a road-holding position sign shall be in the national language, be in conformity with the local traffic regulations and include the following:

a) a requirement to stop; and

b) where appropriate:

1) a requirement to obtain ATC clearance; and

2) location designator.

Note.— Examples of road-holding position signs are contained in the Aerodrome Design Manual, *Part 4.*

5.4.7.5 A road-holding position sign intended for night use shall be retroreflective or illuminated.

5.5 Markers

5.5.1 General

Markers shall be frangible. Those located near a runway or taxiway shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

Note 1.— Anchors or chains, to prevent markers which have broken from their mounting from blowing away, are sometimes used.

Note 2.— Guidance on frangibility of markers is given in the Aerodrome Design Manual, *Part 6 (in preparation).*

5.5.2 Unpaved runway edge markers

Application

5.5.2.1 **Recommendation.—** *Markers should be provided when the extent of an unpaved runway is not clearly indicated by the appearance of its surface compared with that of the surrounding ground.*

Location

5.5.2.2 **Recommendation.—** *Where runway lights are provided, the markers should be incorporated in the light fixtures. Where there are no lights, markers of flat rectangular or conical shape should be placed so as to delimit the runway clearly.*

Characteristics

5.5.2.3 **Recommendation.—** *The flat rectangular markers should have a minimum size of 1 m by 3 m and should be placed with their long dimension parallel to the runway centre line. The conical markers should have a height not exceeding 50 cm.*

5.5.3 Stopway edge markers

Application

5.5.3.1 **Recommendation.—** *Stopway edge markers should be provided when the extent of a stopway is not clearly indicated by its appearance compared with that of the surrounding ground.*

Characteristics

5.5.3.2 The stopway edge markers shall be sufficiently different from any runway edge markers used to ensure that the two types of markers cannot be confused.

Note.— Markers consisting of small vertical boards camouflaged on the reverse side, as viewed from the runway, have proved operationally acceptable.

5.5.4 Edge markers for snow-covered runways

Application

5.5.4.1 **Recommendation.—** *Edge markers for snow-covered runways should be used to indicate the usable limits of a snow-covered runway when the limits are not otherwise indicated.*

Note.— Runway lights could be used to indicate the limits.

Location

5.5.4.2 **Recommendation.—** *Edge markers for snow-covered runways should be placed along the sides of the runway at intervals of not more than 100 m, and should be located symmetrically about the runway centre line at such a distance from the centre line that there is adequate clearance for wing tips and power plants. Sufficient markers should be placed across the threshold and end of the runway.*

Characteristics

5.5.4.3 **Recommendation.—** *Edge markers for snow-covered runways should consist of conspicuous objects such as evergreen trees about 1.5 m high, or light-weight markers.*

5.5.5 Taxiway edge markers

Application

5.5.5.1 **Recommendation.—** *Taxiway edge markers should be provided on a taxiway where the code number is 1 or 2 and taxiway centre line or edge lights or taxiway centre line markers are not provided.*

Location

5.5.5.2 **Recommendation.—** *Taxiway edge markers should be installed at least at the same locations as would the taxiway edge lights had they been used.*

Characteristics

5.5.5.3 A taxiway edge marker shall be retroreflective blue.

5.5.5.4 **Recommendation.—** *The marked surface as viewed by the pilot should be a rectangle and should have a minimum viewing area of 150 cm^2.*

5.5.5.5 Taxiway edge markers shall be frangible. Their height shall be sufficiently low to preserve clearance for propellers and for the engine pods of jet aircraft.

5.5.6 Taxiway centre line markers

Application

5.5.6.1 **Recommendation.—** *Taxiway centre line markers should be provided on a taxiway where the code number is 1 or 2 and taxiway centre line or edge lights or taxiway edge markers are not provided.*

5.5.6.2 **Recommendation.—** *Taxiway centre line markers should be provided on a taxiway where the code number is 3 or 4 and taxiway centre line lights are not provided if there is a need to improve the guidance provided by the taxiway centre line marking.*

Location

5.5.6.3 **Recommendation.—** *Taxiway centre line markers should be installed at least at the same location as would taxiway centre line lights had they been used.*

Note.— See 5.3.15.8 for the spacing of taxiway centre line lights.

5.5.6.4 **Recommendation.—** *Taxiway centre line markers should normally be located on the taxiway centre line marking except that they may be offset by not more than 30 cm where it is not practicable to locate them on the marking.*

Characteristics

5.5.6.5 A taxiway centre line marker shall be retro-reflective green.

5.5.6.6 **Recommendation.—** *The marked surface as viewed by the pilot should be a rectangle and should have a minimum viewing area of 20 cm².*

5.5.6.7 Taxiway centre line markers shall be so designed and fitted as to withstand being run over by the wheels of an aircraft without damage either to the aircraft or to the markers themselves.

5.5.7 Unpaved taxiway edge markers

Application

5.5.7.1 **Recommendation.—** *Where the extent of an unpaved taxiway is not clearly indicated by its appearance compared with that of the surrounding ground, markers should be provided.*

Location

5.5.7.2 **Recommendation.—** *Where taxiway lights are provided, the markers should be incorporated in the light fixtures. Where there are no lights, markers of conical shape should be placed so as to delimit the taxiway clearly.*

5.5.8 Boundary markers

Application

5.5.8.1 Boundary markers shall be provided at an aerodrome where the landing area has no runway.

Location

5.5.8.2 Boundary markers shall be spaced along the boundary of the landing area at intervals of not more than 200 m, if the type shown in Figure 5-24 is used, or approximately 90 m, if the conical type is used with a marker at any corner.

Characteristics

5.5.8.3 **Recommendation.—** *Boundary markers should be of a form similar to that shown in Figure 5-24, or in the form of a cone not less than 50 cm high and not less than 75 cm in diameter at the base. The markers should be coloured to contrast with the background against which they will be seen. A single colour, orange or red, or two contrasting colours, orange and white or alternatively red and white, should be used, except where such colours merge with the background.*

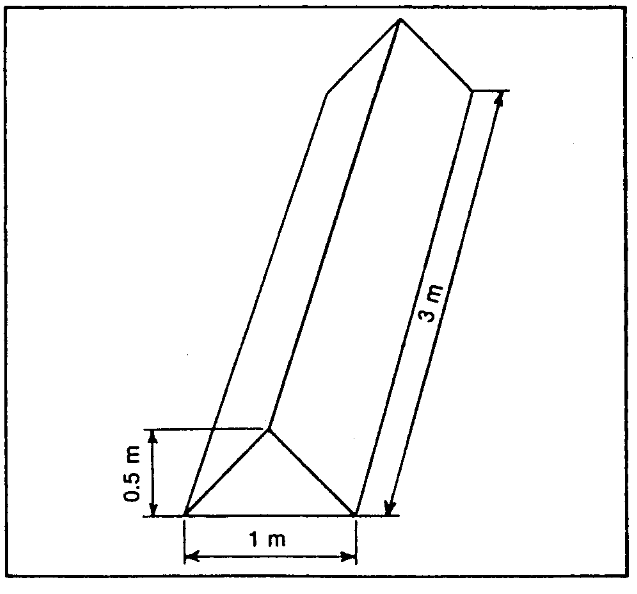


Figure 5-24. Boundary markers

CHAPTER 6. VISUAL AIDS FOR DENOTING OBSTACLES

6.1 Objects to be marked and/or lighted

Note.— The marking and/or lighting of obstacles is intended to reduce hazards to aircraft by indicating the presence of the obstacles. It does not necessarily reduce operating limitations which may be imposed by an obstacle.

6.1.1 **Recommendation.—** *A fixed obstacle that extends above a take-off climb surface within 3 000 m of the inner edge should be marked and, if the runway is used at night, lighted, except that:*

a) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;

b) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

c) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.2 **Recommendation.—** *A fixed object, other than an obstacle, adjacent to a take-off climb surface should be marked and, if the runway is used at night, lighted if such marking and lighting is considered necessary to ensure its avoidance, except that the marking may be omitted when the object is lighted by high-intensity obstacle lights by day.*

6.1.3 A fixed obstacle that extends above an approach or transitional surface within 3 000 m of the inner edge of the approach surface shall be marked and, if the runway is used at night, lighted, except that:

a) such marking and lighting may be omitted when the obstacle is shielded by another fixed obstacle;

b) the marking may be omitted when the obstacle is lighted by high intensity obstacle lights by day; and

c) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.4 **Recommendation.—** *A fixed obstacle above a horizontal surface should be marked and, if the aerodrome is used at night, lighted except that:*

a) such marking and lighting may be omitted when:

1) the obstacle is shielded by another fixed obstacle; or

2) for a circuit extensively obstructed by immovable objects or terrain, procedures have been established to ensure safe vertical clearance below prescribed flight paths; or

3) an aeronautical study shows the obstacle not to be of operational significance;

b) the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day; and

c) the lighting may be omitted where the obstacle is a lighthouse and an aeronautical study indicates the lighthouse light to be sufficient.

6.1.5 A fixed object that extends above an obstacle protection surface shall be marked and, if the runway is used at night, lighted.

6.1.6 Vehicles and other mobile objects, excluding aircraft, on the movement area of an aerodrome are obstacles and shall be marked and, if the vehicles and aerodrome are used at night or in conditions of low visibility, lighted, except that aircraft servicing equipment and vehicles used only on aprons may be exempt.

6.1.7 Elevated aeronautical ground lights within the movement area shall be marked so as to be conspicuous by day.

6.1.8 All obstacles within the distance specified in Table 3-1, column 11 or 12 from the centre line of a taxiway, an apron taxiway or aircraft stand taxilane shall be marked and, if the taxiway, apron taxiway or aircraft stand taxilane is used at night, lighted.

6.1.9 **Recommendation.—** *Obstacles in accordance with 4.3.2 should be marked and, if the aerodrome is used at night, lighted, except that the marking may be omitted when the obstacle is lighted by high-intensity obstacle lights by day.*

6.1.10 **Recommendation.—** *Overhead wires, cables, etc., crossing a river, valley or highway should be marked and their supporting towers marked and lighted if an aeronautical study indicates that the wires or cables could constitute a hazard to aircraft, except that the marking of the supporting towers may be omitted when they are lighted by high-intensity obstacle lights by day.*

6.1.11 **Recommendation.—** *When it has been determined that an overhead wire, cable, etc., needs to be marked* *but it is not practicable to install markers on the wire, cable, etc., then high-intensity obstacle lights should be provided on their supporting towers.*

6.2 Marking of objects

General

6.2.1 All fixed objects to be marked shall, whenever practicable, be coloured, but if this is not practicable, markers or flags shall be displayed on or above them, except that objects that are sufficiently conspicuous by their shape, size or colour need not be otherwise marked.

6.2.2 All mobile objects to be marked shall be coloured or display flags.

Use of colours

6.2.3 **Recommendation.**— *An object should be coloured to show a chequered pattern if it has essentially unbroken surfaces and its projection on any vertical plane equals or exceeds 4.5 m in both dimensions. The pattern should consist of rectangles of not less than 1.5 m and not more than 3 m on a side, the corners being of the darker colour. The colours of the pattern should contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white should be used, except where such colours merge with the background. (See Figure 6-1.)*

6.2.4 **Recommendation.**— *An object should be coloured to show alternating contrasting bands if:*

a) it has essentially unbroken surfaces and has one dimension, horizontal or vertical, greater than 1.5 m, and the other dimension, horizontal or vertical, less than 4.5 m; or

b) it is of skeletal type with either a vertical or a horizontal dimension greater than 1.5 m.

The bands should be perpendicular to the longest dimension and have a width approximately 1/7 of the longest dimension or 30 m, whichever is less. The colours of the bands should contrast with the background against which they will be seen. Orange and white should be used, except where such colours are not conspicuous when viewed against the background. The bands on the extremities of the object should be of the darker colour. (See Figures 6-1 and 6-2.)

Note.— Table 6-1 shows a formula for determining band widths and for having an odd number of bands, thus permitting both the top and bottom bands to be of the darker colour.

6.2.5 **Recommendation.**— *An object should be coloured in a single conspicuous colour if its projection on any vertical plane has both dimensions less than 1.5 m. Orange or red should be used, except where such colours merge with the background.*

Note.— Against some backgrounds it may be found necessary to use a different colour from orange or red to obtain sufficient contrast.

6.2.6 **Recommendation.**— *When mobile objects are marked by colour, a single conspicuous colour, preferably red or yellowish green for emergency vehicles and yellow for service vehicles should be used.*

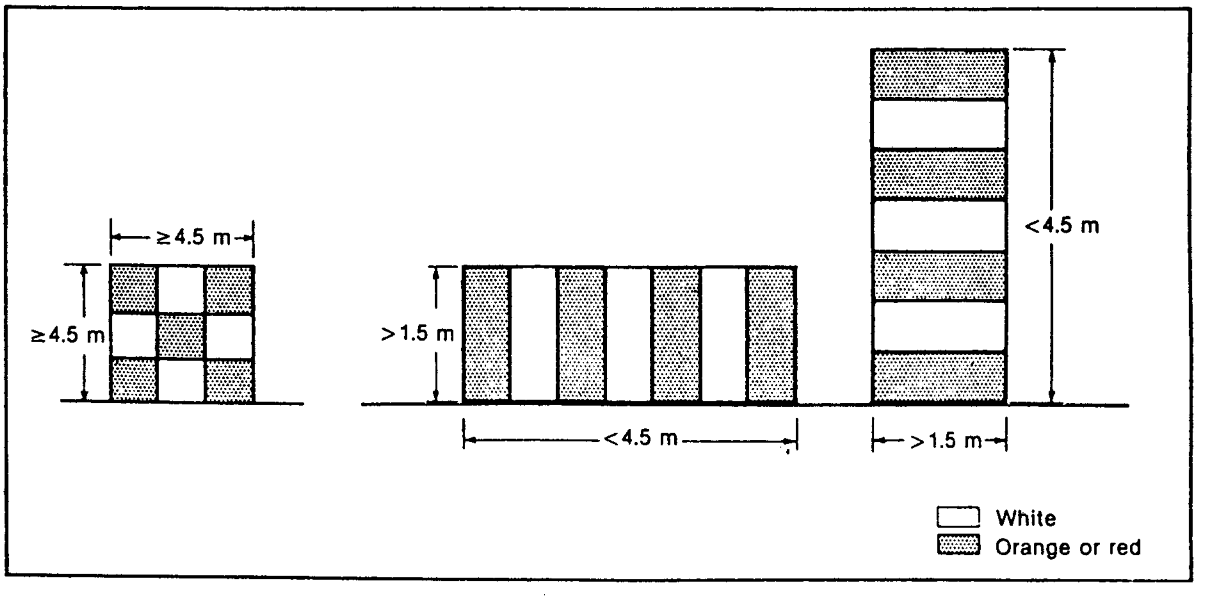


Figure 6-1. Basic marking patterns

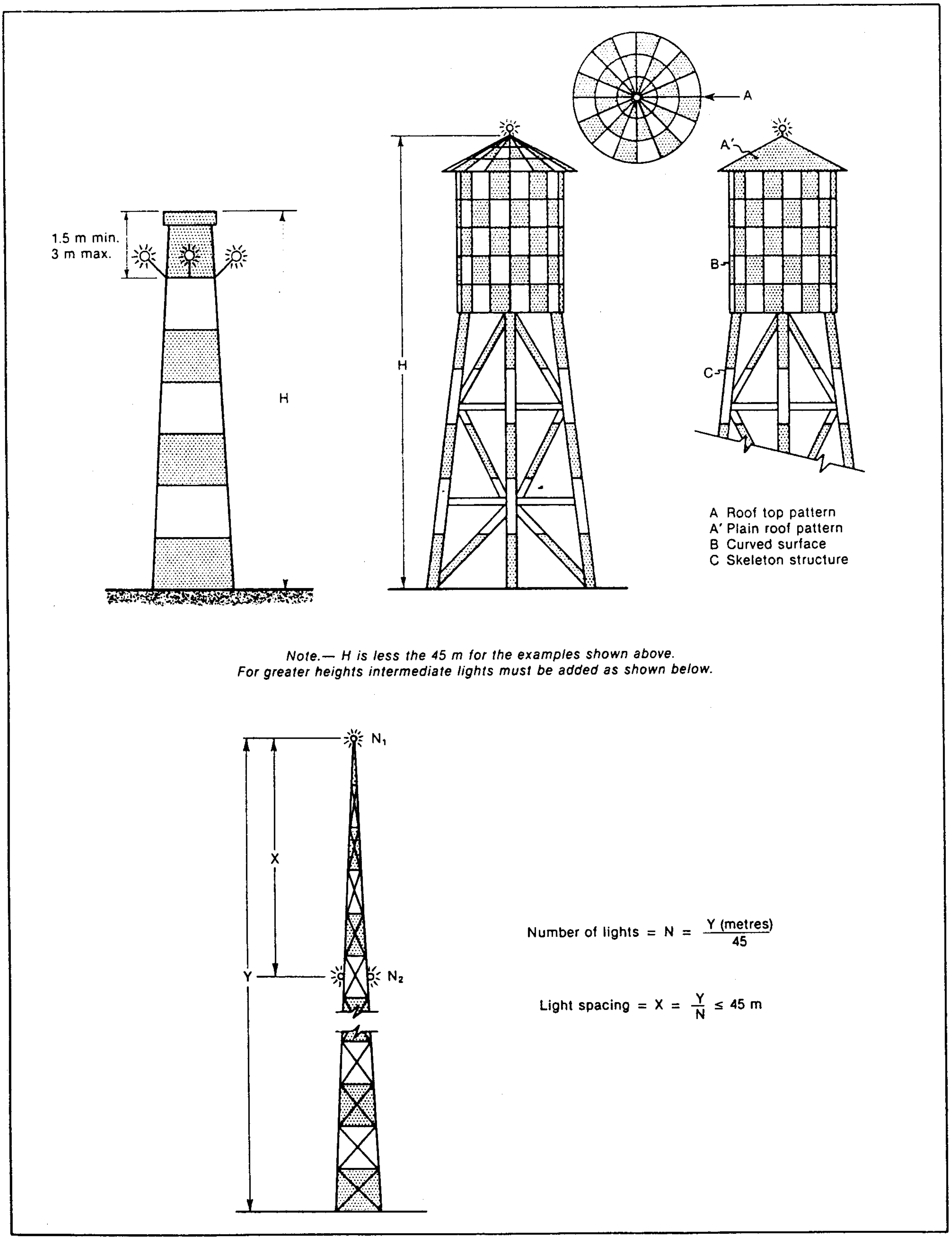


Figure 6-2. Examples of marking and lighting of tall structures

Table 6-1. Marking band widths

Longest dimension Greater than	 Not exceeding	Band width
1.5 m	210 m	1/7 of longest dimension
210 m	270 m	1/9 " " "
270 m	330 m	1/11 " " "
330 m	390 m	1/13 " " "
390 m	450 m	1/15 " " "
450 m	510 m	1/17 " " "
510 m	570 m	1/19 " " "
570 m	630 m	1/21 " " "

Use of markers

6.2.7 Markers displayed on or adjacent to objects shall be located in conspicuous positions so as to retain the general definition of the object and shall be recognizable in clear weather from a distance of at least 1 000 m for an object to be viewed from the air and 300 m for an object to be viewed from the ground in all directions in which an aircraft is likely to approach the object. The shape of markers shall be distinctive to the extent necessary to ensure that they are not mistaken for markers employed to convey other information, and they shall be such that the hazard presented by the object they mark is not increased.

6.2.8 **Recommendation.—** *A marker displayed on an overhead wire, cable, etc., should be spherical and have a diameter of not less than 60 cm.*

6.2.9 **Recommendation.—** *The spacing between two consecutive markers or between a marker and a supporting tower should be appropriate to the diameter of the marker, but in no case should the spacing exceed:*

a) 30 m where the marker diameter is 60 cm progressively increasing with the diameter of the marker to

b) 35 m where the marker diameter is 80 cm and further progressively increasing to a maximum of

c) 40 m where the marker diameter is of at least 130 cm.

Where multiple wires, cables, etc. are involved, a marker should be located not lower than the level of the highest wire at the point marked.

6.2.10 **Recommendation.—** *A marker should be of one colour. When installed, white and red, or white and orange markers should be displayed alternately. The colour selected should contrast with the background against which it will be seen.*

Use of flags

6.2.11 Flags used to mark objects shall be displayed around, on top of, or around the highest edge of, the object. When flags are used to mark extensive objects or groups of closely spaced objects, they shall be displayed at least every 15 m. Flags shall not increase the hazard presented by the object they mark.

6.2.12 Flags used to mark fixed objects shall not be less than 0.6 m square and flags used to mark mobile objects, not less than 0.9 m square.

6.2.13 **Recommendation.—** *Flags used to mark fixed objects should be orange in colour or a combination of two triangular sections, one orange and the other white, or one red and the other white, except that where such colours merge with the background, other conspicuous colours should be used.*

6.2.14 Flags used to mark mobile objects shall consist of a chequered pattern, each square having sides of not less than 0.3 m. The colours of the pattern shall contrast each with the other and with the background against which they will be seen. Orange and white or alternatively red and white shall be used, except where such colours merge with the background.

6.3 Lighting of objects

Use of obstacle lights

6.3.1 The presence of objects which must be lighted shall be indicated by low-, medium- or high-intensity obstacle lights, or a combination of such lights.

Note.— High-intensity obstacle lights are intended for day use as well as night use. Care is needed to ensure that these lights do not create disconcerting dazzle. Guidance on the design, location and operation of high-intensity obstacle lights is given in the Aerodrome Design Manual, *Part 4.*

6.3.2 **Recommendation.—** *Where the use of low-intensity obstacle lights would be inadequate or an early special warning is required, then medium- or high-intensity obstacle lights should be used.*

6.3.3 **Recommendation.—** *Medium-intensity obstacle lights should be used, either alone or in combination with low-intensity obstacle lights, where the object is an extensive one or its height above the level of the surrounding ground is greater than 45 m.*

Note.— A group of trees or buildings is regarded as an extensive object.

6.3.4 **Recommendation.—** *High-intensity obstacle lights, Type A, should be used to indicate the presence of an object if* *its height above the level of the surrounding ground exceeds 150 m and an aeronautical study indicates such lights to be essential for the recognition of the object by day.*

6.3.5 **Recommendation.—** *High-intensity obstacle lights, Type B, should be used to indicate the presence of a tower supporting overhead wires, cables, etc. where:*

— *an aeronautical study indicates such lights to be essential for the recognition of the presence of wires, cables, etc; or*

— *it has not been found practicable to install markers on the wires, cables, etc.*

Location of obstacle lights

6.3.6 One or more low-, medium- or high-intensity obstacle lights shall be located as close as practicable to the top of the object. The top lights shall be so arranged as to at least indicate the points or edges of the object highest in relation to the obstacle limitation surface.

6.3.7 **Recommendation.—** *In the case of chimney or other structure of like function, the top lights should be placed sufficiently below the top so as to minimize contamination by smoke etc. (see Figures 6-2 and 6-3).*

6.3.8 In the case of a guyed tower or antenna where it is not possible to locate a high-intensity obstacle light on the top, such a light shall be located at the highest practicable point and a medium-intensity obstacle light, showing white, mounted on the top.

6.3.9 In the case of an extensive object or of a group of closely spaced objects, top lights shall be displayed at least on the points or edges of the objects highest in relation to the obstacle limitation surface, so as to indicate the general definition and the extent of the objects. If two or more edges are of the same height, the edge nearest the landing area shall be marked. Where low-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 45 m. Where medium-intensity lights are used, they shall be spaced at longitudinal intervals not exceeding 900 m.

6.3.10 **Recommendation.—** *When the obstacle limitation surface concerned is sloping and the highest point above the obstacle limitation surface is not the highest point of the object, additional obstacle lights should be placed on the highest point of the object.*

6.3.11 Where an object is indicated by low- or medium-intensity obstacle lights, and the top of the object is more than 45 m above the level of the surrounding ground or the elevation of tops of nearby buildings (when the object to be marked is surrounded by buildings) additional lights shall be provided at intermediate levels. These additional intermediate lights shall be spaced as equally as practicable, between the top lights and ground level or the level of tops of nearby buildings, as appropriate, with the spacing not exceeding 45 m.

6.3.12 Where high-intensity obstacle lights, Type A, are used, they shall be spaced at uniform intervals not exceeding 105 m between the ground level and the top light(s) specified in 6.3.6 except that where an object to be marked is surrounded by buildings, the elevation of the tops of the buildings may be used as the equivalent of the ground level when determining the number of light levels.

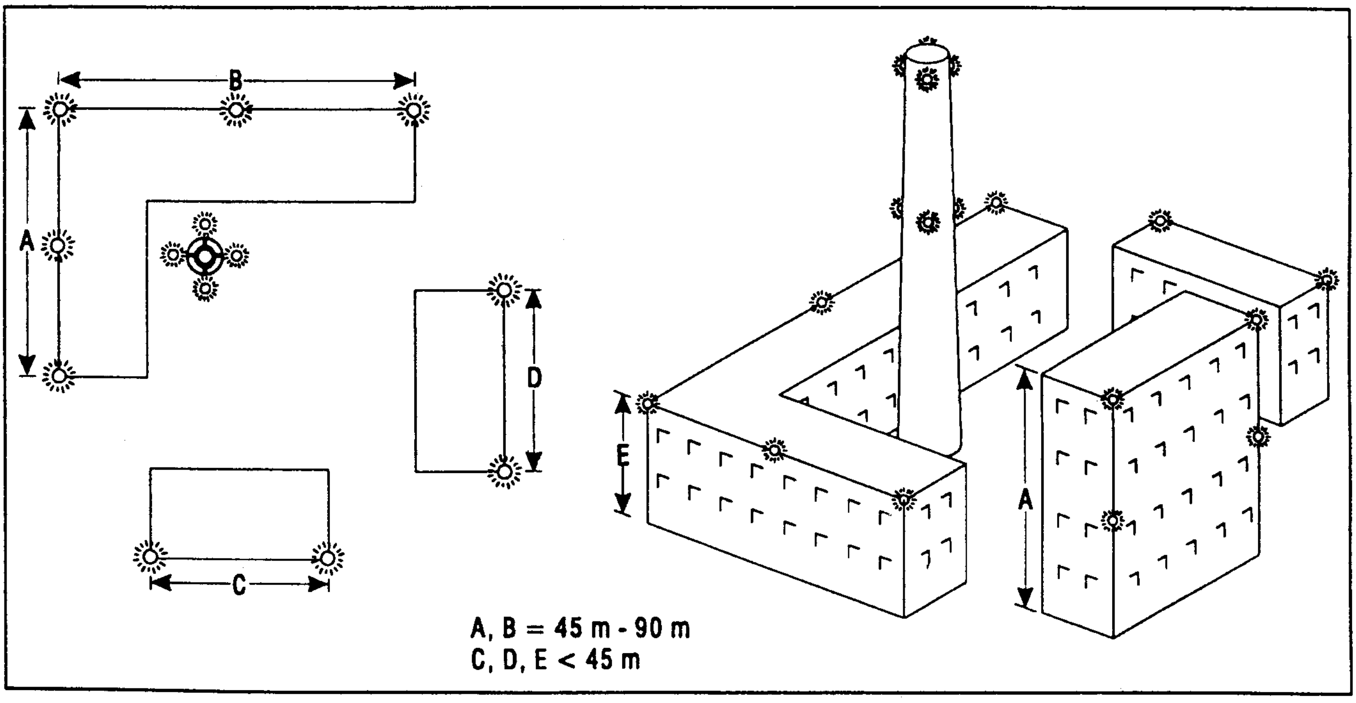


Figure 6-3. Lighting of buildings

6.3.13 Where high-intensity obstacle lights, Type B, are used, they shall be located at three levels:

— at the top of the tower;
— at the lowest level of the catenary of the wires or cables; and
— at approximately midway between these two levels.

Note.— In some cases, this may require locating the lights off the tower.

6.3.14 The number and arrangement of low-, medium- or high-intensity obstacle lights at each level to be marked shall be such that the object is indicated from every angle in azimuth. Where a light is shielded in any direction by an adjacent object, additional lights shall be provided on that object in such a way as to retain the general definition of the object to be lighted, the shielded light being omitted if it does not contribute to the definition of the object to be lighted.

Low-intensity obstacle light — Characteristics

6.3.15 Low-intensity obstacle lights on fixed objects shall be fixed red lights having an intensity sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general level of illumination against which they would normally be viewed. In no case shall the intensity be less than 10 cd of red light.

Note.— Guidance on lighting overhead high-tension wires is given in the Aerodrome Design Manual, *Part 4.*

6.3.16 Low-intensity obstacle lights displayed on vehicles associated with emergency or security shall be flashing-blue and those displayed on other vehicles shall be flashing-yellow. The flash frequency shall be between 60 and 90 per minute. The effective-intensity of the flash shall be not less than:

a) 200 cd of yellow light when displayed on follow-me vehicles; and

b) 40 cd of blue or yellow light when displayed on other vehicles.

6.3.17 Low-intensity obstacle lights on objects with limited mobility such as aerobridges shall be steady-red. The intensity of the lights shall be sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general levels of illumination against which they would normally be viewed. In no case shall the intensity be less than 10 cd of red light.

Note.— See Annex 2 for lights to be displayed by aircraft.

Medium-intensity obstacle light — Characteristics

6.3.18 Medium-intensity obstacle lights shall be flashing red lights, except that when used in conjunction with high-intensity obstacle lights they shall be flashing white lights. The flash frequency shall be between 20 and 60 per minute. The effective intensity of the flash shall be not less than 1 600 cd of red light.

6.3.19 **Recommendation.—** *Medium-intensity obstacle lights located on an object should flash simultaneously.*

High-intensity obstacle light — Characteristics

6.3.20 High-intensity obstacle lights, Types A and B, shall be flashing-white lights.

6.3.21 **Recommendation.—** *The effective intensity of a high-intensity obstacle light, Type A, should be variable and dependent on the background luminance as follows:*

Background luminance	Effective intensity
above 500 cd/m²	*200 000 ± 25% cd*
50 to 500 cd/m²	*20 000 ± 25% cd*
less than 50 cd/m²	*2 000 ± 25% cd*

6.3.22 **Recommendation.—** *The effective intensity of a high-intensity obstacle light, Type B, should be variable and dependent on the background luminance as follows:*

Background luminance	Effective intensity
above 500 cd/m²	*100 000 ± 25% cd*
50 to 500 cd/m²	*20 000 ± 25% cd*
less than 50 cd/m²	*2 000 ± 25% cd*

6.3.23 **Recommendation.—** *High-intensity obstacle lights, Type A, located on an object should flash simultaneously at a rate between 40 and 60 per minute.*

6.3.24 **Recommendation.—** *High-intensity obstacle lights, Type B, located on a tower should flash sequentially; first the middle light, second the top light and last, the bottom light. The intervals between flashes of the lights should approximate the following ratios:*

Flash interval between	Ratio of cycle time
middle and top light	*1/13*
top and bottom light	*2/13*
bottom and middle light	*10/13*

The cycle frequency should be 60 per minute.

CHAPTER 7. VISUAL AIDS FOR DENOTING RESTRICTED USE AREAS

7.1 Closed runways and taxiways, or parts thereof

Application

7.1.1 A closed marking shall be displayed on a runway or taxiway, or portion thereof, which is permanently closed to the use of all aircraft.

7.1.2 **Recommendation.—** *A closed marking should be displayed on a temporarily closed runway or taxiway or portion thereof, except that such marking may be omitted when the closing is of short duration and adequate warning by air traffic services is provided.*

Location

7.1.3 On a runway a closed marking shall be placed at each end of the runway, or portion thereof, declared closed, and additional markings shall be so placed that the maximum interval between markings does not exceed 300 m. On a taxiway a closed marking shall be placed at least at each end of the taxiway or portion thereof closed.

Characteristics

7.1.4 The closed marking shall be of the form and proportions as detailed in Figure 7-1, Illustration a), when displayed on a runway, and shall be of the form and proportions as detailed in Figure 7-1, Illustration b), when displayed on a taxiway. The marking shall be white when displayed on a runway and shall be yellow when displayed on a taxiway.

Note.— When an area is temporarily closed, frangible barriers or markings utilizing materials other than paint or other suitable means may be used to identify the closed area.

7.1.5 When a runway or taxiway or portion thereof is permanently closed, all normal runway and taxiway markings shall be obliterated.

7.1.6 Lighting on a closed runway or taxiway or portion thereof shall not be operated, except as required for maintenance purposes.

7.1.7 In addition to closed markings, when the runway or taxiway or portion thereof closed is intercepted by a usable runway or taxiway which is used at night, unserviceability lights shall be placed across the entrance to the closed area at intervals not exceeding 3 m (see 7.4.4).

7.2 Non-load-bearing surfaces

Application

7.2.1 Shoulders for taxiways, holding bays and aprons and other non-load-bearing surfaces which cannot readily be distinguished from load-bearing surfaces and which, if used by aircraft, might result in damage to the aircraft shall have the boundary between such areas and the load-bearing surface marked by a taxi side stripe marking.

Note.— The marking of runway sides is specified in 5.2.7.

Location

7.2.2 **Recommendation.—** *A taxi side stripe marking should be placed along the edge of the load-bearing pavement, with the outer edge of the marking approximately on the edge of the load-bearing pavement.*

Characteristics

7.2.3 **Recommendation.—** *A taxi side stripe marking should consist of a pair of solid lines, each 15 cm wide and spaced 15 cm apart and the same colour as the taxiway centre line marking.*

Note.— Guidance on providing additional transverse stripes at an intersection or a small area on the apron is given in the Aerodrome Design Manual, *Part 4.*

7.3 Pre-threshold area

Application

7.3.1 **Recommendation.—** *When the surface before a threshold is paved and exceeds 60 m in length and is not suitable for normal use by aircraft, the entire length before the threshold should be marked with a chevron marking.*

Location

7.3.2 **Recommendation.—** *A chevron marking should point in the direction of the runway and be placed as shown in Figure 7-2.*

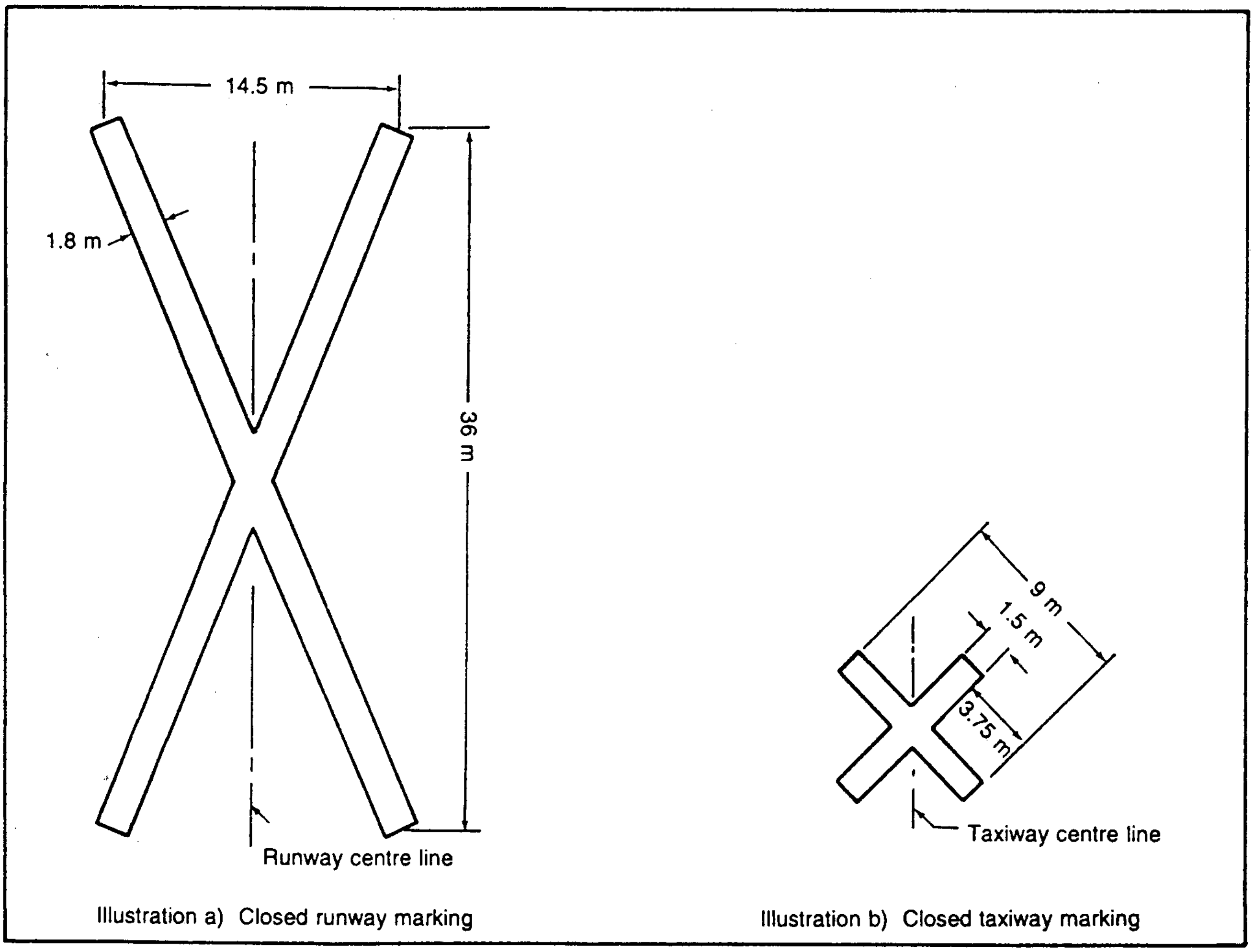


Figure 7-1. Closed runway and taxiway markings

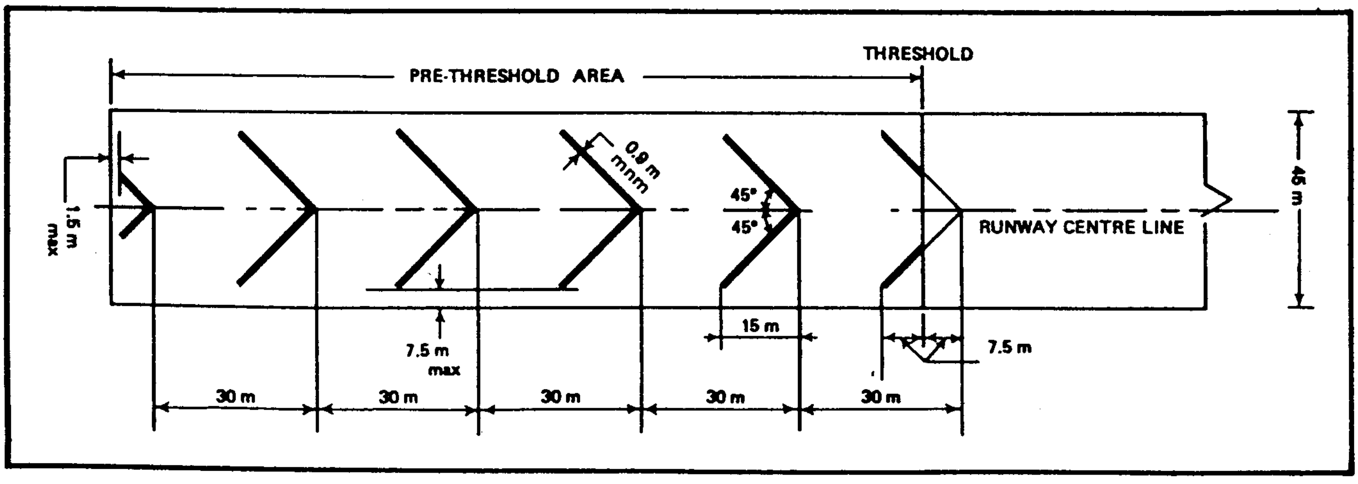


Figure 7-2. Pre-threshold marking

Characteristics

7.3.3 **Recommendation.—** *A chevron marking should be of conspicuous colour and contrast with the colour used for the runway markings; it should preferably be yellow. It should have an over-all width of at least 0.9 m.*

7.4 Unserviceable areas

Application

7.4.1 Unserviceability markers shall be displayed wherever any portion of a taxiway, apron or holding bay is unfit for the movement of aircraft but it is still possible for aircraft to bypass the area safely. On a movement area used at night, unserviceability lights shall be used.

Note.— Unserviceability markers and lights are used for such purposes as warning pilots of a hole in a taxiway or apron pavement or outlining a portion of pavement, such as on an apron, that is under repair. They are not suitable for use when a portion of a runway becomes unserviceable, nor on a taxiway when a major portion of the width becomes unserviceable. In such instances, the runway or taxiway is normally closed.

Location

7.4.2 Unserviceability markers and lights shall be placed at intervals sufficiently close so as to delineate the unserviceable area.

Note.— Guidance on the location of unserviceability lights is given in Attachment A, Section 13.

Characteristics of unserviceability markers

7.4.3 Unserviceability markers shall consist of conspicuous upstanding devices such as flags, cones or marker boards.

Characteristics of unserviceability lights

7.4.4 An unserviceability light shall consist of a red fixed light. The light shall have an intensity sufficient to ensure conspicuity considering the intensity of the adjacent lights and the general level of illumination against which it would normally be viewed. In no case shall the intensity be less than 10 cd of red light.

Characteristics of unserviceability cones

7.4.5 **Recommendation.—** *An unserviceability cone should be at least 0.5 m in height and red, orange or yellow or any one of these colours in combination with white.*

Characteristics of unserviceability flags

7.4.6 **Recommendation.—** *An unserviceability flag should be at least 0.5 m square and red, orange or yellow or any one of these colours in combination with white.*

Characteristics of unserviceability marker boards

7.4.7 **Recommendation.—** *An unserviceability marker board should be at least 0.5 m in height and 0.9 m in length, with alternate red and white or orange and white vertical stripes.*

CHAPTER 8. EQUIPMENT AND INSTALLATIONS

8.1 Secondary power supply

General

Application

8.1.1 **Recommendation.—** *A secondary power supply should be provided, capable of supplying the power requirements of at least the aerodrome facilities listed below:*

a) the signalling lamp and the minimum lighting necessary to enable air traffic services personnel to carry out their duties;

Note.— The requirement for minimum lighting may be met by other than electrical means.

b) all obstacle lights which, in the opinion of the appropriate authority, are essential to ensure the safe operation of aircraft;

c) approach, runway and taxiway lighting as specified in 8.1.5 to 8.1.8;

d) meteorological equipment;

e) essential security lighting, if provided in accordance with 8.5;

f) essential equipment and facilities for the aerodrome responding emergency agencies; and

g) floodlighting on a designated isolated aircraft parking position if provided in accordance with 5.3.20.1.

Note.— Specifications for secondary power supply for radio navigation aids and ground elements of communications systems are given in Annex 10, Volume I, Part I, Chapter 2.

Characteristics

8.1.2 **Recommendation.—** *Electric power supply connexions to those facilities for which secondary power is required should be so arranged that the facilities are automatically connected to the secondary power supply on failure of the normal source of power.*

8.1.3 **Recommendation.—** *The time interval between failure of the normal source of power and the complete restoration of the services required by 8.1.1 should be as short as practicable and should not exceed two minutes, except that for visual aids associated with non-precision, precision approach or take-off runways the requirements of Table 8-1 should apply.*

Note.— In certain cases, less than thirty seconds has been found to be attainable.

8.1.4 **Recommendation.—** *Requirements for a secondary power supply should be met by either of the following:*

— independent public power, which is a source of power supplying the aerodrome service from a substation other than the normal substation through a transmission line following a route different from the normal power supply route and such that the possibility of a simultaneous failure of the normal and independent public power supplies is extremely remote; or

— standby power unit(s), which are engine generators, batteries, etc., from which electric power can be obtained.

Note.— Guidance on secondary power supply is given in the Aerodrome Design Manual, *Part 5.*

Visual aids

Application

8.1.5 **Recommendation.—** *At an aerodrome where the primary runway is a non-instrument runway, a secondary power supply capable of meeting the requirements of 8.1.3 should be provided, except that a secondary power supply for visual aids need not be provided when an emergency lighting system in accordance with the specification of 5.3.2 is provided and capable of being deployed in 15 minutes.*

Note.— Guidance on means of achieving the specified secondary power supply switch-over times, etc., is given in the Aerodrome Design Manual, *Part 5.*

8.1.6 **Recommendation.—** *At an aerodrome where the primary runway is a non-precision approach runway, a secondary power supply capable of meeting the requirements of Table 8-1 should be provided except that a secondary power supply for visual aids need not be provided for more than one non-precision approach runway.*

Table 8-1. Secondary power supply requirements
(see 8.1.3)

Runway	Lighting aids requiring power	Maximum switch-over time
Non-instrument	Visual approach slope indicators[a]	See 8.1.3 and 8.1.5
	Runway edge[b]	
	Runway threshold[b]	
	Runway end[b]	
	Obstacle[a]	
Non-precision approach	Approach lighting system	15 seconds
	Visual approach slope indicators[a]	15 seconds
	Runway edge	15 seconds
	Runway threshold	15 seconds
	Runway end	15 seconds
	Obstacle[a]	15 seconds
Precision approach category I	Approach lighting system	15 seconds
	Runway edge	15 seconds
	Visual approach slope indicators[a]	15 seconds
	Runway threshold	15 seconds
	Runway end	15 seconds
	Essential taxiway[a]	15 seconds
	Obstacle[a]	15 seconds
Precision approach category II/III	Approach lighting system	15 seconds
	Supplementary approach lighting barrettes	1 second
	Obstacle[a]	15 seconds
	Runway edge	15 seconds
	Runway threshold	1 second
	Runway end	1 second
	Runway centre line	1 second
	Runway touchdown zone	1 second
	All stop bars	1 second
	Essential taxiway	15 seconds
Runway meant for take-off in runway visual range conditions less than a value of 550 m	Runway edge	15 seconds[c]
	Runway end	1 second
	Runway centre line	1 second
	All stop bars	1 second
	Essential taxiway[a]	15 seconds
	Obstacle[a]	15 seconds

a. Supplied with secondary power when their operation is essential to the safety of flight operation.
b. See Chapter 5, 5.3.2 regarding the use of emergency lighting.
c. One second where no runway centre line lights are provided.

8.1.7 For a precision approach runway, a secondary power supply capable of meeting the requirements of Table 8-1 for the appropriate category of precision approach runway shall be provided. Electric power supply connexions to those facilities for which secondary power is required shall be so arranged that the facilities are automatically connected to the secondary power supply on failure of the normal source of power.

8.1.8 For a runway meant for take-off in runway visual range conditions less than a value of 550 m, a secondary power supply capable of meeting the relevant requirements of Table 8-1 shall be provided.

Note.— Guidance on electrical systems is included in the Aerodrome Design Manual, *Part 5* — Electrical Systems *(Doc 9157).*

8.2 Electrical systems

8.2.1 For a runway meant for use in runway visual range conditions less than a value of 550 m, the electrical systems for the power supply, lighting and control of the lighting systems included in Table 8-1 shall be so designed that an equipment failure will not leave the pilot with inadequate visual guidance or misleading information.

Note.— Guidance on means of providing this protection is given in the Aerodrome Design Manual, *Part 5* — Electrical Systems *(Doc 9157).*

8.2.2 Where the secondary power supply of an aerodrome is provided by the use of duplicate feeders, such supplies shall be physically and electrically separate so as to ensure the required level of availability and independence.

Note.— Guidance on acceptable power source arrangements for the use of duplicate feeders for a secondary power supply is given in the Aerodrome Design Manual, *Part 5* — Electrical Systems *(Doc 9157).*

8.2.3 Where a runway forming part of a standard taxi-route is provided with runway lighting and taxiway lighting, the lighting systems shall be interlocked to preclude the possibility of simultaneous operation of both forms of lighting.

8.3 Monitoring

Note.— Guidance on this subject is given in the Aerodrome Design Manual, *Part 5.*

8.3.1 **Recommendation.—** *A system of monitoring visual aids should be employed to ensure lighting system reliability.*

8.3.2 Where lighting systems are used for aircraft control purposes, such systems shall be monitored automatically so as to provide an immediate indication of any fault which may affect the control functions. This information shall be automatically relayed to the air traffic service unit.

8.3.3 **Recommendation.—** *For a runway meant for use in runway visual range conditions less than a value of 550 m, the lighting systems detailed in Table 8-1 should be monitored so as to provide an immediate indication when the serviceability level of any element falls below the minimum serviceability level specified in 9.4.21 to 9.4.25, as appropriate. This information should be immediately relayed to the maintenance crew.*

8.3.4 **Recommendation.—** *For a runway meant for use in runway visual range conditions less than a value of 550 m, the lighting systems detailed in Table 8-1 should be monitored automatically to provide an immediate indication when the serviceability level of any element falls below the minimum level specified by the appropriate authority below which operations should not continue. This information should be automatically relayed to the air traffic services unit and displayed in a prominent position.*

Note.— Guidance on air traffic control interface and visual aids monitoring is included in the Aerodrome Design Manual, *Part 5* — Electrical Systems *(Doc 9157).*

8.4 Fencing

Application

8.4.1 **Recommendation.—** *A fence or other suitable barrier should be provided on an aerodrome to prevent the entrance to the movement area of animals large enough to be a hazard to aircraft.*

8.4.2 **Recommendation.—** *A fence or other suitable barrier should be provided on an aerodrome to deter the inadvertent or premeditated access of an unauthorized person onto a non-public area of the aerodrome.*

Note 1.— This is intended to include the barring of sewers, ducts, tunnels, etc., where necessary to prevent access.

Note 2.— Special measures may be required to prevent the access of an unauthorized person to runways or taxiways which overpass public roads.

8.4.3 **Recommendation.—** *Suitable means of protection should be provided to deter the inadvertent or premeditated access of unauthorized persons into ground installations and facilities essential for the safety of civil aviation located off the aerodrome.*

Location

8.4.4 **Recommendation.—** *The fence or barrier should be located so as to separate the movement area and other facilities or zones on the aerodrome vital to the safe operation of aircraft from areas open to public access.*

8.4.5 **Recommendation.—** *When greater security is thought necessary, a cleared area should be provided on both sides of the fence or barrier to facilitate the work of patrols and to make trespassing more difficult. Consideration should be given to the provision of a perimeter road inside the aerodrome fencing for the use of both maintenance personnel and security patrols.*

8.5 Security lighting

Recommendation.— *At an aerodrome where it is deemed desirable for security reasons, a fence or other barrier provided for the protection of international civil aviation and its facilities should be illuminated at a minimum essential level. Consideration should be given to locating lights so that the ground area on both sides of the fence or barrier, particularly at access points, is illuminated.*

8.6 Airport design

Recommendation.— *Architectural and infrastructure-related requirements necessary for the optimum implementation of international civil aviation security measures should be integrated into the design and construction of new facilities and alterations to existing facilities at an aerodrome.*

Note.— Guidance on all aspects of the planning of aerodromes including security considerations is contained in the Airport Planning Manual, *Part 1.*

8.7 Siting and construction of equipment and installations on operational areas

Note 1.— Requirements for obstacle limitation surfaces are specified in 4.2.

Note 2.— The design of light fixtures and their supporting structures, light units of visual approach slope indicators, signs, and markers, is specified in 5.3.1, 5.3.5, 5.4.1 and 5.5.1, respectively. Guidance on the frangible design of visual and non-visual aids for navigation is given in the Aerodrome Design Manual, *Part 6 (in preparation).*

8.7.1 Unless its function requires it to be there for air navigation purposes, no equipment or installation shall be:

a) on a runway strip, a runway end safety area, a taxiway strip or within the distances specified in Table 3-1, column 11, if it would endanger an aircraft; or

b) on a clearway if it would endanger an aircraft in the air.

8.7.2 **Recommendation.—** *Any equipment or installation required for air navigation purposes which must be located in an area identified in 8.7.1 should be regarded as an obstacle and should be frangible and mounted as low as possible.*

Note.— Guidance on the siting of navigation aids is contained in the Aerodrome Design Manual, *Part 6 (in preparation).*

8.7.3 Any equipment or installation required for air navigation purposes which must be located on or near a strip of a precision approach runway category I, II or III and which:

a) is situated on that portion of the strip within:

1) 60 m of the runway centre line where the code number is 3 or 4; or

2) 45 m of the runway centre line where the code number is 1 or 2; or

b) penetrates the inner approach surface, the inner transitional surface or the balked landing surface;

shall be frangible and mounted as low as possible.

8.7.4 **Recommendation.—** *Any equipment or installation required for air navigation purposes and which is an obstacle of operational significance in accordance with 4.2.4, 4.2.11, 4.2.20 or 4.2.27 should be frangible and mounted as low as possible.*

8.8 Aerodrome vehicle operations

Note 1.— Guidance on aerodrome vehicle operations is contained in Attachment A, Section 17 and on traffic rules and regulations for vehicles is contained in the Manual of Surface Movement Guidance and Control Systems (SMGCS).

Note 2.— It is intended that roads located on the movement area be restricted to the exclusive use of aerodrome personnel and other authorized persons, and that access to the public buildings by an unauthorized person will not require use of such roads.

8.8.1 A vehicle shall be operated:

a) on a manoeuvring area only as authorized by the aerodrome control tower; and

b) on an apron only as authorized by the appropriate designated authority.

8.8.2 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by markings and signs unless otherwise authorized by:

a) the aerodrome control tower when on the manoeuvring area; or

b) the appropriate designated authority when on the apron.

8.8.3 The driver of a vehicle on the movement area shall comply with all mandatory instructions conveyed by lights.

8.8.4 The driver of a vehicle on the movement area shall be appropriately trained for the tasks to be performed and shall comply with the instructions issued by:

a) the aerodrome control tower, when on the manoeuvring area; and

b) the appropriate designated authority, when on the apron.

8.8.5 The driver of a radio-equipped vehicle shall establish satisfactory two-way radio communication with the aerodrome control tower before entering the manoeuvring area and with the appropriate designated authority before entering the apron. The driver shall maintain a continuous listening watch on the assigned frequency when on the movement area.

8.9 Surface movement guidance and control systems

Application

8.9.1 A surface movement guidance and control system shall be provided at an aerodrome.

Note.— Guidance on surface movement guidance and control systems is contained in the Manual of Surface Movement Guidance and Control Systems (SMGCS).

Characteristics

8.9.2 **Recommendation.—** *The design of a surface movement guidance and control system should take into account:*

a) the density of air traffic;

b) the visibility conditions under which operations are intended;

c) the need for pilot orientation;

d) the complexity of the aerodrome layout; and

e) movements of vehicles.

8.9.3 **Recommendation.—** *The visual aid components of a surface movement guidance and control system, i.e. markings, lights and signs should be designed to conform with the relevant specifications in 5.2, 5.3 and 5.4, respectively.*

8.9.4 **Recommendation.—** *A surface movement guidance and control system should be designed to assist in the prevention of inadvertent incursions of aircraft and vehicles onto an active runway.*

8.9.5 **Recommendation.—** *The system should be designed to assist in the prevention of collisions between aircraft, and between aircraft and vehicles or objects, on any part of the movement area.*

Note.— Guidance on control of stop bars through induction loops and on a visual taxiing guidance and control system is contained in the Aerodrome Design Manual, *Part 4.*

8.9.6 Where a surface movement guidance and control system is provided by selective switching of stop bars and taxiway centre line lights, the following requirements shall be met:

a) taxiway routes which are indicated by illuminated taxiway centre line lights shall be capable of being terminated by an illuminated stop bar;

b) the control circuits shall be so arranged that when a stop bar located ahead of an aircraft is illuminated the appropriate section of taxiway centre line lights beyond it is suppressed; and

c) the taxiway centre line lights are activated ahead of an aircraft when the stop bar is suppressed.

Note 1.— See Sections 5.3.15 and 5.3.17 for specifications on taxiway centre line lights and stop bars, respectively.

Note 2.— Guidance on installation of stop bars and taxiway centre line lights in surface movement guidance and control systems is given in the Aerodrome Design Manual, *Part 4.*

8.9.7 **Recommendation.—** *Surface movement radar for the manoeuvring area should be provided at an aerodrome intended for use in runway visual range conditions less than a value of 350 m.*

8.9.8 **Recommendation.—** *Surface movement radar for the manoeuvring area should be provided at an aerodrome other than that in 8.9.7 when traffic density and operating conditions are such that regularity of traffic flow cannot be maintained by alternative procedures and facilities.*

Note.— Guidance on the use of surface movement radar is given in the Manual of Surface Movement Guidance and Control Systems (SMGCS) *and in the* Air Traffic Services Planning Manual *(Doc 9426).*

CHAPTER 9. EMERGENCY AND OTHER SERVICES

9.1 Aerodrome emergency planning

General

Introductory Note.— Aerodrome emergency planning is the process of preparing an aerodrome to cope with an emergency occurring at the aerodrome or in its vicinity. The objective of aerodrome emergency planning is to minimize the effects of an emergency, particularly in respect of saving lives and maintaining aircraft operations. The aerodrome emergency plan sets forth the procedures for co-ordinating the response of different aerodrome agencies (or services) and of those agencies in the surrounding community that could be of assistance in responding to the emergency. Guidance material to assist the appropriate authority in establishing aerodrome emergency planning is given in the Airport Services Manual, *Part 7.*

9.1.1 An aerodrome emergency plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome.

9.1.2 The aerodrome emergency plan shall provide for the co-ordination of the actions to be taken in an emergency occurring at an aerodrome or in its vicinity.

Note.— Examples of emergencies are: aircraft emergencies, sabotage including bomb threats, unlawfully seized aircraft, dangerous goods occurrences, building fires and natural disasters.

9.1.3 The plan shall co-ordinate the response or participation of all existing agencies which, in the opinion of the appropriate authority, could be of assistance in responding to an emergency.

Note.— Examples of agencies are:

- *on the aerodrome: air traffic control unit, rescue and fire fighting services, aerodrome administration, medical and ambulance services, aircraft operators, security services, and police;*
- *off the aerodrome: fire departments, police, medical and ambulance services, hospitals, military, and harbour patrol or coast guard.*

9.1.4 **Recommendation.—** *The plan should provide for co-operation and co-ordination with the rescue co-ordination centre, as necessary.*

9.1.5 **Recommendation.—** *The aerodrome emergency plan document should include at least the following:*

a) types of emergencies planned for;

b) agencies involved in the plan;

c) responsibility and role of each agency, the emergency operations centre and the command post, for each type of emergency;

d) information on names and telephone numbers of offices or people to be contacted in the case of a particular emergency; and

e) a grid map of the aerodrome and its immediate vicinity.

Emergency operations centre and command post

9.1.6 **Recommendation.—** *A fixed emergency operations centre and a mobile command post should be available for use during an emergency.*

9.1.7 **Recommendation.—** *The emergency operations centre should be a part of the aerodrome facilities and should be responsible for the over-all co-ordination and general direction of the response to an emergency.*

9.1.8 **Recommendation.—** *The command post should be a facility capable of being moved rapidly to the site of an emergency, when required, and should undertake the local co-ordination of those agencies responding to the emergency.*

9.1.9 **Recommendation.—** *A person should be assigned to assume control of the emergency operations centre and, when appropriate, another person the command post.*

Communication system

9.1.10 **Recommendation.—** *Adequate communication systems linking the command post and the emergency operations centre with each other and with the participating agencies should be provided in accordance with the plan and consistent with the particular requirements of the aerodrome.*

Aerodrome emergency exercise

9.1.11 The plan shall contain procedures for periodic testing of the adequacy of the plan and for reviewing the results in order to improve its effectiveness.

Note.— The plan includes all participating agencies and associated equipment.

9.1.12 The plan shall be tested by conducting:

a) a full-scale aerodrome emergency exercise at intervals not exceeding two years; and

b) partial emergency exercises in the intervening year to ensure that any deficiencies found during the full-scale aerodrome emergency exercise have been corrected; and

reviewed thereafter, or after an actual emergency, so as to correct any deficiency found during such exercises or actual emergency.

Note.— The purpose of a full-scale exercise is to ensure the adequacy of the plan to cope with different types of emergencies. The purpose of a partial exercise is to ensure the adequacy of the response to individual participating agencies and components of the plan, such as the communications system.

9.2 Rescue and fire fighting

General

Introductory Note.— The principal objective of a rescue and fire fighting service is to save lives. For this reason, the provision of means of dealing with an aircraft accident or incident occurring at, or in the immediate vicinity of, an aerodrome assumes primary importance because it is within this area that there are the greatest opportunities of saving lives. This must assume at all times the possibility of, and need for, extinguishing a fire which may occur either immediately following an aircraft accident or incident, or at any time during rescue operations.

The most important factors bearing on effective rescue in a survivable aircraft accident are: the training received, the effectiveness of the equipment and the speed with which personnel and equipment designated for rescue and fire fighting purposes can be put into use.

Requirements to combat building and fuel farm fires, or to deal with foaming of runways, are not taken into account.

Application

9.2.1 Rescue and fire fighting equipment and services shall be provided at an aerodrome.

Note 1.— Public or private organizations, suitably located and equipped, may be designated to provide the rescue and fire fighting service. It is intended that the fire station housing these organizations be normally located on the aerodrome, although an off-aerodrome location is not precluded provided the response time can be met.

Note 2.— It is intended that the above include the availability of suitable rescue equipment and services at an aerodrome located close to water, swampy areas or other difficult environment where a significant portion of approach or departure operations takes place over these areas. Special fire fighting equipment need not be provided for water areas; this does not prevent the provision of such equipment if it would be of practical use, such as when the areas concerned include reefs or islands.

Level of protection to be provided

9.2.2 The level of protection provided at an aerodrome for rescue and fire fighting shall be appropriate to the aerodrome category determined using the principles in 9.2.4 and 9.2.5, except that, where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months, the level of protection provided shall be:

a) up to 31 December 1999 not less than two categories below the determined category; and

b) from 1 January 2000 not less than one category below the determined category.

Note.— Either a take-off or a landing constitutes a movement.

9.2.3 **Recommendation.—** *From 1 January 2005, the level of protection provided at an aerodrome for rescue and fire fighting should be equal to the aerodrome category determined using the principles in 9.2.4 and 9.2.5.*

9.2.4 The aerodrome category shall be determined from Table 9-1 and shall be based on the longest aeroplanes normally using the aerodrome and their fuselage width.

Note.— To categorize the aeroplanes using the aerodrome, first evaluate their over-all length and second, their fuselage width.

9.2.5 If, after selecting the category appropriate to the longest aeroplane's over-all length, that aeroplane's fuselage width is greater than the maximum width in Table 9-1, column 3 for that category, then the category for that aeroplane shall actually be one category higher.

Note.— Guidance on categorizing aerodromes for rescue and fire fighting purposes and on providing rescue and fire fighting equipment and services is given in Attachment A, Section 16 and in the Airport Services Manual, *Part 1.*

Table 9-1. Aerodrome category for rescue and fire fighting

Aerodrome category (1)	Aeroplane over-all length (2)	Maximum fuselage width (3)
1	0 m up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m
3	12 m up to but not including 18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
10	76 m up to but not including 90 m	8 m

9.2.6 During anticipated periods of reduced activity, the level of protection available shall be no less than that needed for the highest category of aeroplane planned to use the aerodrome during that time irrespective of the number of movements.

Extinguishing agents

9.2.7 **Recommendation.—** *Both principal and complementary agents should normally be provided at an aerodrome.*

Note.— Descriptions of the agents may be found in the Airport Services Manual, *Part 1.*

9.2.8 **Recommendation.—** *The principal extinguishing agent should be:*

a) a foam meeting the minimum performance level A; or

b) a foam meeting the minimum performance level B; or

c) a combination of these agents;

except that the principal extinguishing agent for aerodromes in categories 1 to 3 should preferably meet the minimum performance level B.

Note.— Information on the required physical properties and fire extinguishing performance criteria needed for a foam to achieve an acceptable performance level A or B rating is given in the Airport Services Manual, *Part 1.*

9.2.9 **Recommendation.—** *The complementary extinguishing agent should be:*

a) CO_2 *; or*

b) dry chemical powders; or

c) halogenated hydrocarbons (halons); or

d) a combination of these agents.

Note 1.— When selecting dry chemical powders for use with foam, care must be exercised to ensure compatibility.

Note 2.— Dry chemical powders and halons are normally considered more efficient than CO_2 *for aircraft rescue and fire fighting operations.*

Note 3.— The production of halons ceased on 31 December 1993 as agreed by the Parties to the Montreal Protocol. However, adequate supplies of banked halons are reported to be available and these are expected to last until the on-going studies identify a suitable replacement.

9.2.10 The amounts of water for foam production and the complementary agents to be provided on the rescue and fire fighting vehicles shall be in accordance with the aerodrome category determined under 9.2.2, 9.2.3, 9.2.4, 9.2.5 and Table 9-2, except that these amounts may be modified as follows:

a) for aerodrome categories 1 and 2 up to 100 per cent of the water may be replaced by complementary agent; or

b) for aerodrome categories 3 to 10 when a foam meeting performance level A is used, up to 30 per cent of the water may be replaced by complementary agent.

For the purpose of agent substitution, the following equivalents shall be used:

1 kg dry chemical powder or 1 kg halon or 2 kg CO_2	=	1.0 L water for production of a foam meeting performance level A
1 kg dry chemical powder or 1 kg halon or 2 kg CO_2	=	0.66 L water for production of a foam meeting performance level B

Note.— The amounts of water specified for foam production are predicated on an application rate of 8.2 L/min/m^2 *for a foam meeting performance level A, and 5.5 L/min/*m^2 *for a foam meeting performance level B.*

Table 9-2. Minimum usable amounts of extinguishing agents

Aerodrome category	Foam meeting performance level A: Water (L)	Foam meeting performance level A: Discharge rate foam solution/minute (L)	Foam meeting performance level B: Water (L)	Foam meeting performance level B: Discharge rate foam solution/minute (L)	Complementary agents: Dry chemical powders (kg)	or	Halons (kg)	or	CO_2 (kg)
(1)	(2)	(3)	(4)	(5)	(6)		(7)		(8)
1	350	350	230	230	45		45		90
2	1 000	800	670	550	90		90		180
3	1 800	1 300	1 200	900	135		135		270
4	3 600	2 600	2 400	1 800	135		135		270
5	8 100	4 500	5 400	3 000	180		180		360
6	11 800	6 000	7 900	4 000	225		225		450
7	18 200	7 900	12 100	5 300	225		225		450
8	27 300	10 800	18 200	7 200	450		450		900
9	36 400	13 500	24 300	9 000	450		450		900
10	48 200	16 600	32 300	11 200	450		450		900

9.2.11 The quantity of foam concentrates separately provided on vehicles for foam production shall be in proportion to the quantity of water provided and the foam concentrate selected.

9.2.12 **Recommendation.**— *The amount of foam concentrate provided on a vehicle should be sufficient to produce at least two loads of foam solution.*

9.2.13 **Recommendation.**— *When both a foam meeting performance level A and a foam meeting performance level B are to be used, the total amount of water to be provided for foam production should first be based on the quantity which would be required if only a foam meeting performance level A were used, and then reduced by 3 L for each 2 L of water provided for the foam meeting performance level B.*

9.2.14 The discharge rate of the foam solution shall not be less than the rates shown in Table 9-2.

9.2.15 **Recommendation.**— *The complementary agents should comply with the appropriate specifications of the International Organization for Standardization (ISO).**

9.2.16 **Recommendation.**— *The discharge rate of complementary agents should be selected for optimum effectiveness of the agent.*

9.2.17 **Recommendation.**— *A reserve supply of foam concentrate and complementary agent, equivalent to 200 per cent of the quantities of these agents to be provided in the rescue and fire fighting vehicles, should be maintained on the aerodrome for vehicle replenishment purposes. Where a major delay in the replenishment of this supply is anticipated, the amount of reserve supply should be increased.*

Rescue equipment

9.2.18 **Recommendation.**— *Rescue equipment commensurate with the level of aircraft operations should be provided on the rescue and fire fighting vehicle(s).*

Note.— Guidance on the rescue equipment to be provided at an aerodrome is given in the Airport Services Manual, *Part 1.*

Response time

9.2.19 **Recommendation.**— *The operational objective of the rescue and fire fighting service should be to achieve response times of two minutes, and not exceeding three minutes, to the end of each runway, as well as to any other part of the movement area, in optimum conditions of visibility and surface conditions.*

Note 1.— Response time is considered to be the time between the initial call to the rescue and fire fighting service, and the time when the first responding vehicle(s) is (are) in position to apply foam at a rate of at least 50 per cent of the discharge rate specified in Table 9-2.

Note 2.— To meet the operational objective as nearly as possible in less than optimum conditions of visibility, it may be necessary to provide guidance for rescue and fire fighting vehicles.

* See ISO Publications 5923 (Carbon Dioxide), 7201 (Halogenated Hydrocarbons) and 7202 (Powder).

9.2.20 **Recommendation.**— *Any other vehicles required to deliver the amounts of extinguishing agents specified in Table 9-2 should arrive no more than one minute after the first responding vehicle(s) so as to provide continuous agent application.*

9.2.21 **Recommendation.**— *A system of preventive maintenance of rescue and fire fighting vehicles should be employed to ensure effectiveness of the equipment and compliance with the specified response time throughout the life of the vehicle.*

Emergency access roads

9.2.22 **Recommendation.**— *Emergency access roads should be provided on an aerodrome where terrain conditions permit their construction, so as to facilitate achieving minimum response times. Particular attention should be given to the provision of ready access to approach areas up to 1 000 m from the threshold, or at least within the aerodrome boundary. Where a fence is provided, the need for convenient access to outside areas should be taken into account.*

Note.— Aerodrome service roads may serve as emergency access roads when they are suitably located and constructed.

9.2.23 **Recommendation.**— *Emergency access roads should be capable of supporting the heaviest vehicles which will use them, and be usable in all weather conditions. Roads within 90 m of a runway should be surfaced to prevent surface erosion and the transfer of debris to the runway. Sufficient vertical clearance should be provided from overhead obstructions for the largest vehicles.*

9.2.24 **Recommendation.**— *When the surface of the road is indistinguishable from the surrounding area, or in areas where snow may obscure the location of the roads, edge markers should be placed at intervals of about 10 m.*

Fire stations

9.2.25 **Recommendation.**— *All rescue and fire fighting vehicles should normally be housed in a fire station. Satellite fire stations should be provided whenever the response time cannot be achieved from a single fire station.*

9.2.26 **Recommendation.**— *The fire station should be located so that the access for rescue and fire fighting vehicles into the runway area is direct and clear, requiring a minimum number of turns.*

Communication and alerting systems

9.2.27 **Recommendation.**— *A discrete communication system should be provided linking a fire station with the control tower, any other fire station on the aerodrome and the rescue and fire fighting vehicles.*

9.2.28 **Recommendation.**— *An alerting system for rescue and fire fighting personnel, capable of being operated from that station, should be provided at a fire station, any other fire station on the aerodrome and the aerodrome control tower.*

Number of rescue and fire fighting vehicles

9.2.29 **Recommendation.**— *The minimum number of rescue and fire fighting vehicles provided at an aerodrome should be in accordance with the following tabulation:*

Aerodrome category	Rescue and fire fighting vehicles
1	*1*
2	*1*
3	*1*
4	*1*
5	*1*
6	*2*
7	*2*
8	*3*
9	*3*
10	*3*

Note.— Guidance on minimum characteristics of rescue and fire fighting vehicles is given in the Airport Services Manual, *Part 1.*

Personnel

9.2.30 All rescue and fire fighting personnel shall be properly trained to perform their duties in an efficient manner and shall participate in live fire drills commensurate with the types of aircraft and type of rescue and fire fighting equipment in use at the aerodrome, including pressure-fed fuel fires.

Note 1.— Guidance to assist the appropriate authority in providing proper training is given in Attachment A, Section 16 of this volume of Annex 14; Airport Services Manual, *Part 1; and* Training Manual, *Part E-2.*

Note 2.— Fires associated with fuel discharged under very high pressure from a ruptured fuel tank are known as "pressure-fed fuel fires".

9.2.31 **Recommendation.**— *During flight operations, sufficient trained personnel should be detailed and be readily available to ride the rescue and fire fighting vehicles and to operate the equipment at maximum capacity. These trained personnel should be deployed in a way that ensures that minimum response times can be achieved and that continuous agent application at the appropriate rate can be fully* *maintained. Consideration should also be given for personnel to use hand lines, ladders and other rescue and fire fighting equipment normally associated with aircraft rescue and fire fighting operations.*

9.2.32 **Recommendation.—** *In determining the number of personnel required to provide for rescue, consideration should be given to the types of aircraft using the aerodrome.*

9.2.33 All responding rescue and fire fighting personnel shall be provided with protective clothing and respiratory equipment to enable them to perform their duties in an effective manner.

9.3 Disabled aircraft removal

Note.— Guidance on removal of a disabled aircraft, including recovery equipment, is given in the Airport Services Manual, *Part 5. See also Annex 13 concerning protection of evidence, custody and removal of aircraft.*

9.3.1 **Recommendation.—** *A plan for the removal of an aircraft disabled on, or adjacent to, the movement area should be established for an aerodrome, and a co-ordinator designated to implement the plan, when necessary.*

9.3.2 **Recommendation.—** *The disabled aircraft removal plan should be based on the characteristics of the aircraft that may normally be expected to operate at the aerodrome, and include among other things:*

a) a list of equipment and personnel on, or in the vicinity of, the aerodrome which would be available for such purpose; and

b) arrangements for the rapid receipt of aircraft recovery equipment kits available from other aerodromes.

9.4 Maintenance

General

9.4.1 **Recommendation.—** *A maintenance programme, including preventive maintenance where appropriate, should be established at an aerodrome to maintain facilities in a condition which does not impair the safety, regularity or efficiency of air navigation.*

Note 1.— Preventive maintenance is programmed maintenance work done in order to prevent a failure or degradation of facilities.

Note 2.— "Facilities" are intended to include such items as pavements, visual aids, fencing, drainage systems and buildings.

Pavements

9.4.2 **Recommendation.—** *The surface of pavements (runways, taxiways, aprons, etc.) should be kept clear of any loose stones or other objects that might cause damage to aircraft structures or engines, or impair the operation of aircraft systems.*

Note.— Guidance on precautions to be taken in regard to the surface of shoulders is given in Attachment A, Section 8, and the Aerodrome Design Manual, *Part 2.*

9.4.3 **Recommendation.—** *The surface of a runway should be maintained in a condition such as to preclude formation of harmful irregularities.*

Note.— See Attachment A, Section 5.

9.4.4 Measurements of the friction characteristics of a runway surface shall be made periodically with a continuous friction measuring device using self-wetting features.

Note.— Guidance on evaluating the friction characteristics of a runway is provided in Attachment A, Section 7. Additional guidance is included in the Airport Services Manual, *Part 2.*

9.4.5 Corrective maintenance action shall be taken when the friction characteristics for either the entire runway or a portion thereof are below a minimum friction level specified by the State.

Note.— A portion of runway in the order of 100 m long may be considered significant for maintenance or reporting action.

9.4.6 **Recommendation.—** *Corrective maintenance action should be considered when the friction characteristics for either the entire runway or a portion thereof are below a maintenance planning level specified by the State.*

9.4.7 **Recommendation.—** *When there is reason to believe that the drainage characteristics of a runway, or portions thereof, are poor due to slopes or depressions, then the runway friction characteristics should be assessed under natural or simulated conditions that are representative of local rain and corrective maintenance action should be taken as necessary.*

9.4.8 **Recommendation.—** *When a taxiway is used by turbine-engined aeroplanes, the surface of the taxiway shoulders should be maintained so as to be free of any loose stones or other objects that could be ingested by the aeroplane engines.*

Note.— Guidance on this subject is given in the Aerodrome Design Manual, *Part 2.*

9.4.9 The surface of a paved runway shall be maintained in a condition so as to provide good friction characteristics and low rolling resistance. Snow, slush, ice, standing water, mud, dust, sand, oil, rubber deposits and other contaminants shall be removed as rapidly and completely as possible to minimize accumulation.

Note.— Guidance on determining and expressing the friction characteristics when conditions of snow or ice cannot be avoided is given in Attachment A, Section 6. The Airport Services Manual, *Part 2, contains further information on this subject, on improving friction characteristics and on clearing of runways.*

9.4.10 **Recommendation.—** *A taxiway should be kept clear of snow, slush, ice, etc., to the extent necessary to enable aircraft to be taxied to and from an operational runway.*

9.4.11 **Recommendation.—** *Aprons should be kept clear of snow, slush, ice, etc., to the extent necessary to enable aircraft to manoeuvre safely or, where appropriate, to be towed or pushed.*

9.4.12 **Recommendation.—** *Whenever the clearance of snow, slush, ice, etc., from the various parts of the movement area cannot be carried out simultaneously, the order of priority should be as follows but may be altered following, as necessary, consultation with the aerodrome users:*

1st — runway(s) in use;

2nd — taxiways serving runway(s) in use;

3rd — apron(s);

4th — holding bays; and

5th — other areas.

9.4.13 **Recommendation.—** *Chemicals to remove or to prevent the formation of ice and frost on aerodrome pavements should be used when conditions indicate their use could be effective. Caution should be exercised in the application of the chemicals so as not to create a more slippery condition.*

Note.— Guidance on the use of chemicals for aerodrome pavements is given in the Airport Services Manual, *Part 2.*

9.4.14 Chemicals which may have harmful effects on aircraft or pavements, or chemicals which may have toxic effects on the aerodrome environment, shall not be used.

Runway pavement overlays

Note.— The following specifications are intended for runway pavement overlay projects when the runway is to be returned to an operational status before overlay of the entire runway is complete thus normally necessitating a temporary ramp between the new and old runway surfaces. Guidance on overlaying pavements and assessing their operational status is given in the Aerodrome Design Manual, *Part 3.*

9.4.15 The longitudinal slope of the temporary ramp, measured with reference to the existing runway surface or previous overlay course, shall be:

a) 0.5 to 1.0 per cent for overlays up to and including 5 cm in thickness; and

b) not more than 0.5 per cent for overlays more than 5 cm in thickness.

9.4.16 **Recommendation.—** *Overlaying should proceed from one end of the runway toward the other end so that based on runway utilization most aircraft operations will experience a down ramp.*

9.4.17 **Recommendation.—** *The entire width of the runway should be overlaid during each work session.*

9.4.18 Before a runway being overlaid is returned to a temporary operational status, a runway centre line marking conforming to the specifications in Section 5.2.3 shall be provided. Additionally, the location of any temporary threshold shall be identified by a 3.6 m wide transverse stripe.

Visual aids

Note.— These specifications are not intended to define the operational failure of a lighting system.

9.4.19 A light shall be deemed to be unserviceable when the main beam is out of its specified alignment or when its average intensity is less than 50 per cent of the specified value.

9.4.20 A system of preventive maintenance of visual aids shall be employed to ensure lighting and marking system reliability.

Note.— Guidance on preventive maintenance of visual aids is given in the Airport Services Manual, *Part 9.*

9.4.21 The system of preventive maintenance employed for a precision approach runway category II or III shall have as its objective that, during any period of category II or III operations, all approach and runway lights are serviceable, and that in any event at least:

a) 95 per cent of the lights are serviceable in each of the following particular significant elements:

1) precision approach category II and III lighting system, the inner 450 m;

2) runway centre line lights;

3) runway threshold lights; and

4) runway edge lights;

b) 90 per cent of the lights are serviceable in the touchdown zone lights;

c) 85 per cent of the lights are serviceable in the approach lighting system beyond 450 m; and

d) 75 per cent of the lights are serviceable in the runway end lights.

In order to provide continuity of guidance, the allowable percentage of unserviceable lights shall not be permitted in such a way as to alter the basic pattern of the lighting system. Additionally, an unserviceable light shall not be permitted adjacent to another unserviceable light, except in a barrette or a crossbar where two adjacent unserviceable lights may be permitted.

Note.— With respect to barrettes, crossbars and runway edge lights, lights are considered to be adjacent if located consecutively and:

— laterally: in the same barrette or crossbar; or

— longitudinally: in the same row of edge lights or barrettes.

9.4.22 The system of preventive maintenance employed for a stop bar provided at a taxi-holding position used in conjunction with a runway intended for operations in runway visual range conditions less than a value of 350 m shall have the following objectives:

a) no more than two lights will remain unserviceable; and

b) two adjacent lights will not remain unserviceable unless the light spacing is significantly less than that specified.

9.4.23 The system of preventive maintenance employed for a taxiway intended for use in runway visual range conditions less than a value of 350 m shall have as its objective that no two adjacent taxiway centre line lights be unserviceable.

9.4.24 The system of preventive maintenance employed for a precision approach runway category I shall have as its objective that, during any period of category I operations, all approach and runway lights are serviceable, and that in any event at least 85 per cent of the lights are serviceable in each of the following:

a) precision approach category I lighting system;

b) runway threshold lights;

c) runway edge lights; and

d) runway end lights.

In order to provide continuity of guidance an unserviceable light shall not be permitted adjacent to another unserviceable light unless the light spacing is significantly less than that specified.

Note.— In barrettes and crossbars, guidance is not lost by having two adjacent unserviceable lights.

9.4.25 The system of preventive maintenance employed for a runway meant for take-off in runway visual range conditions less than a value of 550 m shall have as its objective that, during any period of operations, all runway lights are serviceable and that in any event:

a) at least 95 per cent of the lights are serviceable in the runway centre line lights (where provided) and in the runway edge lights; and

b) at least 75 per cent of the lights are serviceable in the runway end lights.

In order to provide continuity of guidance, an unserviceable light shall not be permitted adjacent to another unserviceable light.

9.4.26 The system of preventive maintenance employed for a runway meant for take-off in runway visual range conditions of a value of 550 m or greater shall have as its objective that, during any period of operations, all runway lights are serviceable and that, in any event, at least 85 per cent of the lights are serviceable in the runway edge lights and runway end lights. In order to provide continuity of guidance, an unserviceable light shall not be permitted adjacent to another unserviceable light.

9.4.27 **Recommendation.—** *During low visibility procedures the appropriate authority should restrict construction or maintenance activities in the proximity of aerodrome electrical systems.*

9.5 Bird hazard reduction

9.5.1 **Recommendation.—** *The bird strike hazard on, or in the vicinity of, an aerodrome should be assessed through:*

a) the establishment of a national procedure for recording and reporting bird strikes to aircraft; and

b) the collection of information from aircraft operators, airport personnel, etc. on the presence of birds on or around the aerodrome.

Note.— The ICAO Bird Strike Information System (IBIS) is designed to collect and disseminate information on bird strikes to aircraft. Information on the system is included in the Manual on the ICAO Bird Strike Information System (IBIS).

9.5.2 **Recommendation.—** *When a bird strike hazard is identified at an aerodrome, the appropriate authority should take action to decrease the number of birds constituting a potential hazard to aircraft operations by adopting measures for discouraging their presence on, or in the vicinity of, an aerodrome.*

Note.— Guidance on effective measures for establishing whether or not birds, on or near an aerodrome, constitute a potential hazard to aircraft operations, and on methods for discouraging their presence, is given in the Airport Services Manual, *Part 3.*

9.5.3 **Recommendation.—** *Garbage disposal dumps or any such other source attracting bird activity on, or in the vicinity of, an aerodrome should be eliminated or their establishment prevented, unless an appropriate study indicates that they are unlikely to create conditions conducive to a bird hazard problem.*

9.6 Apron management service

9.6.1 **Recommendation.—** *When warranted by the volume of traffic and operating conditions, an appropriate apron management service should be provided on an apron by an aerodrome ATS unit, by another aerodrome operating authority, or by a co-operative combination of these, in order to:*

a) regulate movement with the objective of preventing collisions between aircraft, and between aircraft and obstacles;

b) regulate entry of aircraft into, and co-ordinate exit of aircraft from, the apron with the aerodrome control tower; and

c) ensure safe and expeditious movement of vehicles and appropriate regulation of other activities.

9.6.2 **Recommendation.—** *When the aerodrome control tower does not participate in the apron management service, procedures should be established to facilitate the orderly transition of aircraft between the apron management unit and the aerodrome control tower.*

Note.— Guidance on an apron management service is given in the Airport Services Manual, *Part 8 and in the* Manual of Surface Movement Guidance and Control Systems (SMGCS).

9.6.3 An apron management service shall be provided with radiotelephony communications facilities.

9.6.4 Where low visibility procedures are in effect, persons and vehicles operating on an apron shall be restricted to the essential minimum.

Note.— Guidance on related special procedures is given in the Manual of Surface Movement Guidance and Control Systems (SMGCS).

9.6.5 An emergency vehicle responding to an emergency shall be given priority over all other surface movement traffic.

9.6.6 A vehicle operating on an apron shall:

a) give way to an emergency vehicle: an aircraft taxiing, about to taxi, or being pushed or towed: and

b) give way to other vehicles in accordance with local regulations.

9.6.7 An aircraft stand shall be visually monitored to ensure that the recommended clearance distances are provided to an aircraft using the stand.

9.7 Ground servicing of aircraft

9.7.1 Fire extinguishing equipment suitable for at least initial intervention in the event of a fuel fire and personnel trained in its use shall be readily available during the ground servicing of an aircraft, and there shall be a means of quickly summoning the rescue and fire fighting service in the event of a fire or major fuel spill.

9.7.2 When aircraft refuelling operations take place while passengers are embarking, on board or disembarking, ground equipment shall be positioned so as to allow:

a) the use of a sufficient number of exits for expeditious evacuation; and

b) a ready escape route from each of the exits to be used in an emergency.

APPENDIX 1. AERONAUTICAL GROUND LIGHT AND SURFACE MARKING COLOURS

1. General

Introductory Note.— The following specifications define the chromaticity limits of colours to be used for aeronautical ground lights and for the marking of surfaces as required in this Annex. The specifications are in accord with the current specifications of the International Commission on Illumination (CIE).

It is not possible to establish specifications for colours such that there is no possibility of confusion. For reasonably certain recognition, it is important that the eye illumination be well above the threshold of perception, that the colour not be greatly modified by selective atmospheric attenuations and that the observer's colour vision be adequate. There is also a risk of confusion of colour at an extremely high level of eye illumination such as may be obtained from a high-intensity source at very close range. Experience indicates that satisfactory recognition can be achieved if due attention is given to these factors.

*The chromaticities are expressed in terms of the standard observer and coordinate system adopted by the International Commission on Illumination (CIE) at its Eighth Session at Cambridge, England, in 1931.**

2. Colours for aeronautical ground lights

2.1 Chromaticities

2.1.1 The chromaticities of aeronautical ground lights shall be within the following boundaries:

CIE Equations (see Figure 1.1):

a) Red
- Purple boundary $y = 0.980 - x$
- Yellow boundary $y = 0.335$

b) Yellow
- Red boundary $y = 0.382$
- White boundary $y = 0.790 - 0.667x$
- Green boundary $y = x - 0.120$

c) Green
- Yellow boundary $x = 0.360 - 0.080y$
- White boundary $x = 0.650y$
- Blue boundary $y = 0.390 - 0.171x$

d) Blue
- Green boundary $y = 0.805x + 0.065$
- White boundary $y = 0.400 - x$
- Purple boundary $x = 0.600y + 0.133$

e) White
- Yellow boundary $x = 0.500$
- Blue boundary $x = 0.285$
- Green boundary $y = 0.440$ and $y = 0.150 + 0.640x$
- Purple boundary $y = 0.050 + 0.750x$ and $y = 0.382$

f) Variable white
- Yellow boundary $x = 0.255 + 0.750y$ and $x = 1.185 - 1.500y$
- Blue boundary $x = 0.285$
- Green boundary $y = 0.440$ and $y = 0.150 + 0.640x$
- Purple boundary $y = 0.050 + 0.750x$ and $y = 0.382$

Note.— Guidance on chromaticity changes resulting from the effect of temperature on filtering elements is given in the Aerodrome Design Manual, *Part 4.*

2.1.2 **Recommendation.—** *Where dimming is not required, or where observers with defective colour vision must be able to determine the colour of the light, green signals should be within the following boundaries:*

Yellow boundary $y = 0.726 - 0.726x$
White boundary $x = 0.650y$
Blue boundary $y = 0.390 - 0.171x$

2.1.3 **Recommendation.—** *Where increased certainty of recognition is more important than maximum visual range, green signals should be within the following boundaries:*

Yellow boundary $y = 0.726 - 0.726x$
White boundary $x = 0.625y - 0.041$
Blue boundary $y = 0.390 - 0.171x$

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* See CIE Publication No. 15, *Colorimetry* (1971).

2.2 Discrimination between lights

2.2.1 **Recommendation.—** *If there is a requirement to discriminate yellow and white from each other, they should be displayed in close proximity of time or space as, for example, by being flashed successively from the same beacon.*

2.2.2 **Recommendation.—** *If there is a requirement to discriminate yellow from green and/or white, as for example on exit taxiway centre line lights the y coordinates of the yellow light should not exceed a value of 0.40.*

Note.— The limits of white have been based on the assumption that they will be used in situations in which the characteristics (colour temperature) of the light source will be substantially constant.

2.2.3 **Recommendation.—** *The colour variable white is intended to be used only for lights that are to be varied in intensity, e.g. to avoid dazzling. If this colour is to be discriminated from yellow, the lights should be so designed and operated that:*

a) the x coordinate of the yellow is at least 0.050 greater than the x coordinate of the white; and

b) the disposition of the lights will be such that the yellow lights are displayed simultaneously and in close proximity to the white lights.

3. Colours for surface markings

Note 1.— The specifications of surface colours given below apply only to freshly coloured surfaces. Colours used for surface markings usually change with time and therefore require renewal.

Note 2.— Guidance on surface colours is contained in the CIE document entitled Recommendations for Surface Colours for Visual Signalling — *Publication No. 39-2 (TC-106) 1983.*

Note 3.— The specifications recommended in 3.4 below for transilluminated panels are interim in nature and are based on the CIE specifications for transilluminated signs. It is intended that these specifications will be reviewed and updated as and when CIE develops specifications for transilluminated panels.

3.1 The chromaticities and luminance factors of ordinary colours, colours of retroreflecting materials and colours of transilluminated (internally illuminated) signs and panels shall be determined under the following standard conditions:

a) angle of illumination: 45°;

b) direction of view: perpendicular to surface; and

c) illuminant: CIE standard illuminant D_{65}.

3.2 **Recommendation.—** *The chromaticity and luminance factors of ordinary colours for surface markings should be within the following boundaries when determined under standard conditions.*

CIE Equations (see Figure 1.2):

a) Red

Purple boundary	$y = 0.345 - 0.051x$
White boundary	$y = 0.910 - x$
Orange boundary	$y = 0.314 + 0.047x$
Luminance factor	$\beta = 0.07$ (mnm)

b) Orange

Red boundary	$y = 0.265 + 0.205x$
White boundary	$y = 0.910 - x$
Yellow boundary	$y = 0.207 + 0.390x$
Luminance factor	$\beta = 0.20$ (mnm)

c) Yellow

Orange boundary	$y = 0.108 + 0.707x$
White boundary	$y = 0.910 - x$
Green boundary	$y = 1.35x - 0.093$
Luminance factor	$\beta = 0.45$ (mnm)

d) White

Purple boundary	$y = 0.010 + x$
Blue boundary	$y = 0.610 - x$
Green boundary	$y = 0.030 + x$
Yellow boundary	$y = 0.710 - x$
Luminance factor	$\beta = 0.75$ (mnm)

e) Black

Purple boundary	$y = x - 0.030$
Blue boundary	$y = 0.570 - x$
Green boundary	$y = 0.050 + x$
Yellow boundary	$y = 0.740 - x$
Luminance factor	$\beta = 0.03$ (max)

f) Yellowish green

Green boundary	$y = 1.317x + 0.4$
White boundary	$y = 0.910 - x$
Yellow boundary	$y = 0.867x + 0.4$

Note.— The small separation between surface red and surface orange is not sufficient to ensure the distinction of these colours when seen separately.

3.3 **Recommendation.—** *The chromaticity and luminance factors of colours of retroreflecting materials for surface markings should be within the following boundaries when determined under standard conditions.*

CIE Equations (see Figure 1.3):

a) Red

Purple boundary	$y = 0.345 - 0.051x$
White boundary	$y = 0.910 - x$
Orange boundary	$y = 0.314 + 0.047x$
Luminance factor	$\beta = 0.03$ (mnm)

b) Orange

Red boundary	$y = 0.265 + 0.205x$
White boundary	$y = 0.910 - x$
Yellow boundary	$y = 0.207 + 0.390x$
Luminance factor	$\beta = 0.14$ (mnm)

c) Yellow

Orange boundary	$y = 0.160 + 0.540x$
White boundary	$y = 0.910 - x$
Green boundary	$y = 1.35x - 0.093$
Luminance factor	$\beta = 0.16$ (mnm)

d) White

Purple boundary	$y = x$
Blue boundary	$y = 0.610 - x$
Green boundary	$y = 0.040 + x$
Yellow boundary	$y = 0.710 - x$
Luminance factor	$\beta = 0.27$ (mnm)

e) Blue

Green boundary	$y = 0.118 + 0.675x$
White boundary	$y = 0.370 - x$
Purple boundary	$y = 1.65x - 0.187$
Luminance factor	$\beta = 0.01$ (mnm)

f) Green

Yellow boundary	$y = 0.711 - 1.22x$
White boundary	$y = 0.243 + 0.670x$
Blue boundary	$y = 0.405 - 0.243x$
Luminance factor	$\beta = 0.03$ (mnm)

3.4 **Recommendation.—** *The chromaticity and luminance factors of colours for transilluminated (internally illuminated) signs and panels should be within the following boundaries when determined under standard conditions.*

CIE Equations (see Figure 1.4):

a) Red

Purple boundary	$y = 0.345 - 0.051x$
White boundary	$y = 0.910 - x$
Orange boundary	$y = 0.314 + 0.047x$
Luminance factor (day condition)	$\beta = 0.07$ (mnm)
Relative luminance to white (night condition)	5% (mnm) 20% (max)

b) Yellow

Orange boundary	$y = 0.108 + 0.707x$
White boundary	$y = 0.910 - x$
Green boundary	$y = 1.35x - 0.093$
Luminance factor (day condition)	$\beta = 0.45$ (mnm)
Relative luminance to white (night condition)	30% (mnm) 80% (max)

c) White

Purple boundary	$y = 0.010 + x$
Blue boundary	$y = 0.610 - x$
Green boundary	$y = 0.030 + x$
Yellow boundary	$y = 0.710 - x$
Luminance factor (day condition)	$\beta = 0.75$ (mnm)
Relative luminance to white (night condition)	100%

d) Black

Purple boundary	$y = x - 0.030$
Blue boundary	$y = 0.570 - x$
Green boundary	$y = 0.050 + x$
Yellow boundary	$y = 0.740 - x$
Luminance factor (day condition)	$\beta = 0.03$ (max)
Relative luminance to white (night condition)	0% (mnm) 2% (max)

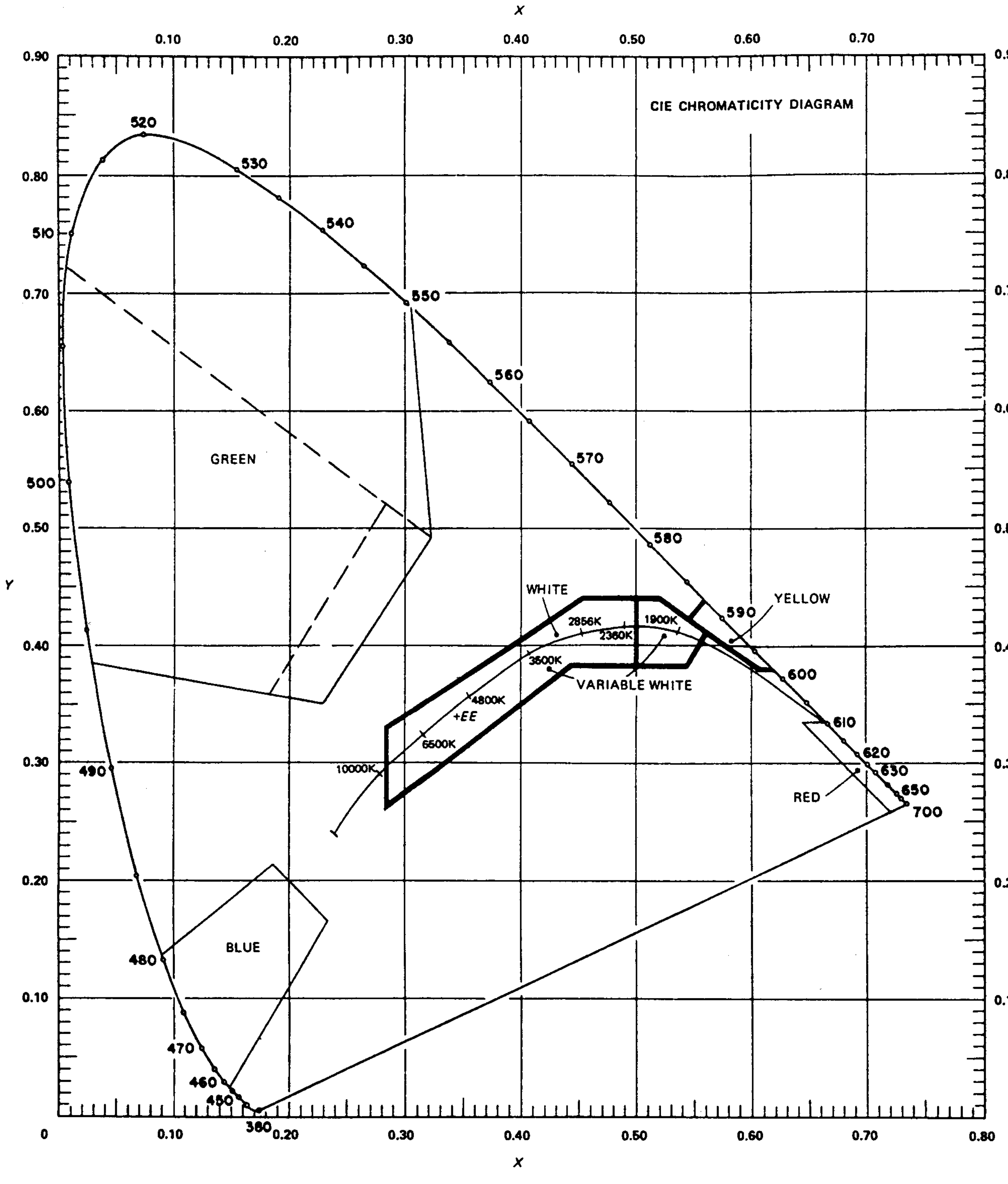

Figure 1.1 Colours for aeronautical ground lights

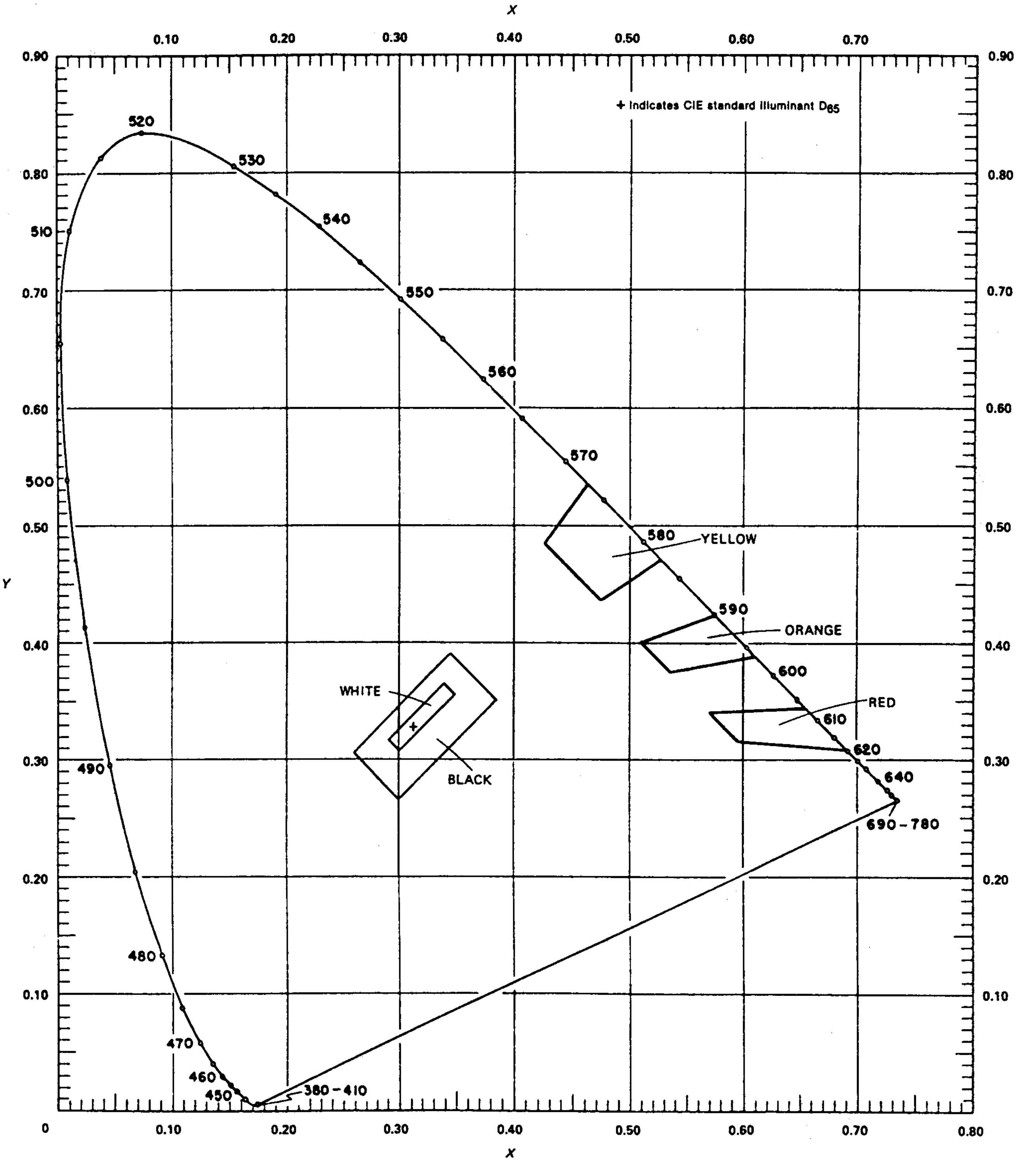

Figure 1.2 Ordinary colours for surface markings

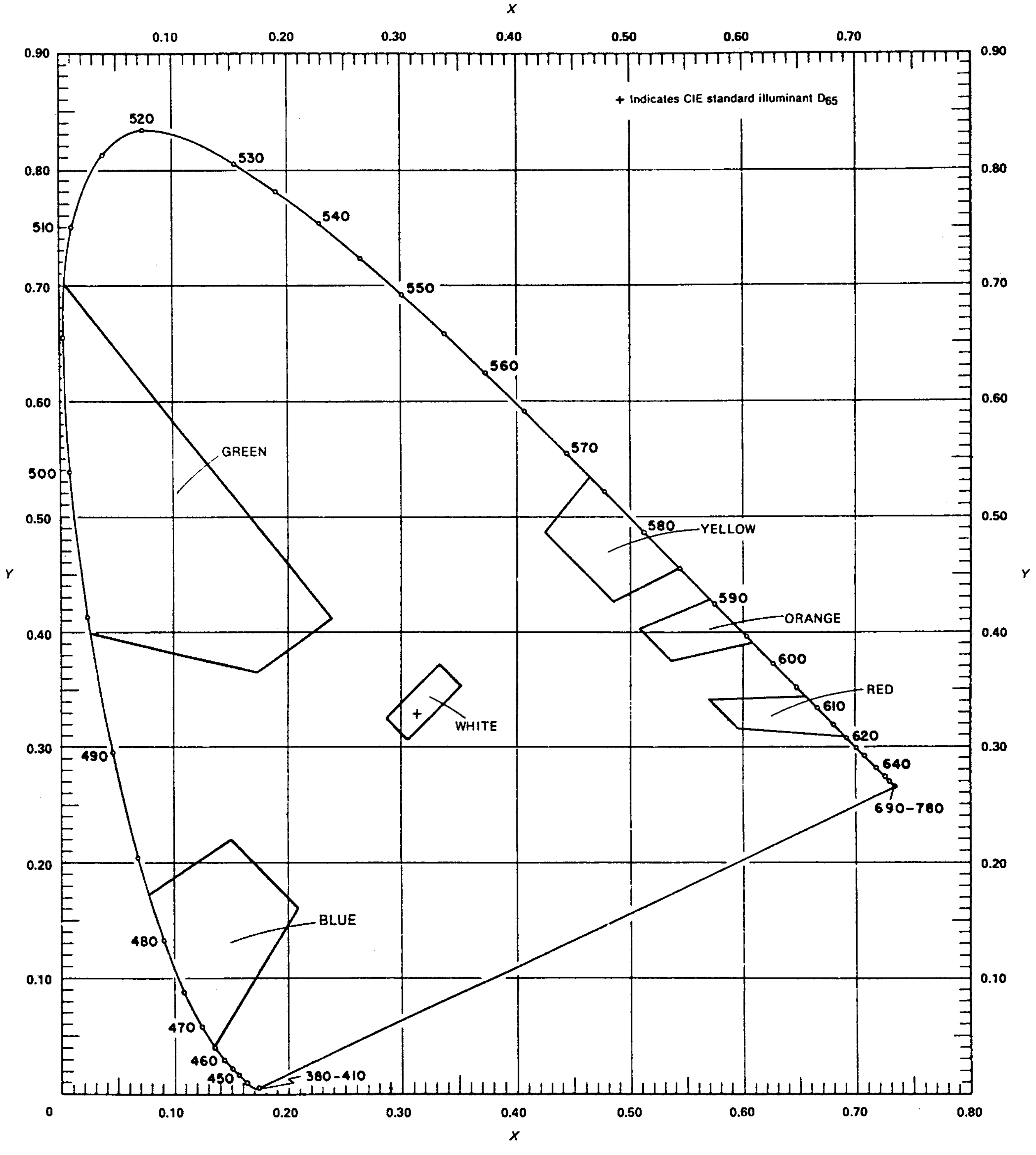

Figure 1.3 Colours of retroreflecting materials for surface markings

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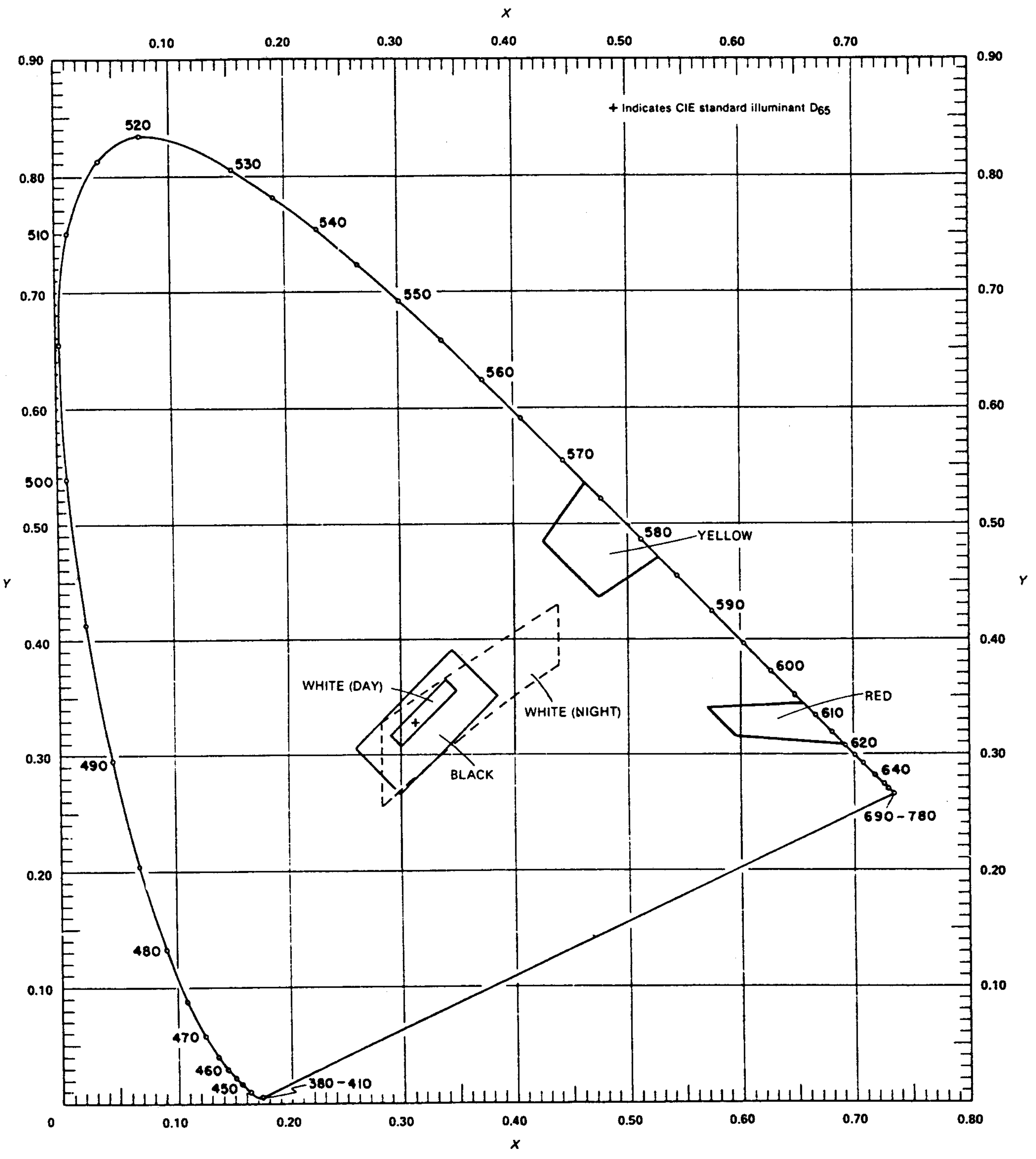

Figure 1.4 Colours of transilluminated (internally illuminated) signs and panels

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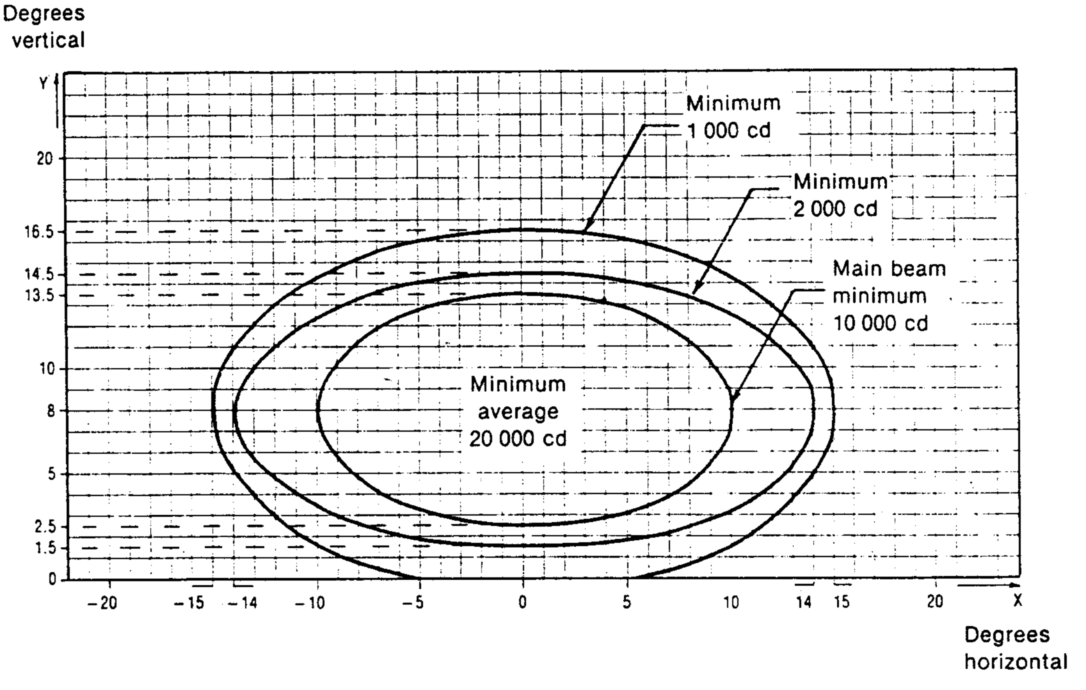
APPENDIX 2. AERONAUTICAL GROUND LIGHT CHARACTERISTICS



Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	10	14	15
b	5.5	6.5	8.5

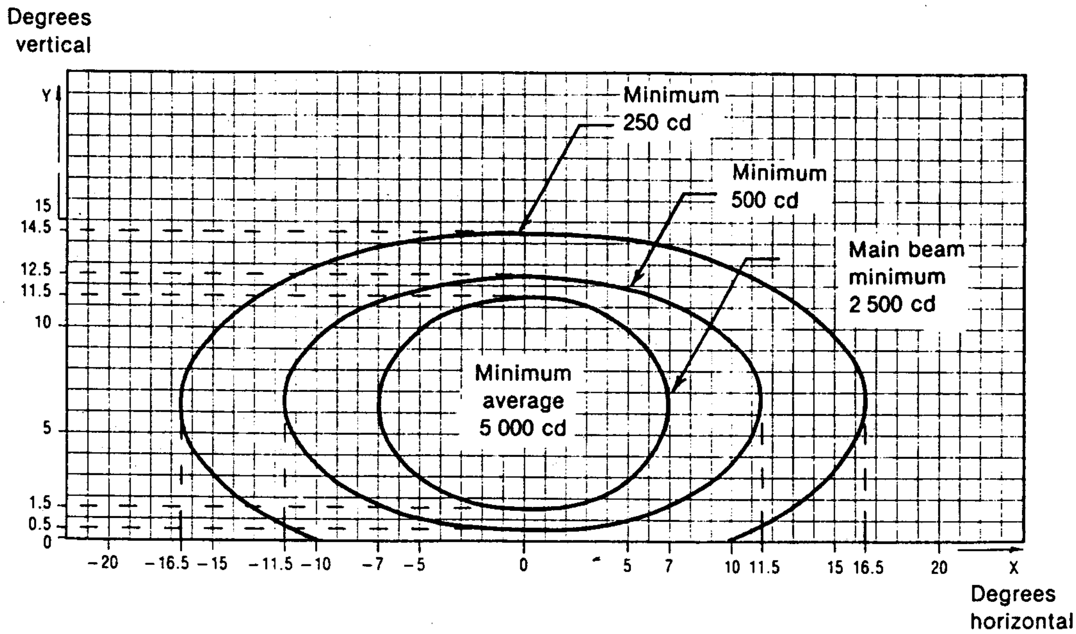
2. Vertical setting angles of the lights shall be such that the following vertical coverage of the main beam will be met:

distance from threshold	vertical main beam coverage
threshold to 315 m	0° — 11°
316 m to 475 m	0.5° — 11.5°
476 m to 640 m	1.5° — 12.5°
641 m and beyond	2.5° — 13.5° (as illustrated above)

3. Lights in crossbars beyond 22.5 m from the centre line shall be toed-in 2 degrees. All other lights shall be aligned parallel to the centre line of the runway.

4. See collective notes for Figures 2.1 to 2.12.

Figure 2.1 Isocandela diagram for approach centre line light and crossbars (white light)



Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

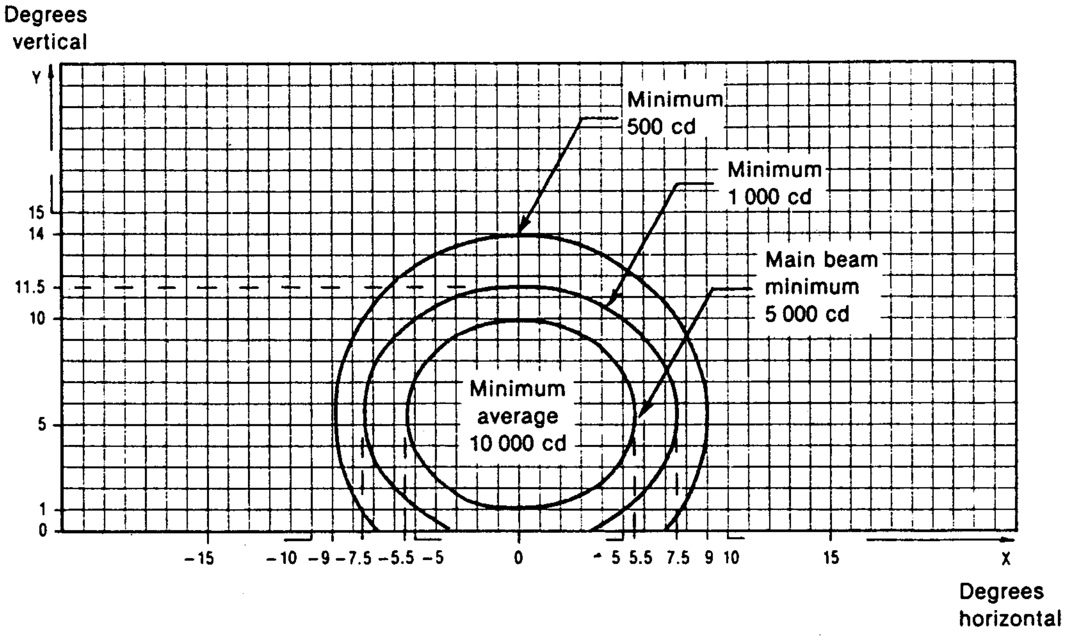
a	7.0	11.5	16.5
b	5.0	6.0	8.0

2. Toe-in 2 degrees
3. Vertical setting angles of the lights shall be such that the following vertical coverage of the main beam will be met:

distance from threshold	vertical main beam coverage
threshold to 115 m	0.5° — 10.5°
116 m to 215 m	1° — 11°
216 m and beyond	1.5° — 11.5° (as illustrated above)

4. See collective notes for Figures 2.1 to 2.12.

Figure 2.2 Isocandela diagram for approach side row light (red light)



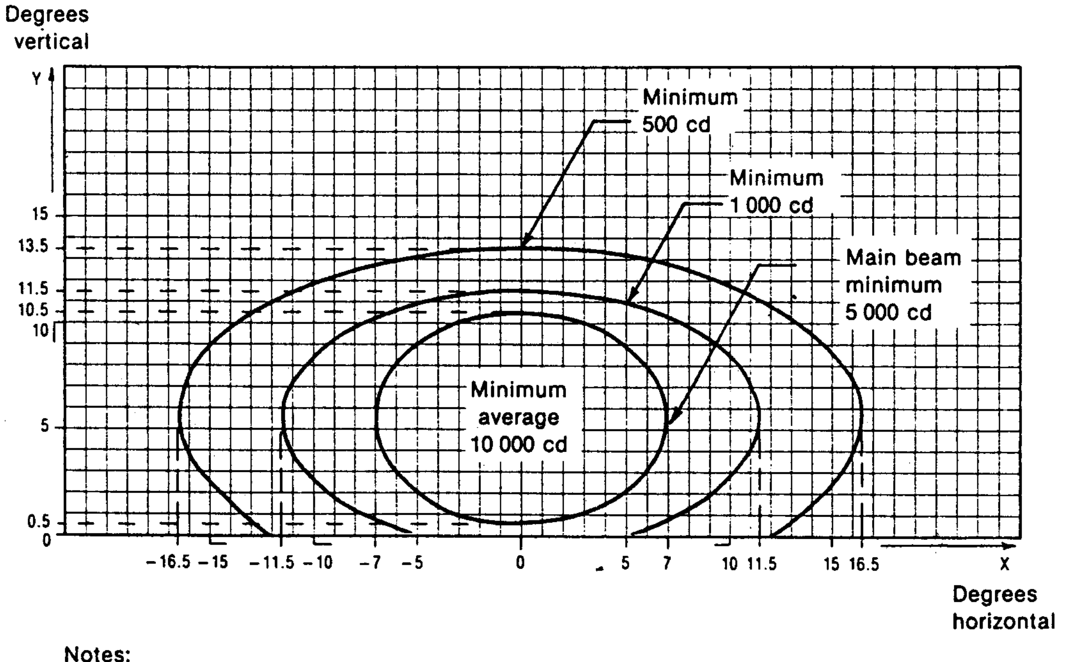
Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.5	7.5	9.0
b	4.5	6.0	8.5

2. Toe-in 3.5 degrees
3. See collective notes for Figures 2.1 to 2.12.

Figure 2.3 Isocandela diagram for threshold light (green light)



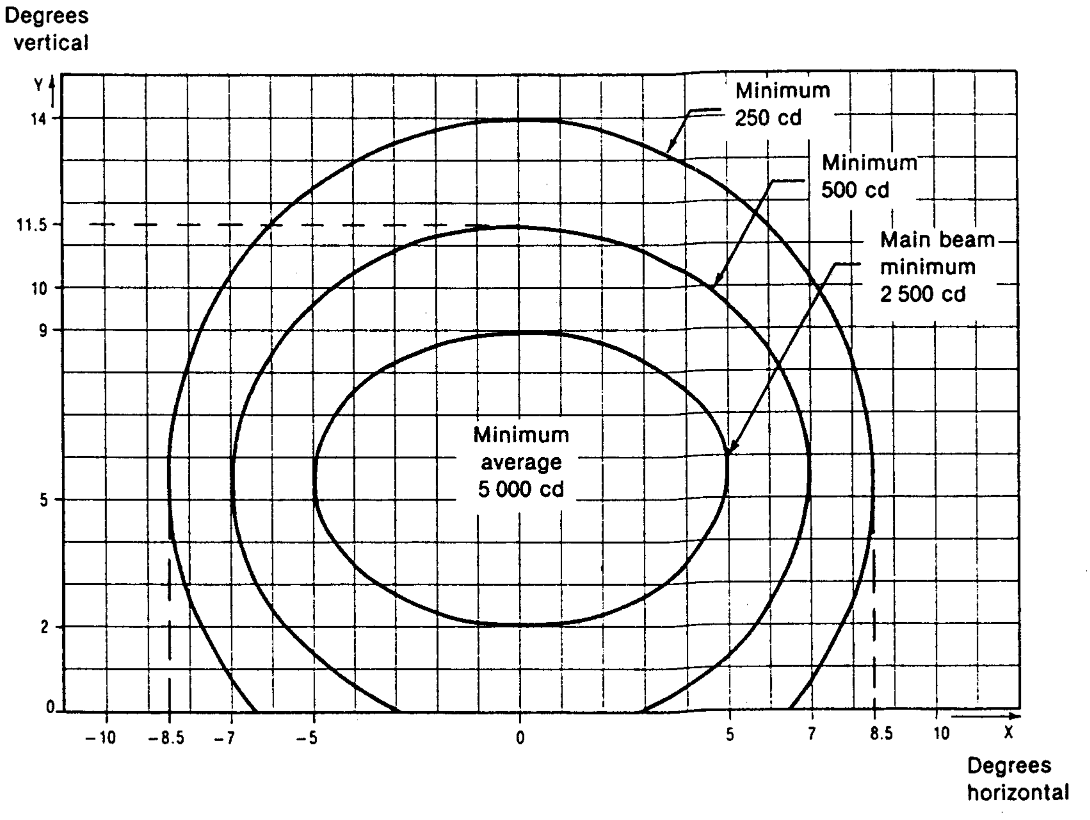
Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	7.0	11.5	16.5
b	5.0	6.0	8.0

2. Toe-in 2 degrees
3. See collective notes for Figures 2.1 to 2.12.

Figure 2.4 Isocandela diagram for threshold wing bar light (green light)



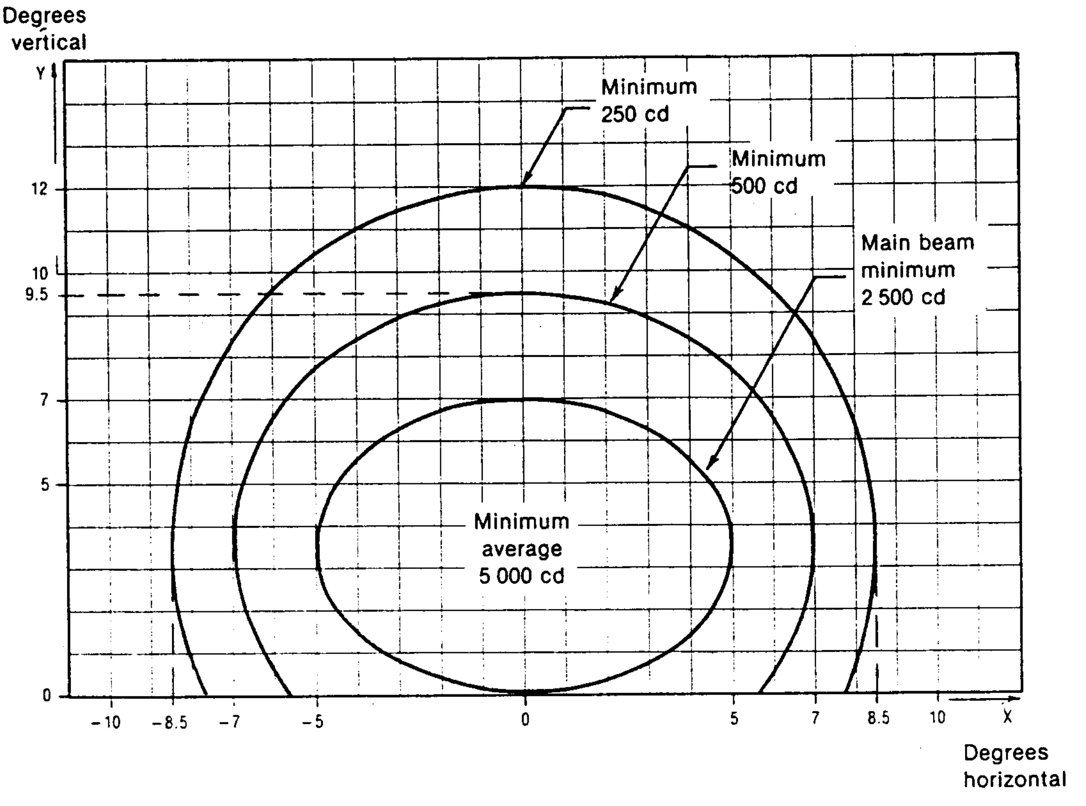
Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.0	7.0	8.5
b	3.5	6.0	8.5

2. Toe-in 4 degrees
3. See collective notes for Figures 2.1 to 2.12.

Figure 2.5 Isocandela diagram for touchdown zone light (white light)



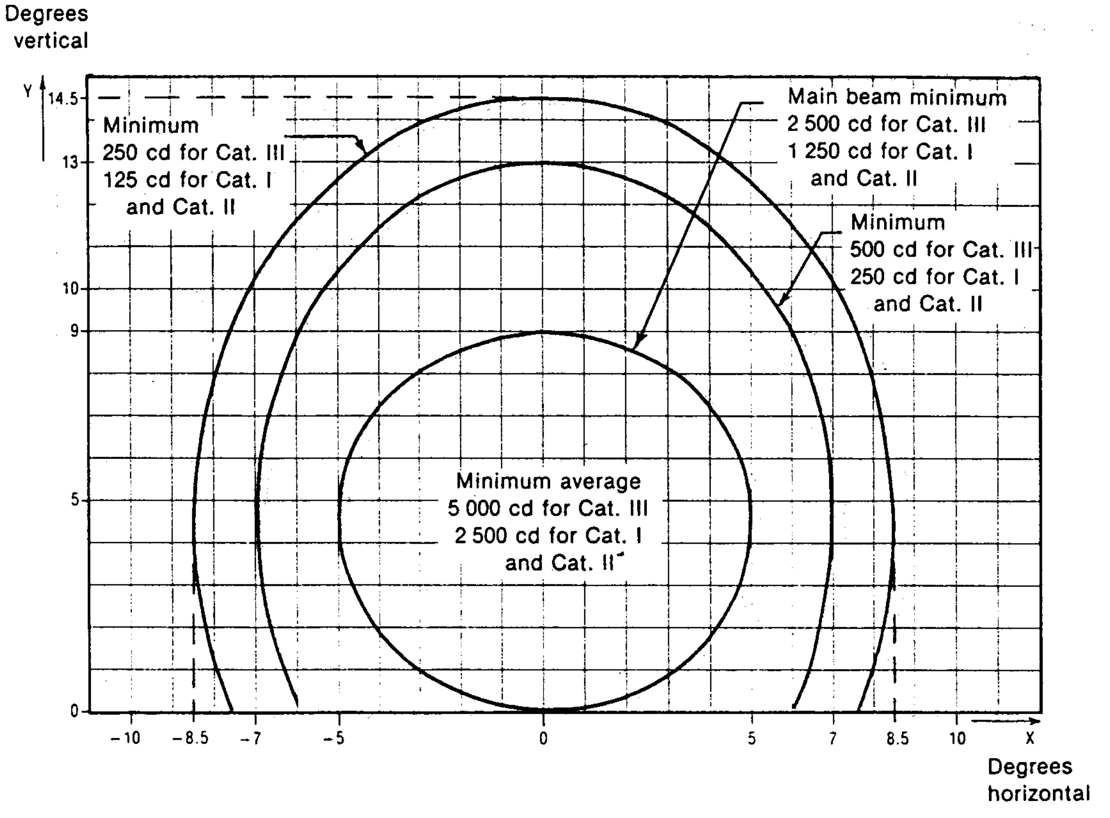
Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.0	7.0	8.5
b	3.5	6.0	8.5

2. For red light multiply values by 0.15
3. See collective notes for Figures 2.1 to 2.12.

Figure 2.6 Isocandela diagram for runway centre line light with 30 m longitudinal spacing (white light)



Notes:

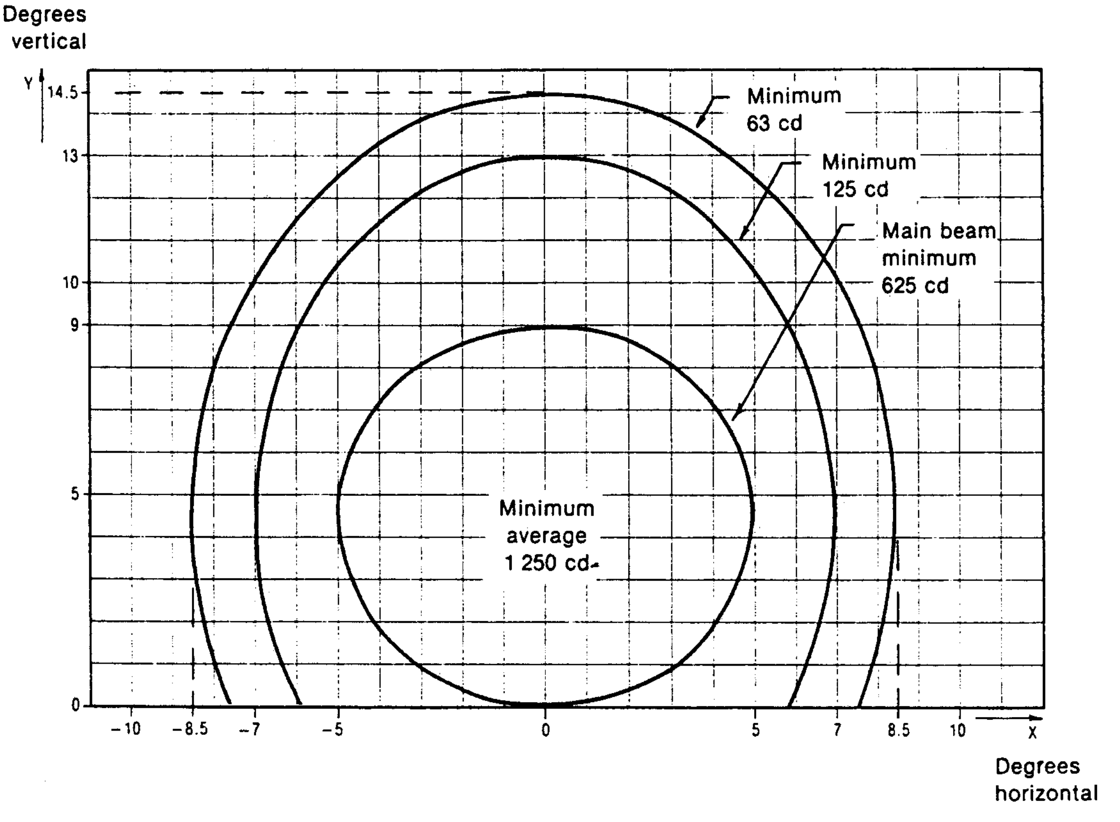
1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.0	7.0	8.5
b	4.5	8.5	10

2. For red light multiply values by 0.15

3. See collective notes for Figures 2.1 to 2.12.

Figure 2.7 Isocandela diagram for runway centre line light with 15 m longitudinal spacing (white light)



Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.0	7.0	8.5
b	4.5	8.5	10

2. For red light multiply values by 0.15

3. See collective notes for Figures 2.1 to 2.12.

Figure 2.8 Isocandela diagram for runway centre line light with 7.5 m longitudinal spacing (white light)

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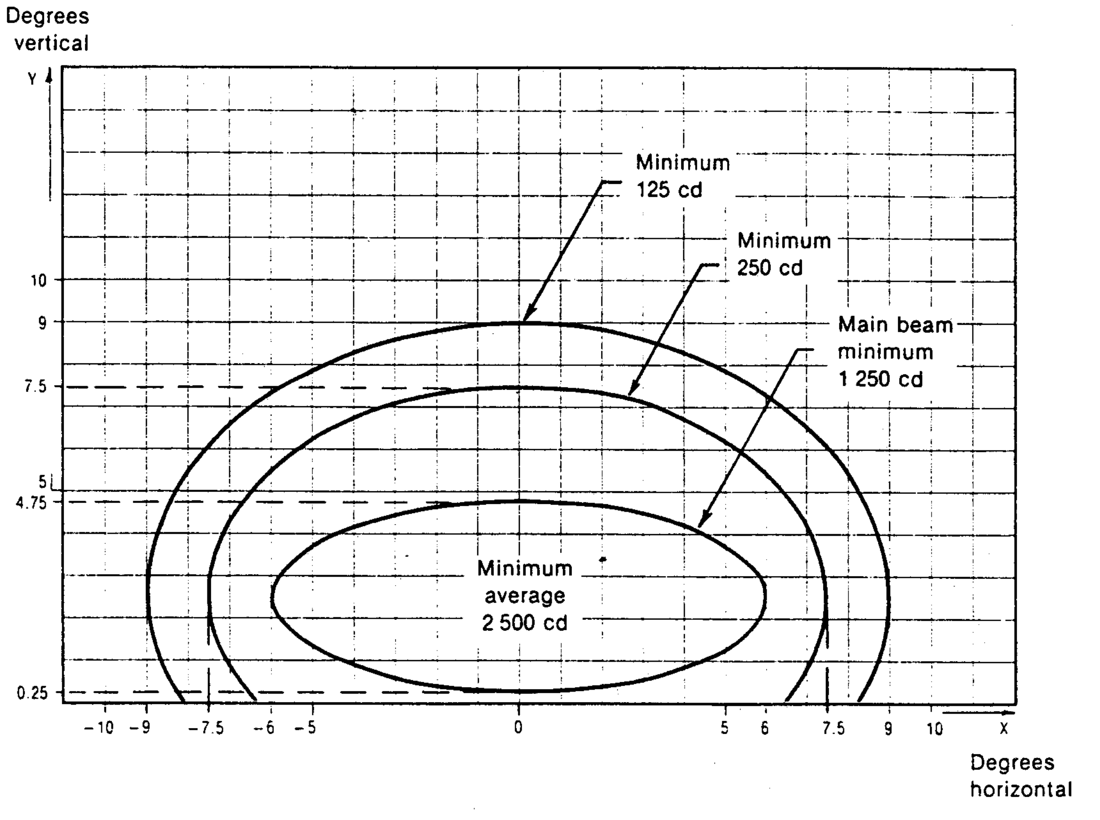


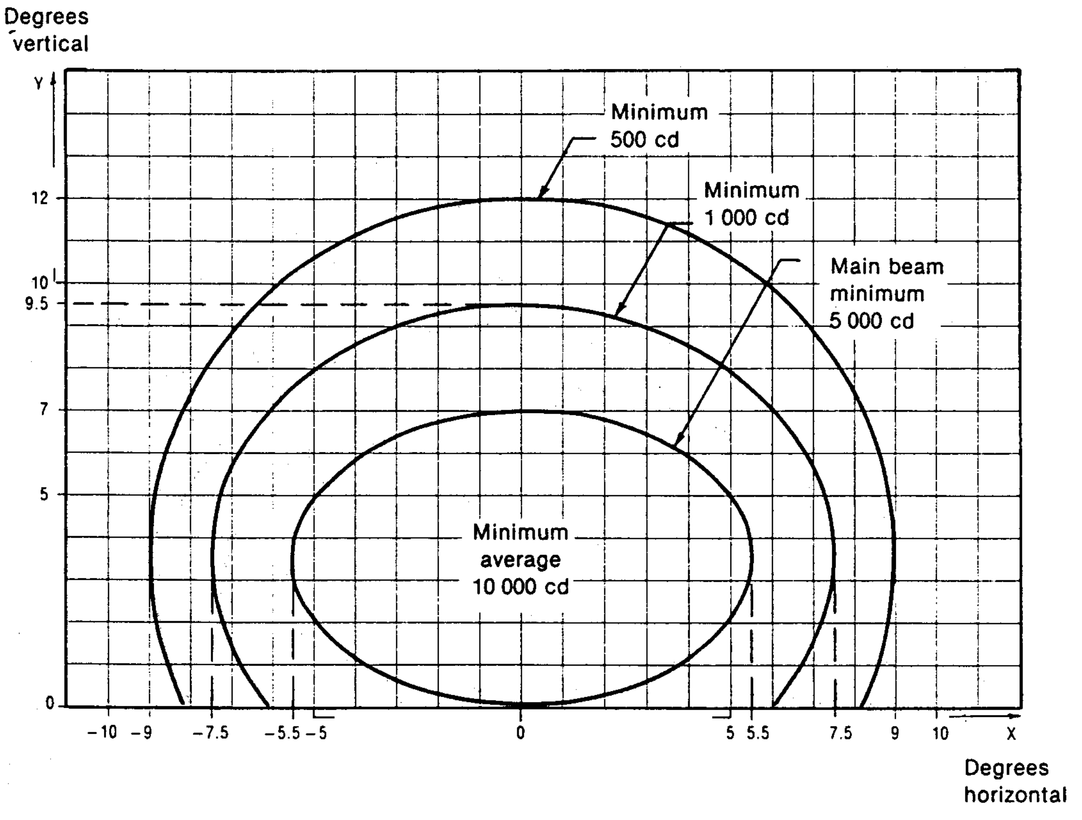
Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	6.0	7.5	9.0
b	2.25	5.0	6.5

2. See collective notes for Figures 2.1 to 2.12.

Figure 2.9 Isocandela diagram for runway end light (red light)



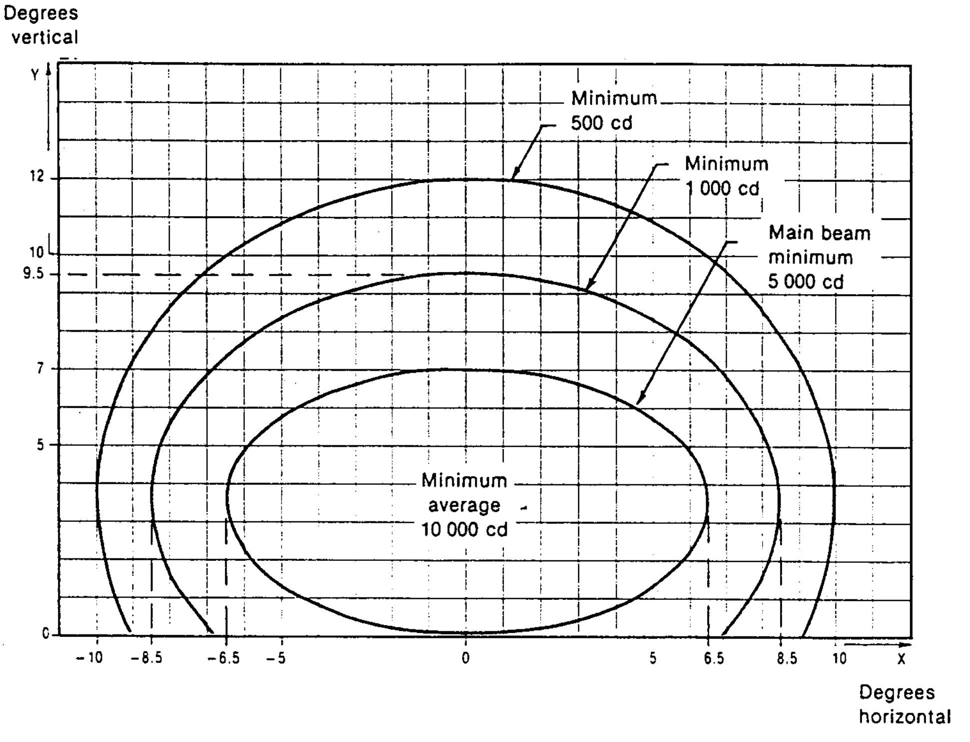
Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	5.5	7.5	9.0
b	3.5	6.0	8.5

2. Toe-in 3.5 degrees
3. For yellow light multiply values by 0.4
4. See collective notes for Figures 2.1 to 2.12.

Figure 2.10 Isocandela diagram for runway edge light where width of runway is 45 m (white light)



Notes:

1. Curves calculated on formula $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

a	6.5	8.5	10.0
b	3.5	6.0	8.5

2. Toe-in 4.5 degrees
3. For yellow light multiply values by 0.4
4. See collective notes for Figures 2.1 to 2.12.

Figure 2.11 Isocandela diagram for runway edge light where width of runway is 60 m (white light)

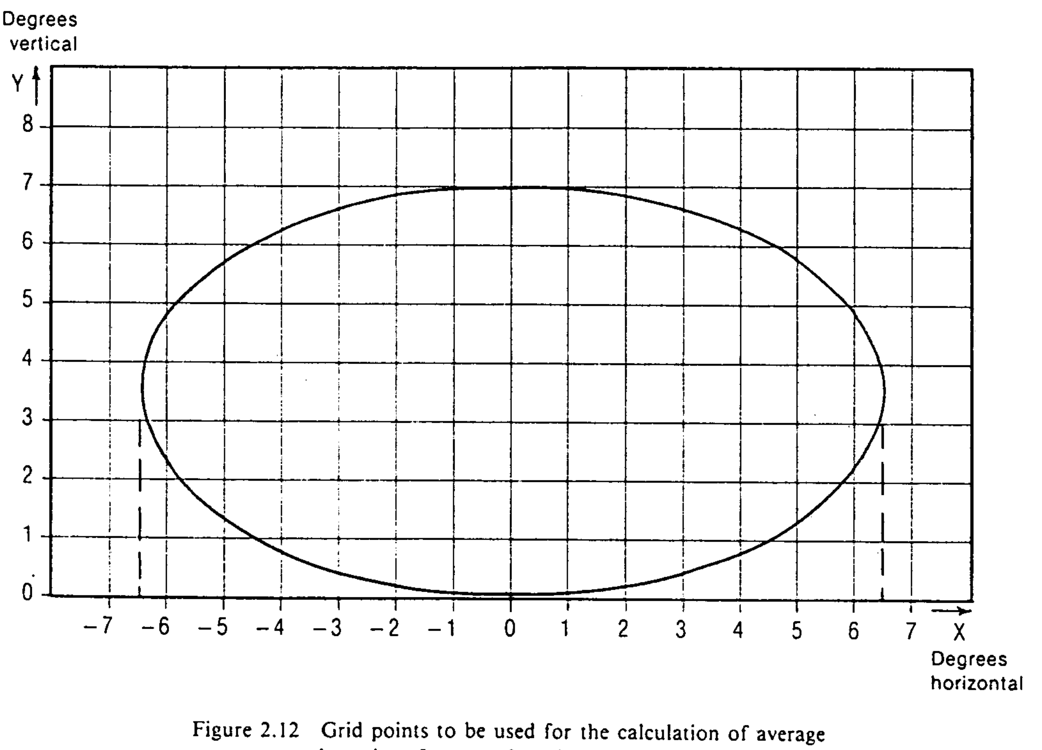


Figure 2.12 Grid points to be used for the calculation of average intensity of approach and runway lights

Collective notes to Figures 2.1 to 2.12

1. The ellipses in each figure are symmetrical about the common vertical and horizontal axes.

2. Figures 2.1 to 2.11 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure 2.12 and using the intensity values measures at all grid points located within and on the perimeter of the ellipse representing the main beam. The average value is the arithmetic average of light intensities measured at all considered grid points.

3. No deviations are acceptable in the main beam pattern when the lighting fixture is properly aimed.

4. Average intensity ratio. The ratio between the average intensity within the ellipse defining the main beam of a typical new light and the average light intensity of the main beam of a new runway edge light shall be as follows:

Figure 2.1	Approach centre line and crossbars	1.5 to 2.0 (white light)
Figure 2.2	Approach side row	0.5 to 1.0 (red light)
Figure 2.3	Threshold	1.0 to 1.5 (green light)
Figure 2.4	Threshold wing bar	1.0 to 1.5 (green light)
Figure 2.5	Touchdown zone	0.5 to 1.0 (white light)
Figure 2.6	Runway centre line (longitudinal spacing 30 m)	0.5 to 1.0 (white light)
Figure 2.7	Runway centre line (longitudinal spacing 15 m)	0.5 to 1.0 for CAT III (white light) 0.25 to 0.5 for CAT I, II (white light)
Figure 2.8	Runway centre line (longitudinal spacing 7.5 m)	0.12 to 0.25 (white light)
Figure 2.9	Runway end	0.25 to 0.5 (red light)
Figure 2.10	Runway edge (45 m runway width)	1.0 (white light)
Figure 2.11	Runway edge (60 m runway width)	1.0 (white light)

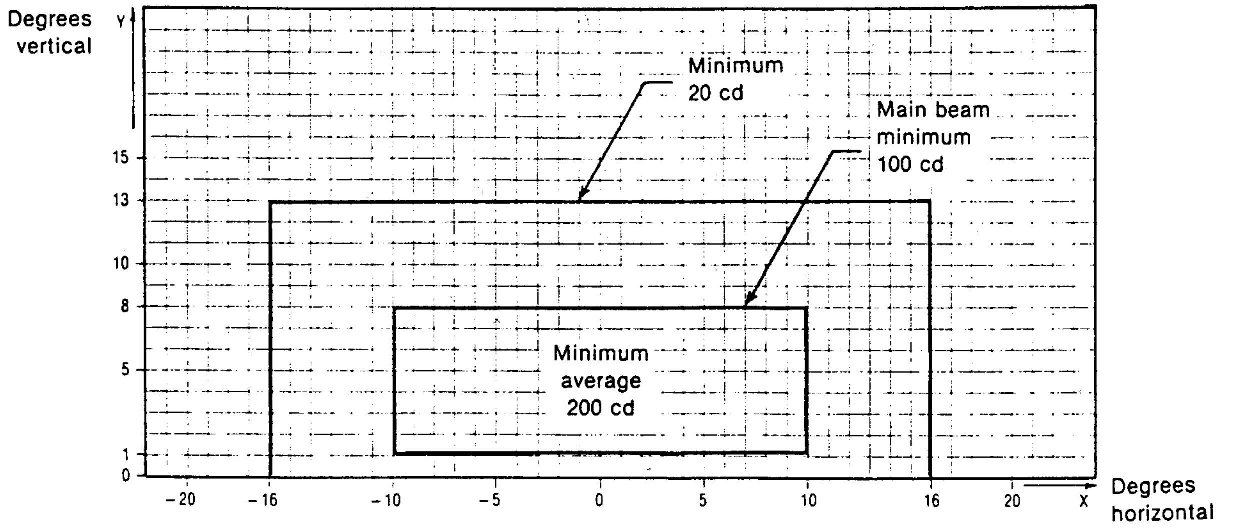
5. The beam coverages in the figures provide the necessary guidance for approaches down to an RVR of the order of 150 m and take-offs down to an RVR of the order of 100 m.

6. Horizontal angles are measured with respect to the vertical plane through the runway centre line. For lights other than centre line lights, the direction towards the runway centre line is considered positive. Vertical angles are measured with respect to the horizontal plane.

7. Where, for approach centre line lights and crossbars and for approach side row lights, inset lights are used in lieu of elevated lights, e.g. on a runway with a displaced threshold, the intensity requirements can be met by installing two or three fittings (lower intensity) at each position.

8. The importance of adequate maintenance cannot be over-emphasized. The average intensity should never fall to a value less than 50 per cent of the value shown in the figures and it should be the aim of airport authorities to maintain a level of light output close to the specified minimum average intensity.

9. The light unit shall be installed so that the main beam is aligned within one-half degree of the specified requirement.

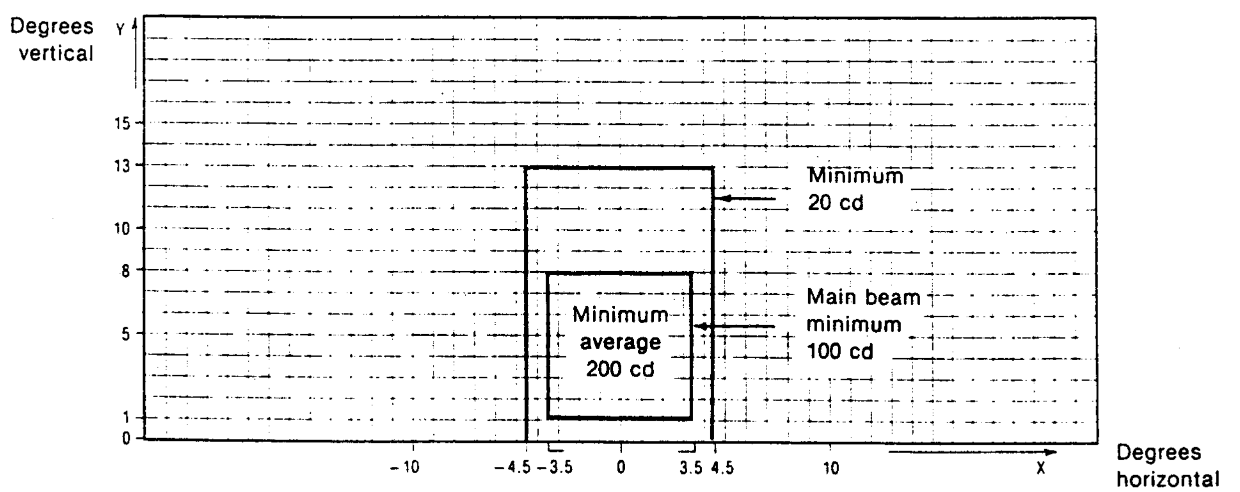


Notes:

1. These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m and are intended for use before and after curves.

2. See collective notes for Figures 2.13 to 2.18

Figure 2.13 Isocandela diagram for taxiway centre line (15 m spacing) and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 350 m where large offsets can occur

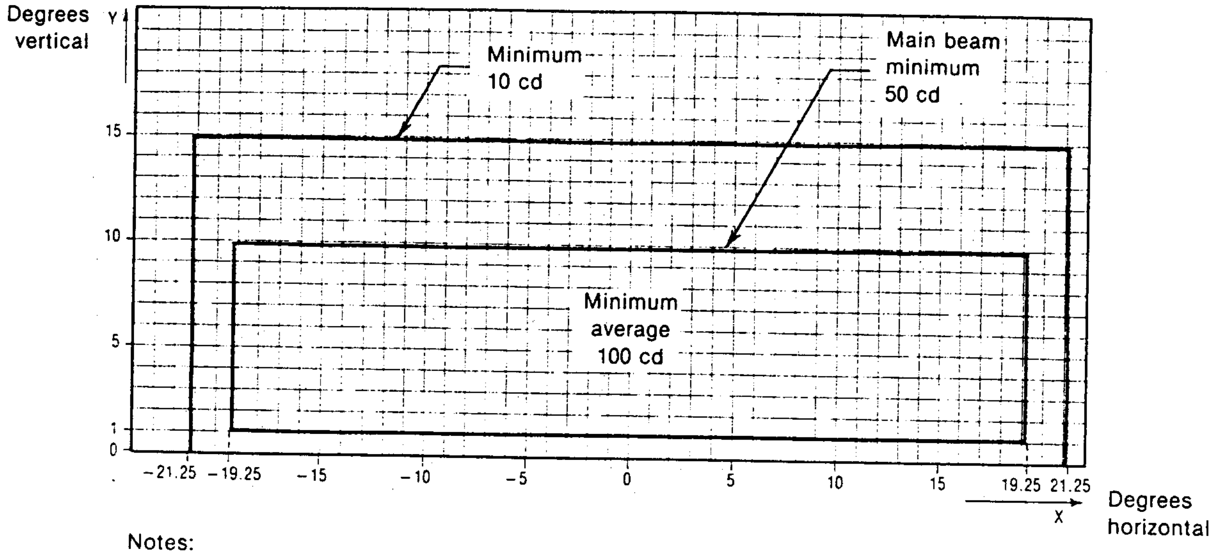


Notes:

1. These beam coverages are generally satisfactory and cater for a normal displacement of the cockpit from the centre line of approximately 3 m.

2. See collective notes for Figures 2.13 to 2.18

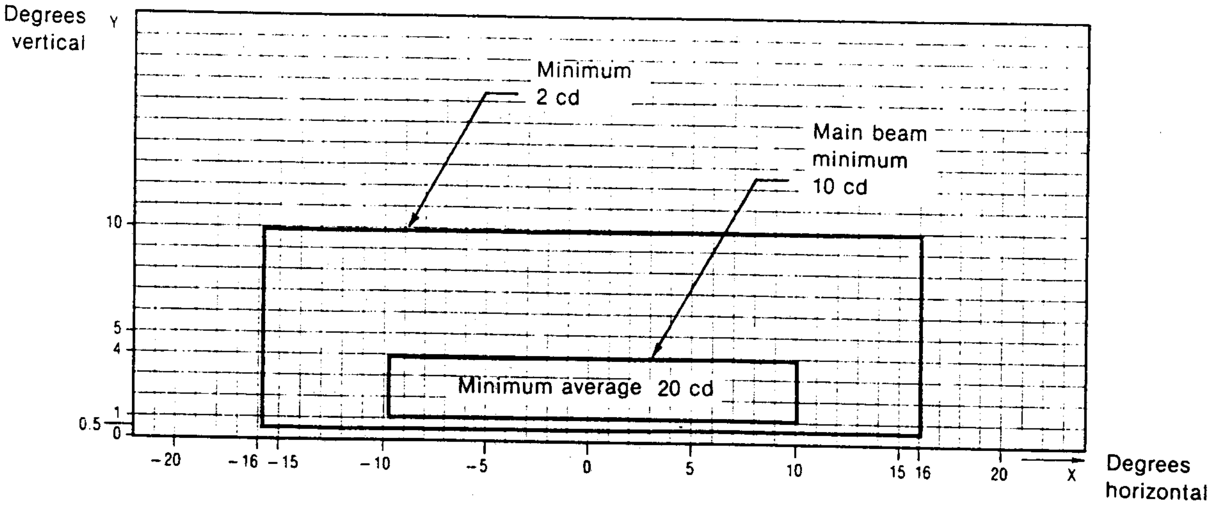
Figure 2.14 Isocandela diagram for taxiway centre line (15 m spacing) and stop bar lights in straight sections intended for use in runway visual range conditions of less than a value of 350 m



Notes:

1. Lights on curves to be toed-in 15.75 degrees with respect to the tangent of the curve.
2. See collective notes for Figures 2.13 to 2.18

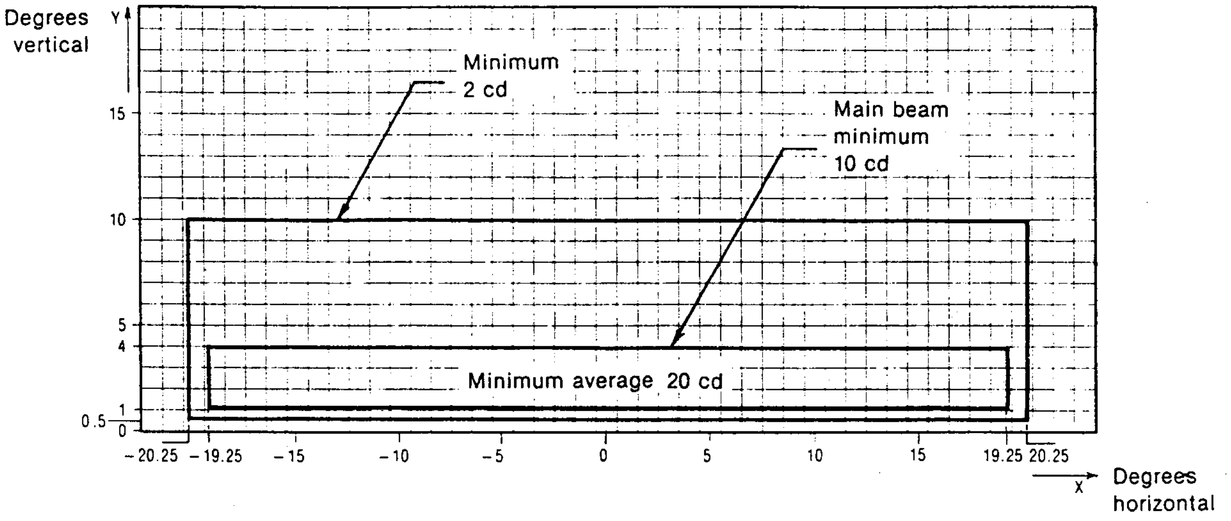
Figure 2.15 Isocandela diagram for taxiway centre line (7.5 m spacing) and stop bar lights in curved sections intended for use in runway visual range conditions of less than a value of 350 m



Notes:

1. At locations where high background luminance is usual and where deterioration of light output resulting from dust, snow and local contamination is a significant factor, the cd-values should be multiplied by 2.5.
2. Where omnidirectional lights are used they shall comply with the vertical beam requirements in this figure.
3. See collective notes for Figures 2.13 to 2.18

Figure 2.16 Isocandela diagram for taxiway centre line (30 m, 60 m spacing) and stop bar lights in straight sections intended for use in runway visual range conditions of 350 m or greater



Notes:

1. Lights on curves to be toed-in 15.75 degrees with respect to the tangent of the curve.
2. At locations where high background luminance is usual and where deterioration of light output resulting from dust, snow and local contamination is a significant factor, the cd-values should be multiplied by 2.5.
3. These beam coverages allow for displacement of the cockpit from the centre line up to distances of the order of 12 m as could occur at the end of curves.
4. See collective notes for Figures 2.13 to 2.18

Figure 2.17 Isocandela diagram for taxiway centre line (7.5 m, 15 m, 30 m spacing) and stop bar lights in curved sections intended for use in runway visual range conditions of 350 m or greater

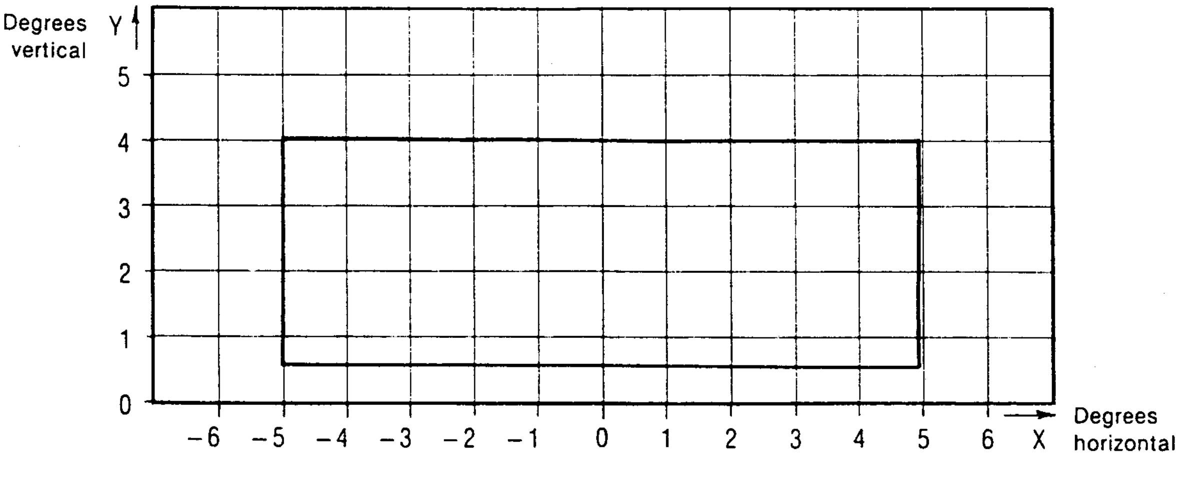


Figure 2.18 Grid points to be used for calculation of average intensity of taxiway centre line and stop bar lights

Collective notes to Figures 2.13 to 2.18

1. Figures 2.13 to 2.17 show candela values in green and yellow for taxiway centre line lights and red for stop bar lights.

2. Figures 2.13 to 2.17 show the minimum allowable light intensities. The average intensity of the main beam is calculated by establishing grid points as shown in Figure 2.18 and using the intensity values measured at all grid points located within and on the perimeter of the rectangle representing the main beam. The average value is the arithmetic average of the light intensities measured at all considered grid points.

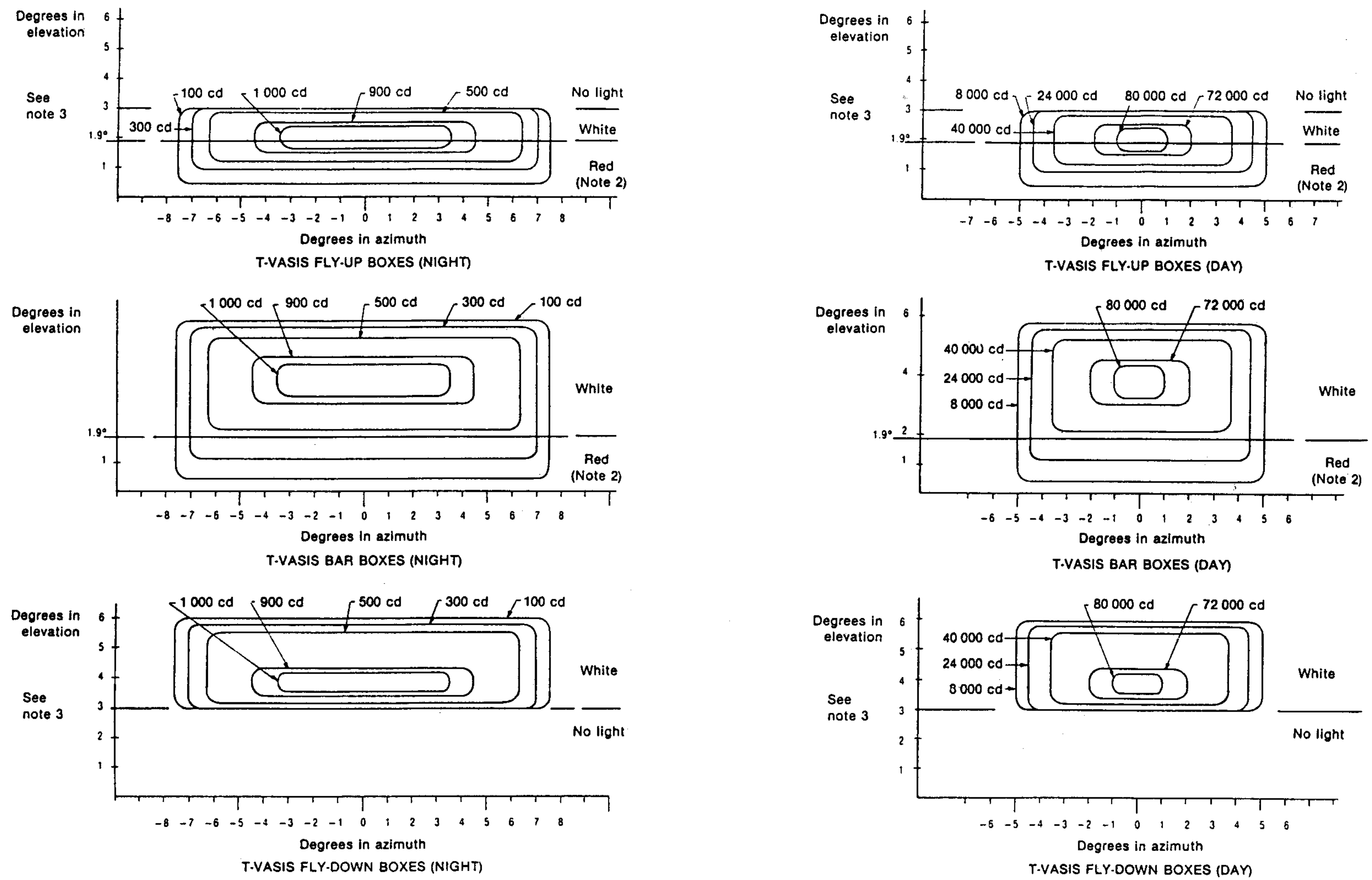
3. No deviations are acceptable in the main beam when the lighting fixture is properly aimed.

4. Horizontal angles are measured with respect to the vertical plane through the taxiway centre line except on curves where they are measured with respect to the tangent to the curve.

5. Vertical angles are measured from the longitudinal slope of the taxiway surface.

6. The importance of adequate maintenance cannot be over-emphasized. The average intensity should never fall to a value less than 50 per cent of the value shown in the figures and it should be the aim of airport authorities to maintain a level of light output close to the specified minimum average intensity.

7. The light unit shall be installed so that the main beam is aligned within one-half degree of the specified requirement.



Note 1.— These curves are for minimum intensities in white light.

Note 2.— Filter transmissivity for all red signals is 15 per cent minimum at operating temperature.

Note 3.— A sharp transition from white to no light in elevation is essential to T-VASIS operation. For exact elevation settings, see Figure 5-11.

Figure 2.19 Light intensity distribution of T-VASIS and AT-VASIS

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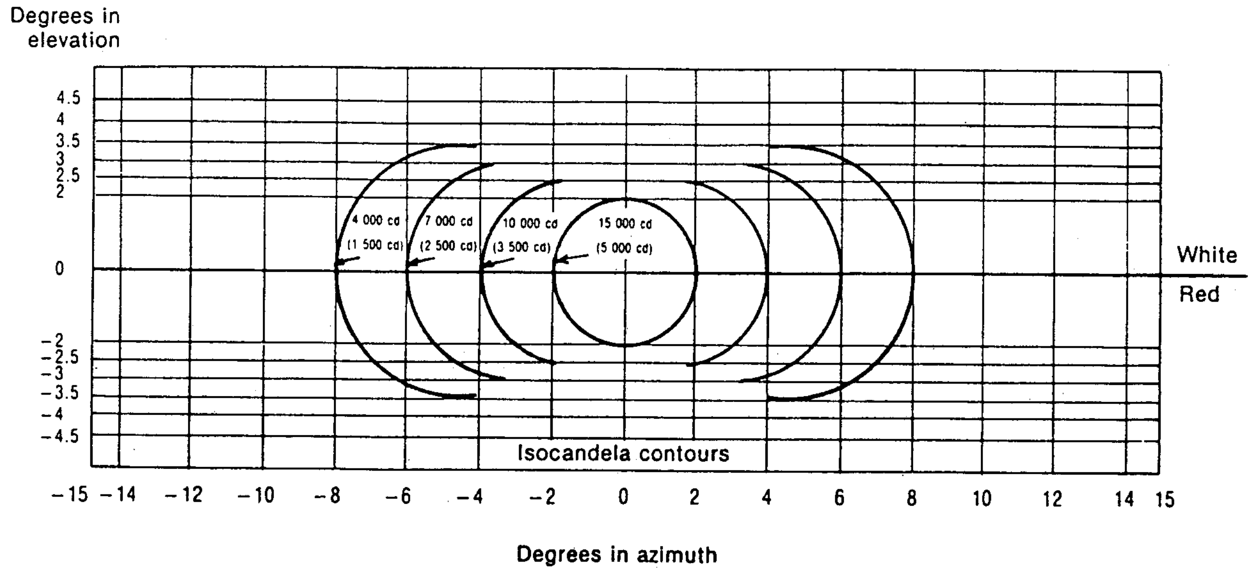


Note 1.— These curves are for minimum intensities in red light.

Note 2.— The intensity value in the white sector of the beam is no less than 2 and may be as high as 6.5 times the corresponding intensity in the red sector.

Note 3.— The intensity values shown in brackets are for APAPI.

Figure 2.20 Light intensity distribution of PAPI and APAPI

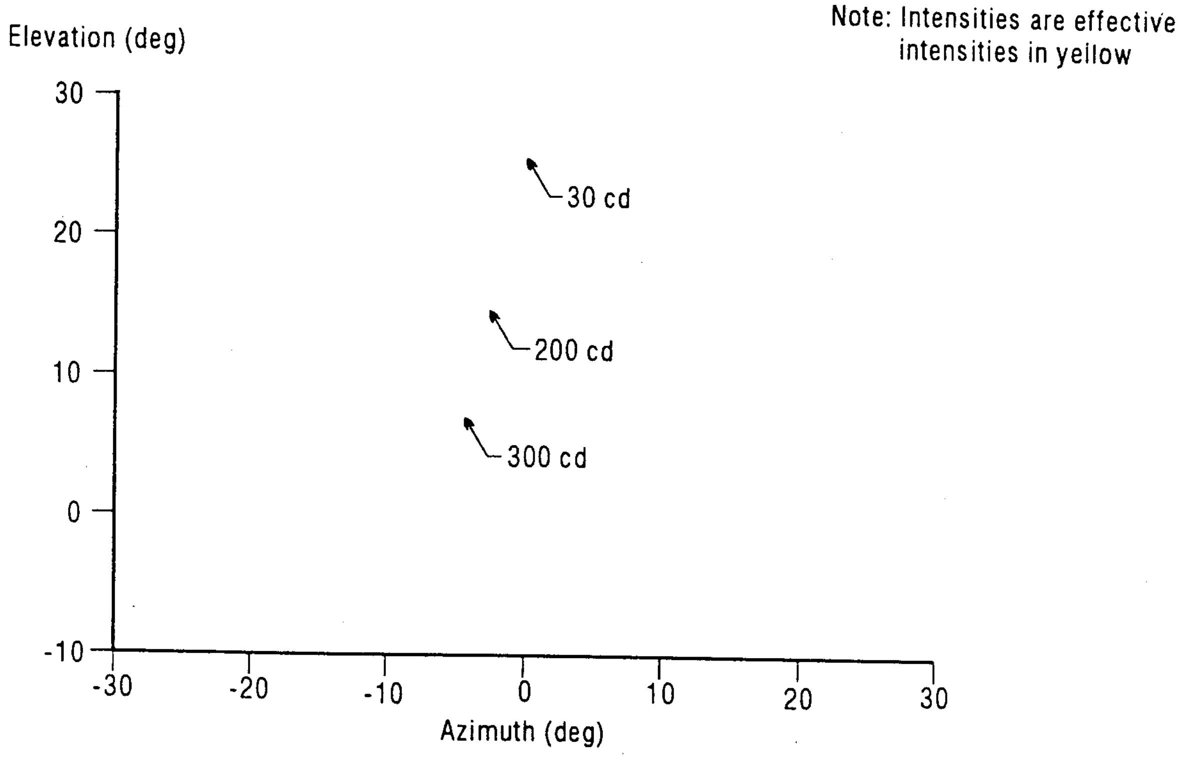
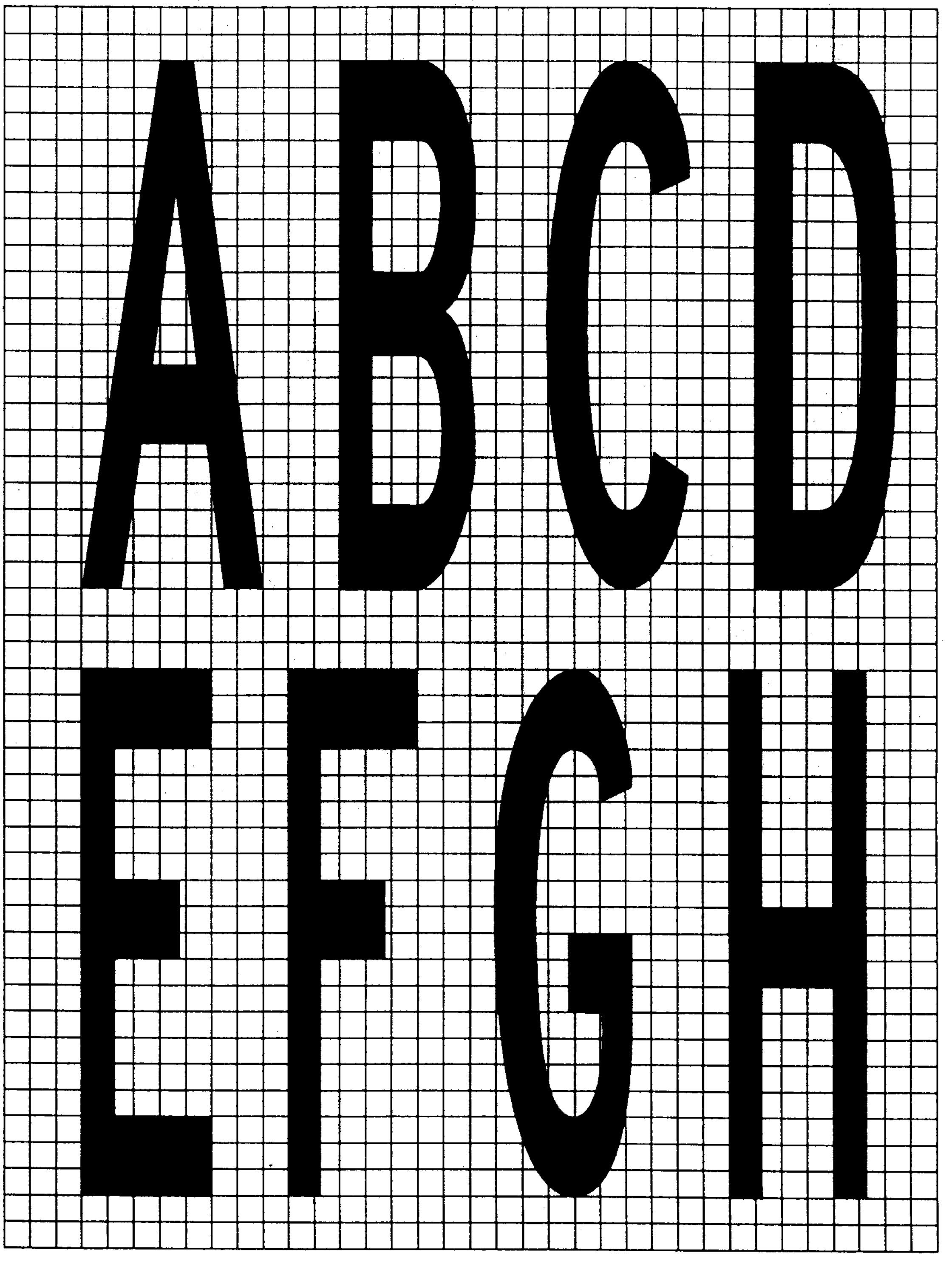


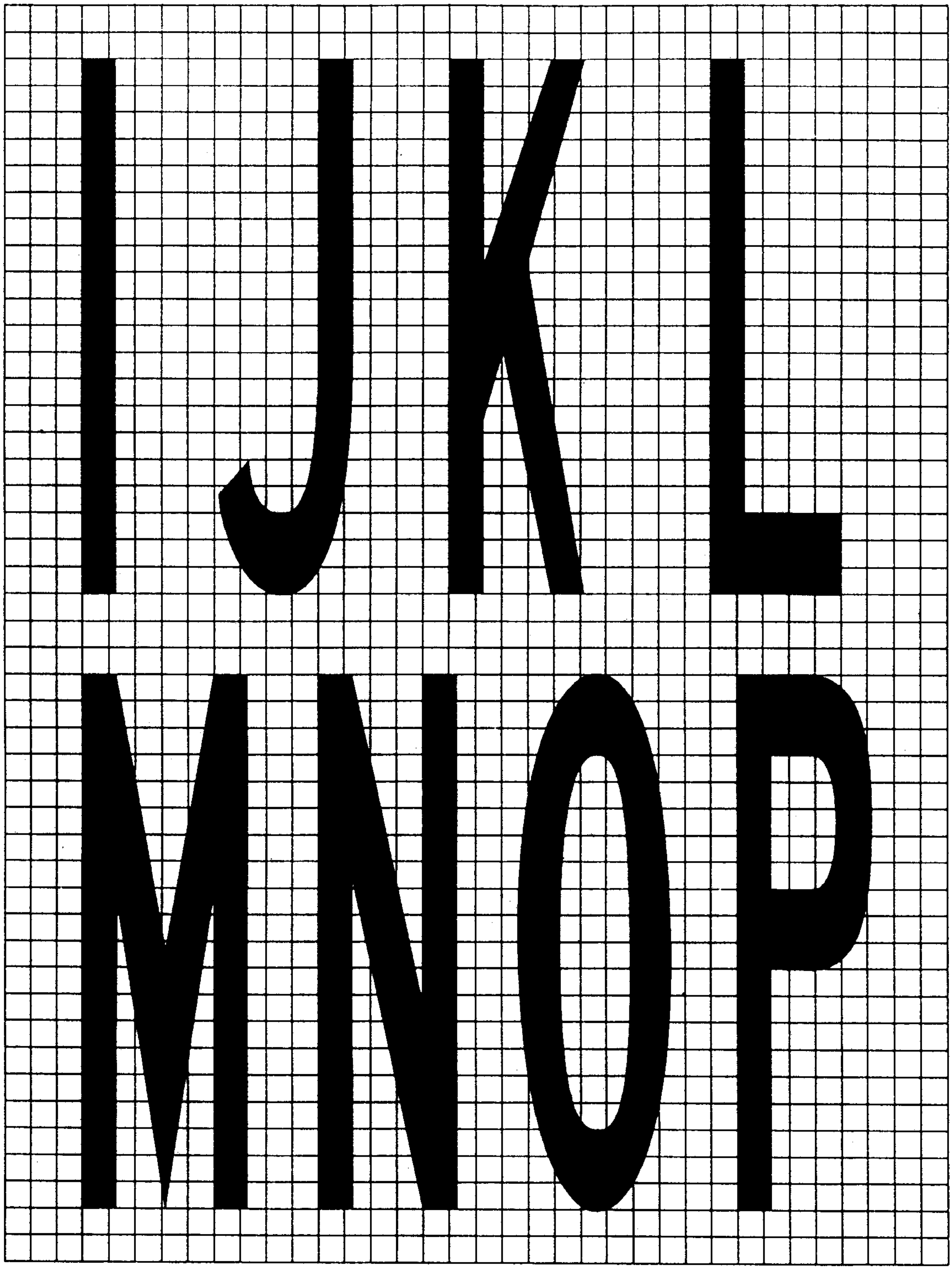
Figure 2.21 Isocandela diagram for runway guard lights. Configuration A

APPENDIX 3. INFORMATION MARKINGS

Note 1.— See Chapter 5, Section 5.2.15 for specifications on the application, location and characteristics of information markings.

Note 2.— The appendix details the form and proportions of the letters, numbers and symbols of information markings on a 20 cm grid.





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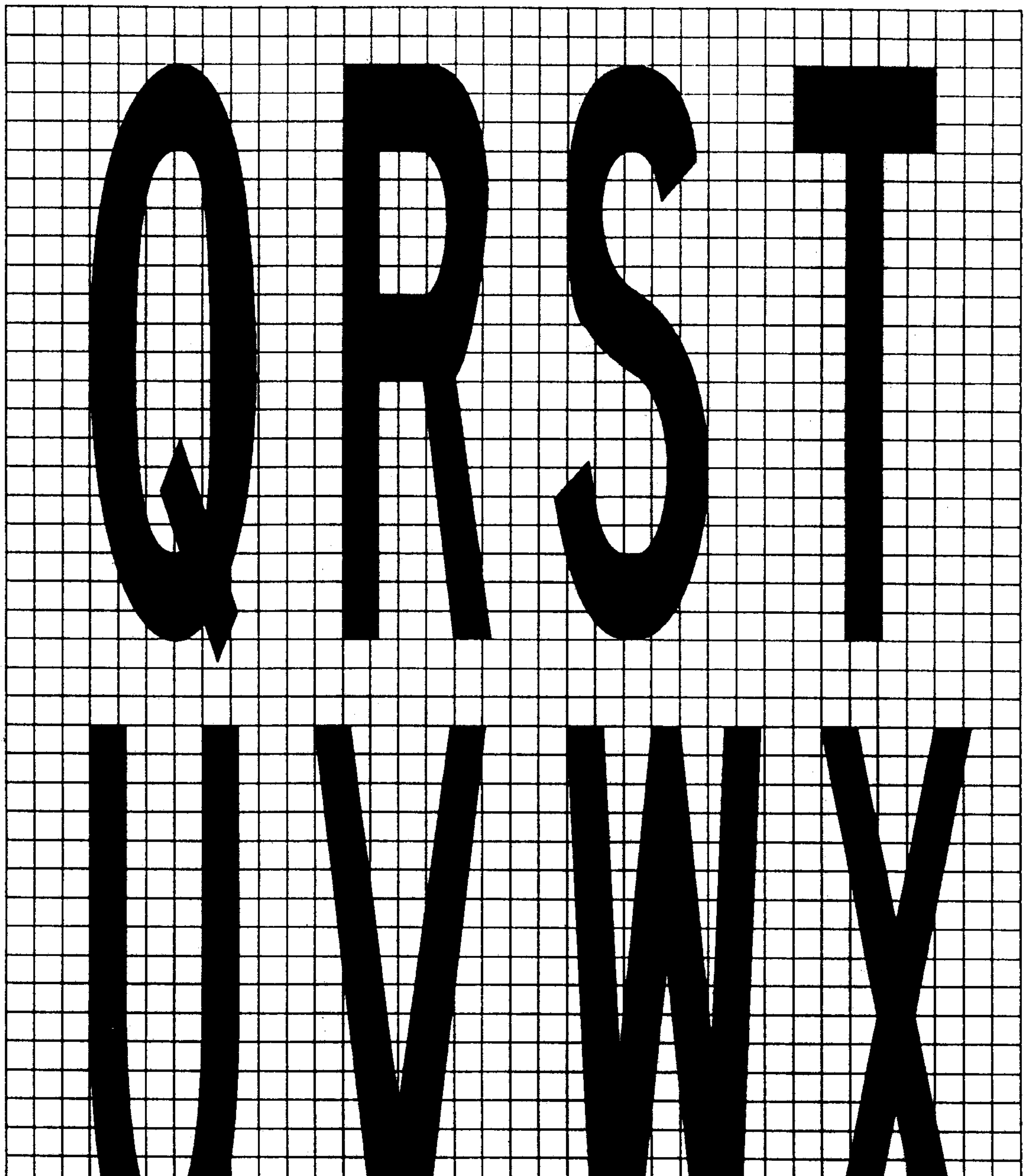

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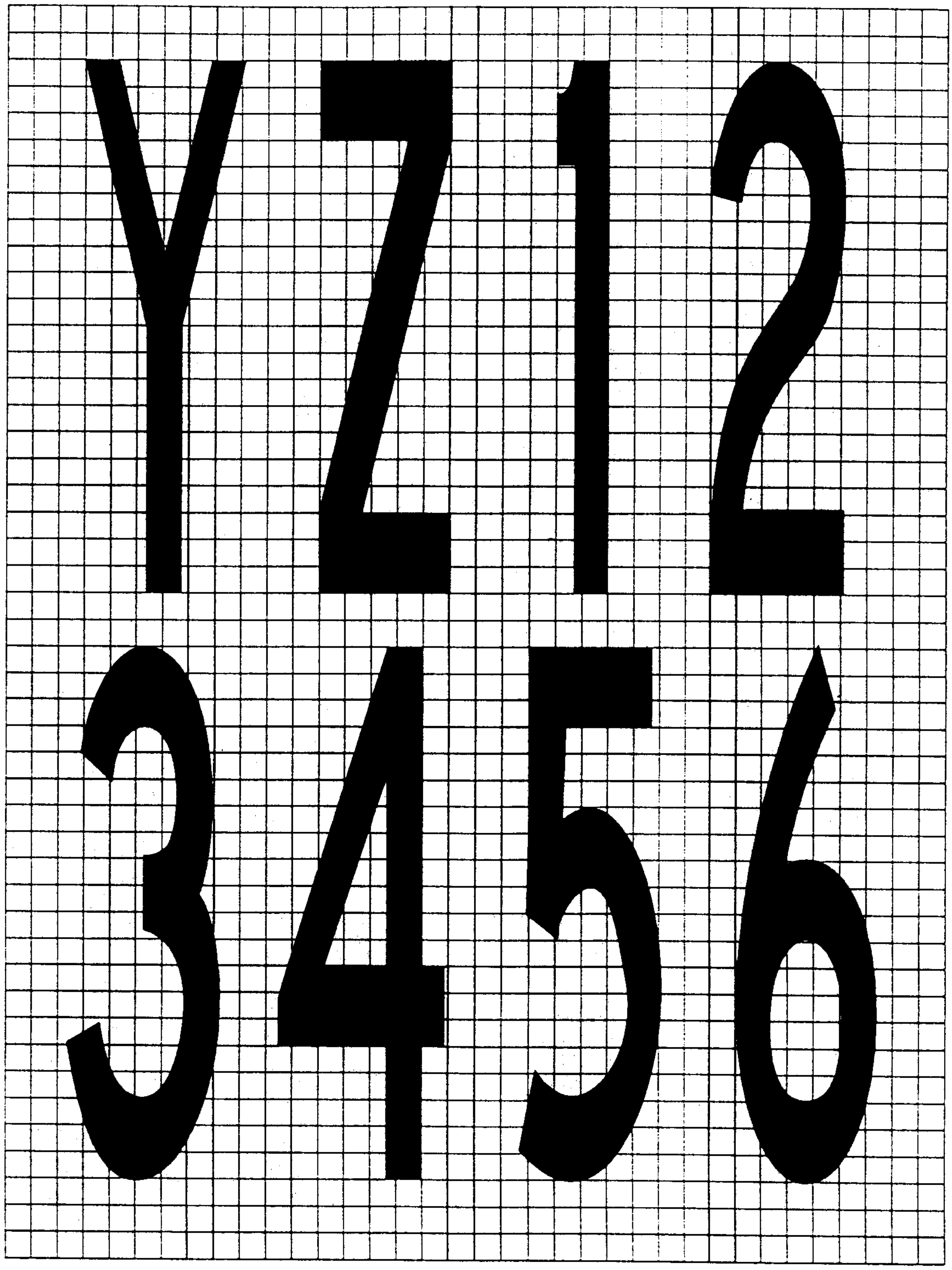

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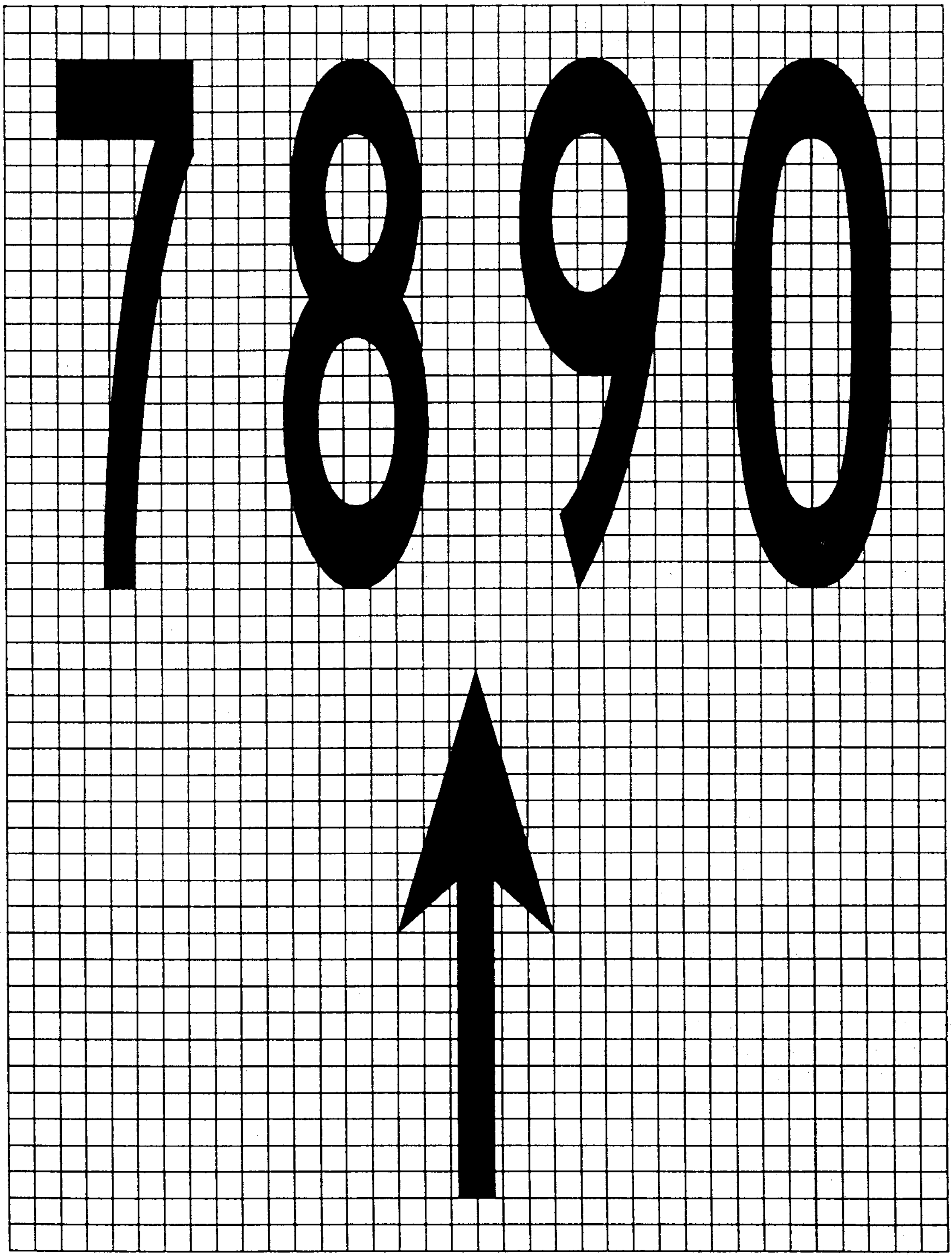

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APPENDIX 4. REQUIREMENTS CONCERNING DESIGN OF TAXIING GUIDANCE SIGNS

Note.— See Chapter 5, Section 5.4 for specifications on the application, location and characteristics of signs.

1. Inscription heights shall conform to the following tabulation.

Runway code number	Minimum character height		
	Mandatory instruction sign	Information sign	
		Runway exit and runway vacated signs	Other signs
1 or 2	300 mm	300 mm	200 mm
3 or 4	400 mm	400 mm	300 mm

2. Arrow dimensions shall be as follows:

Legend height	*Stroke*
200 mm	32 mm
300 mm	48 mm
400 mm	64 mm

3. Stroke width for single letter shall be as follows:

Legend height	*Stroke*
200 mm	32 mm
300 mm	48 mm
400 mm	64 mm

4. Sign luminance (average sign background luminance) shall be as follows:

a) Where operations are conducted in runway visual range conditions less than a value of 800 m, average sign luminance shall be at least:

Red	30 cd/m^2
Yellow	150 cd/m^2
White	300 cd/m^2

b) Where operations are conducted in accordance with 5.4.1.6 b) and c) and 5.4.1.7, average sign luminance shall be at least:

Red	10 cd/m^2
Yellow	50 cd/m^2
White	100 cd/m^2

Note.— In runway visual range conditions less than a value of 400 m, there will be some degradation in the performance of signs.

5. The luminance ratio between red and white elements of a mandatory sign shall be not less than 1:5 and not greater than 1:10.

6. The average luminance of the sign is calculated by establishing grid points as shown in Figure 4.1 and using the luminance values measured at all grid points located within the rectangle representing the sign.

7. The average value is the arithmetic average of the luminance values measured at all considered grid points.

Note.— Guidance on measuring the average luminance of a sign is contained in the Aerodrome Design Manual, *Part 4.*

8. The forms of characters, i.e. letters, numbers, arrows and symbols, shall conform to those shown in Figure 4.2.

9. The face height of signs shall be as follows:

Legend height	*Face height (min)*
200 mm	400 mm
300 mm	600 mm
400 mm	800 mm

10. The face width of signs shall be determined using Figure 4.3 except that, where a mandatory instruction sign is provided on one side of a taxiway only, the face width shall not be less than:

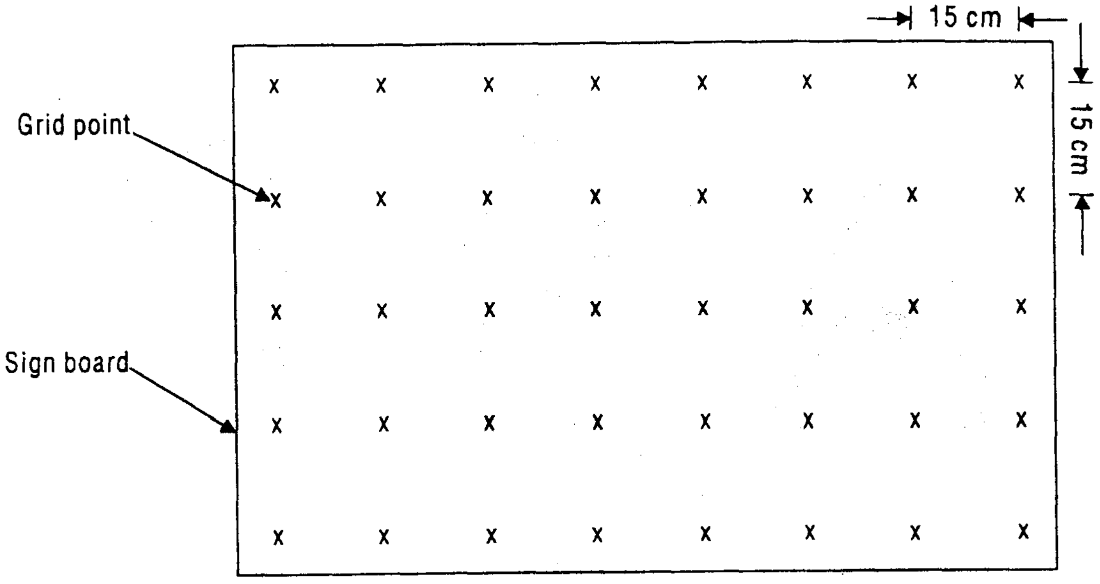
a) 1.94 m where the code number is 3 or 4; and

b) 1.46 m where the code number is 1 or 2.

11. Borders

a) The black vertical delineator between adjacent direction signs should have a width of approximately 0.7 of the stroke width.

b) The yellow border on a stand-alone location sign should be approximately 0.5 stroke width.



Note 1.— The average luminance of a sign background is calculated by establishing grid points as shown in the figure on a blank face plate (without inscriptions) of the appropriate colour (red for mandatory instruction signs and yellow for direction and destination signs). Luminance values are measured at all grid points within the sign area. The average value of the luminance is the arithmetic mean of all the measured values.

Note 2.— In order to achieve uniformity of signal, luminance values should not exceed a ratio of 1.5:1 between adjacent grid points and 5:1 between maximum and minimum values over the whole face.

Note 3.— Grid points within 5 cm of the edge of the sign should be excluded from the calculations.

Note 4.— Further guidance on determining the average luminance of a sign is contained in the Aerodrome Design Manual, *Part 4 —* Visual Aids *(Doc 9157).*

Figure 4.1 Means of calculating average luminance of a sign background

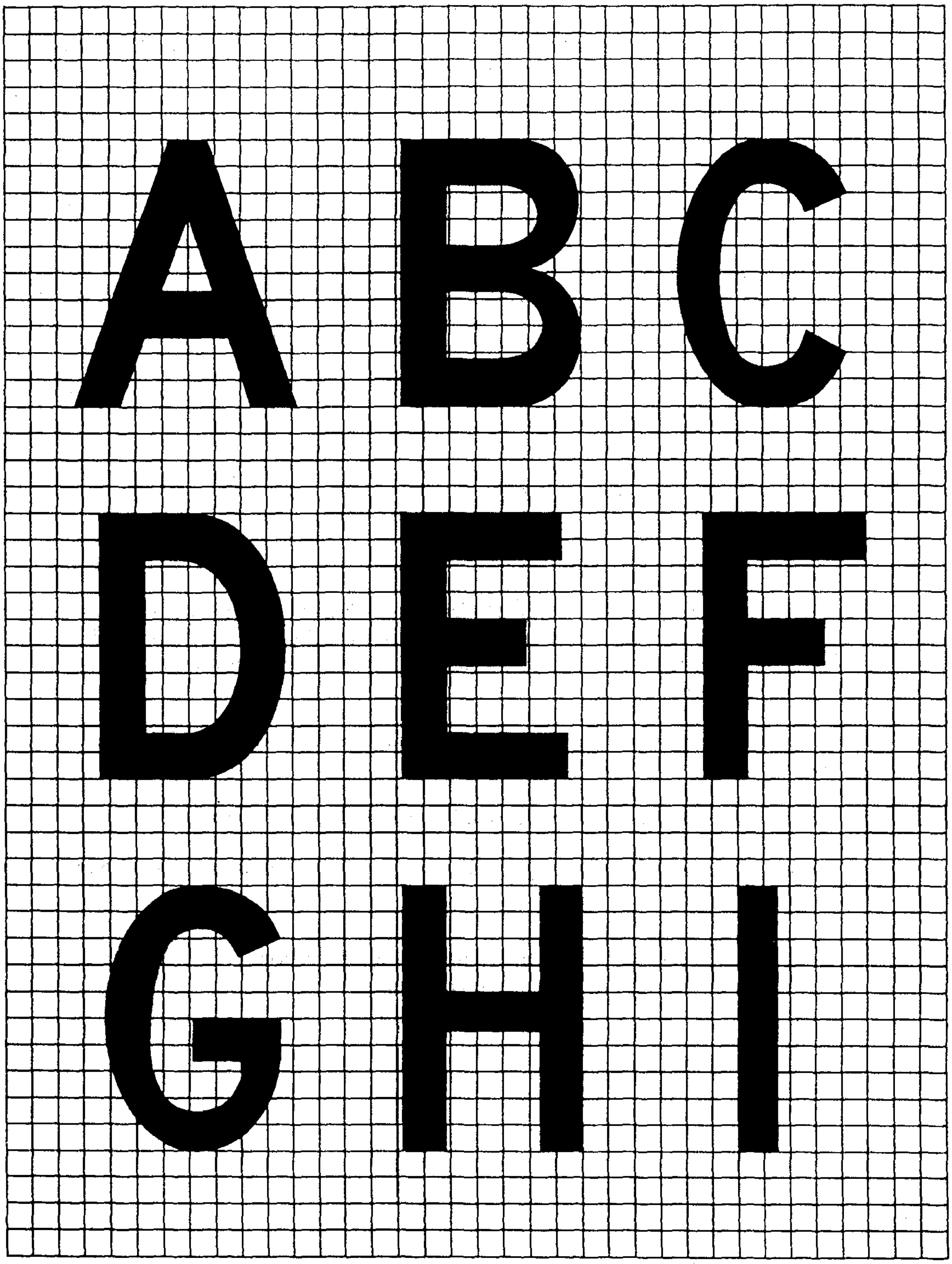


Figure 4.2 Forms of characters

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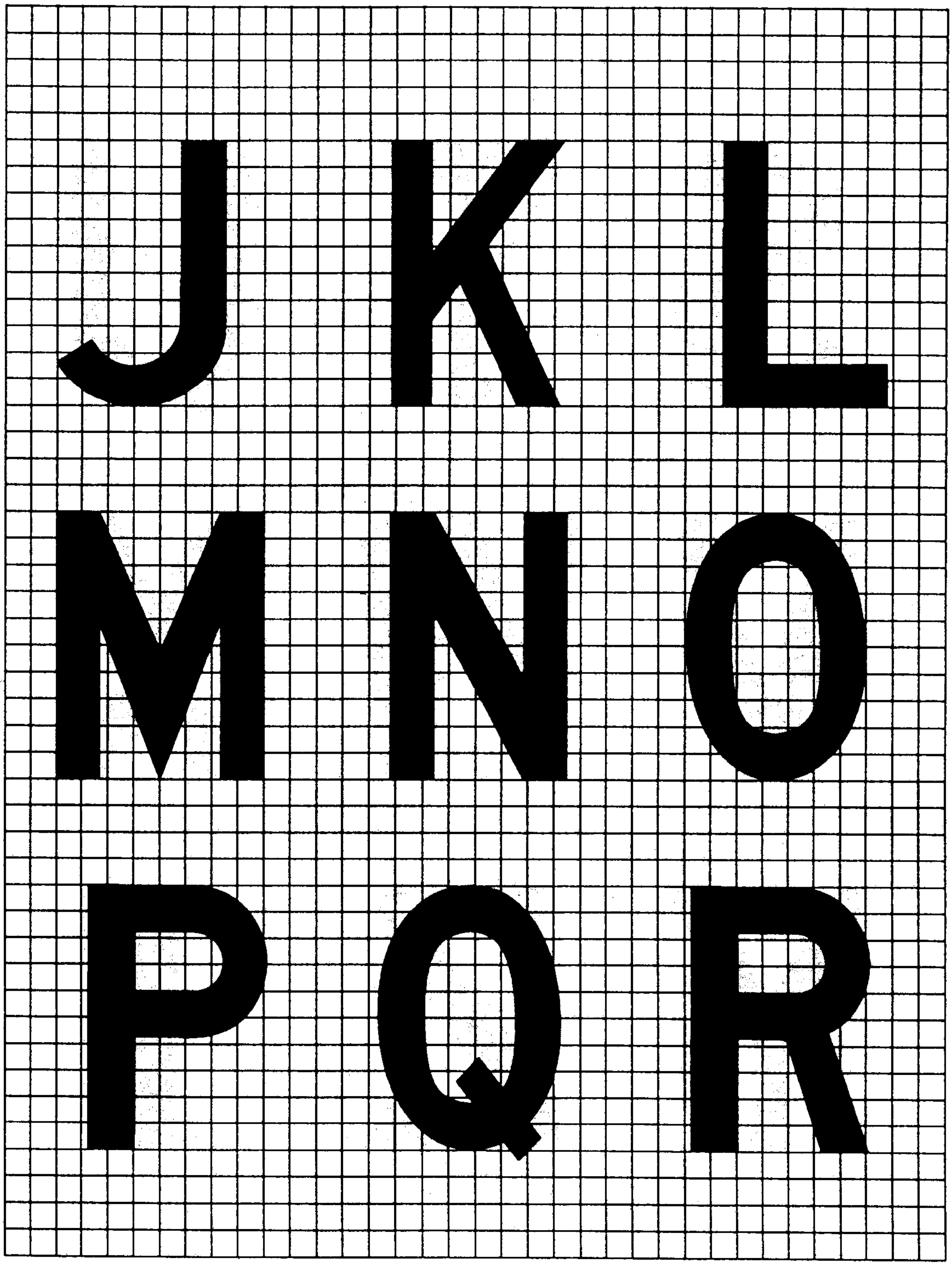

Figure 4.2 (cont.)

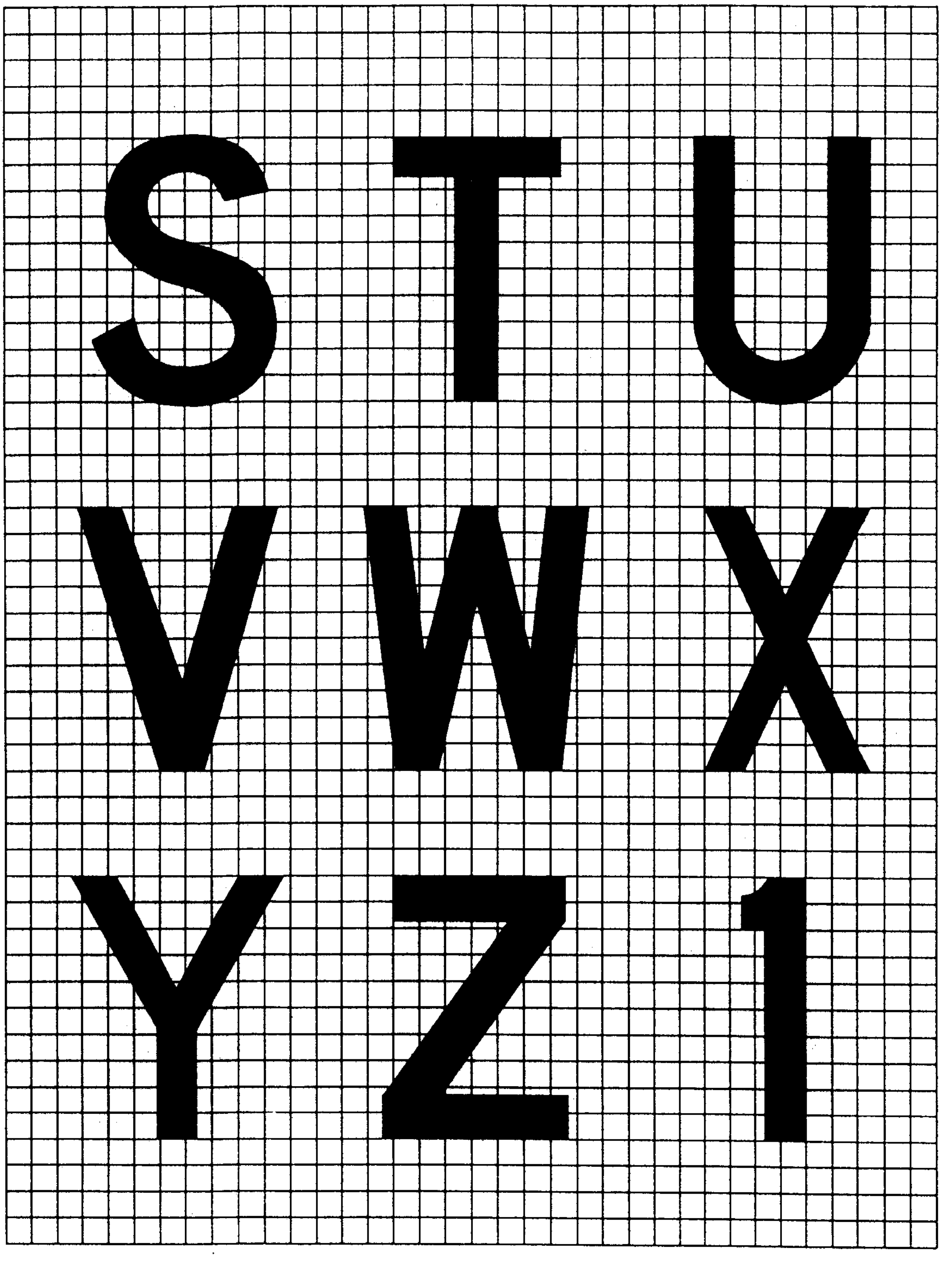

Figure 4.2 (cont.)

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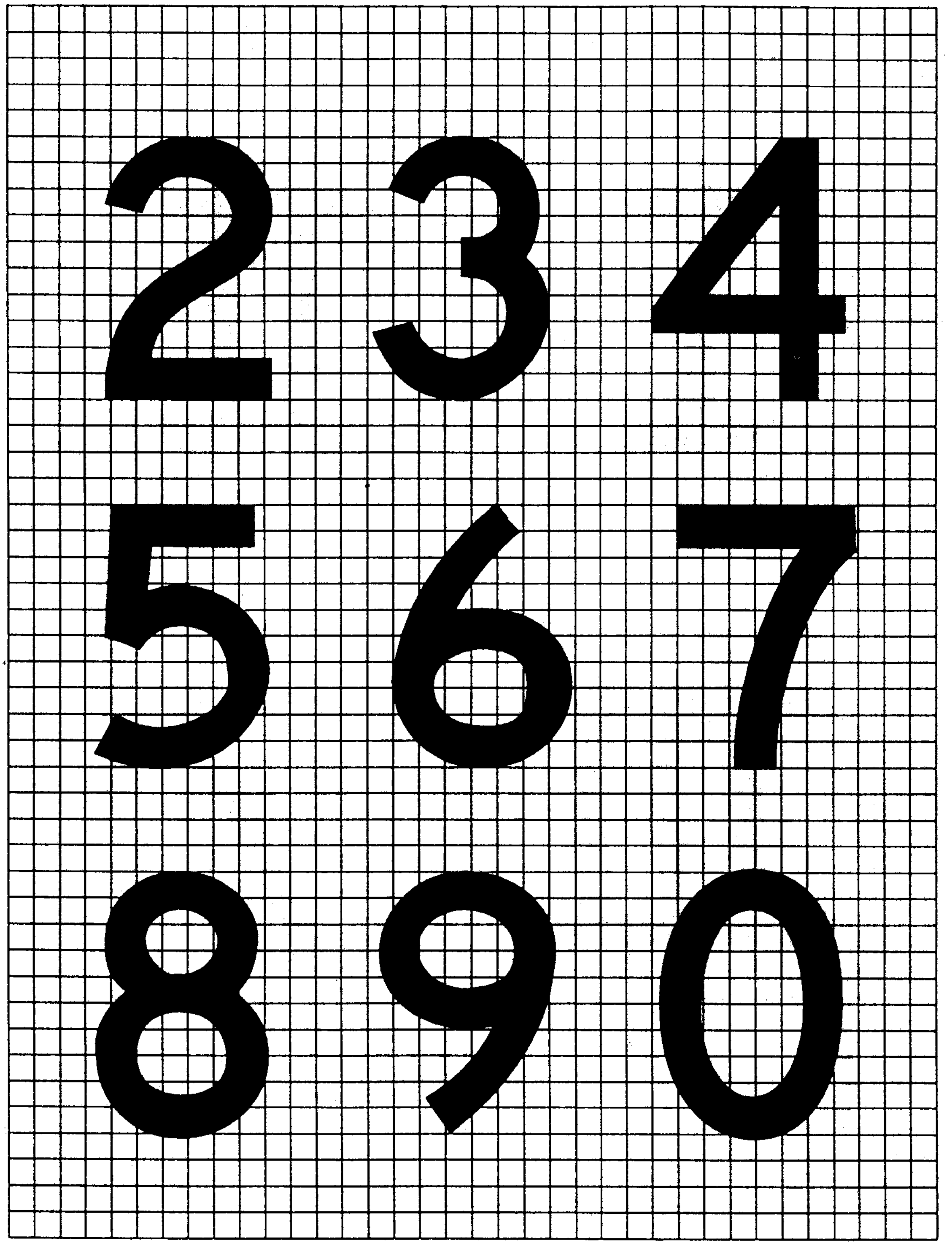


Figure 4.2 (cont.)

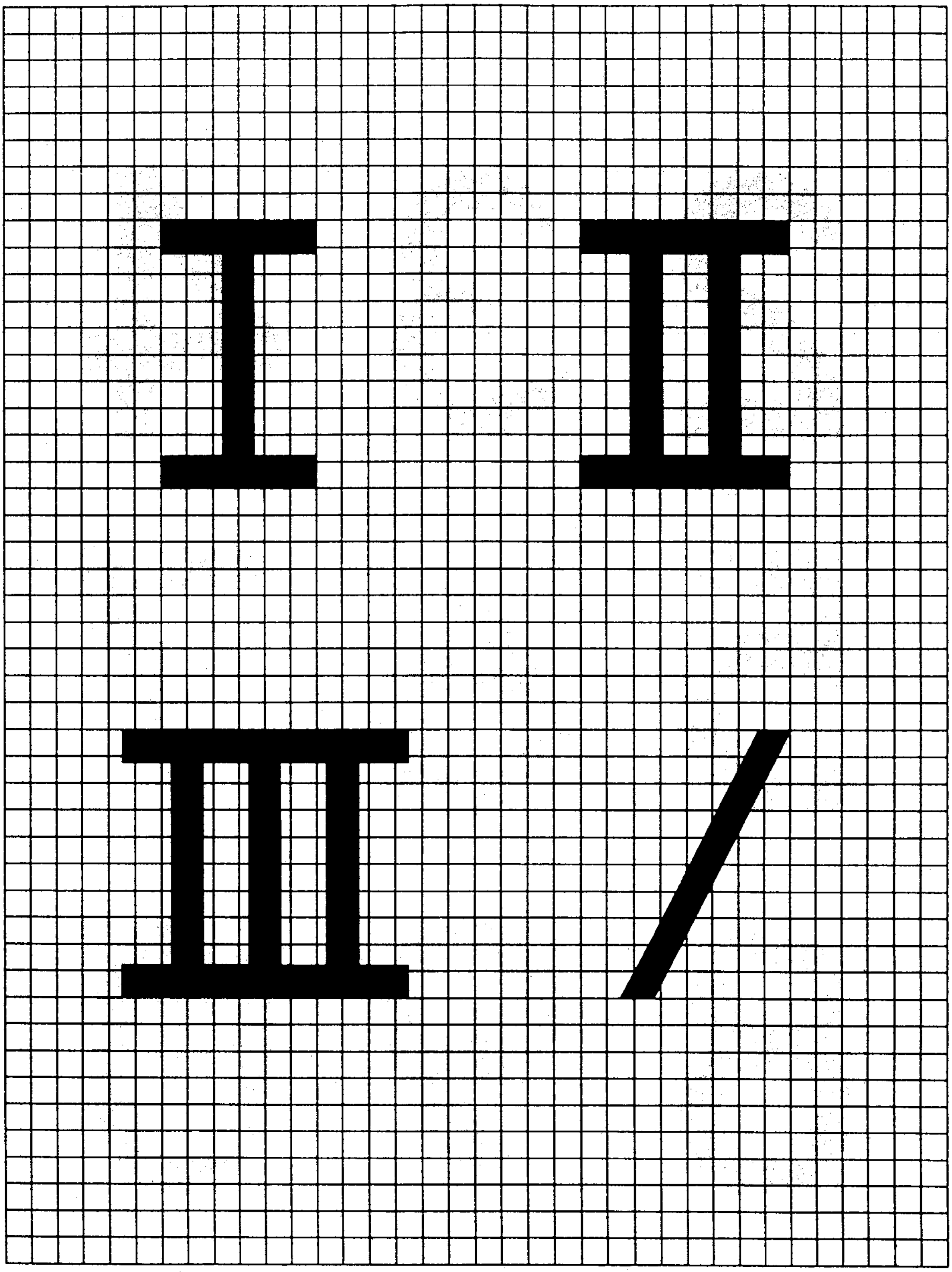
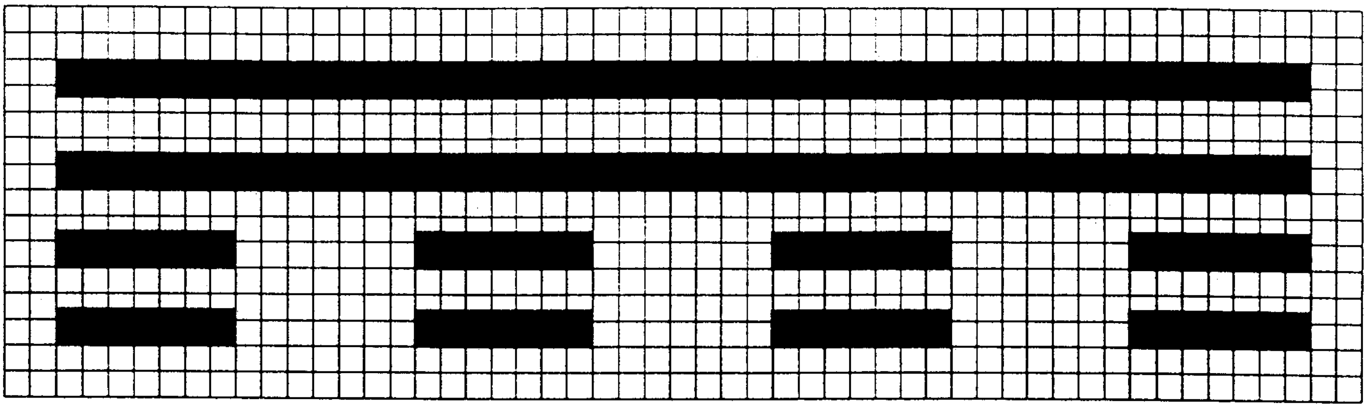
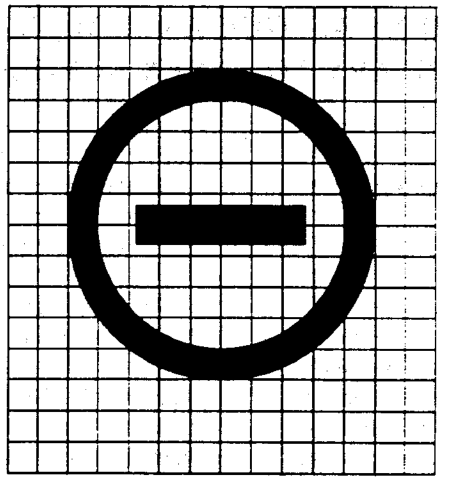


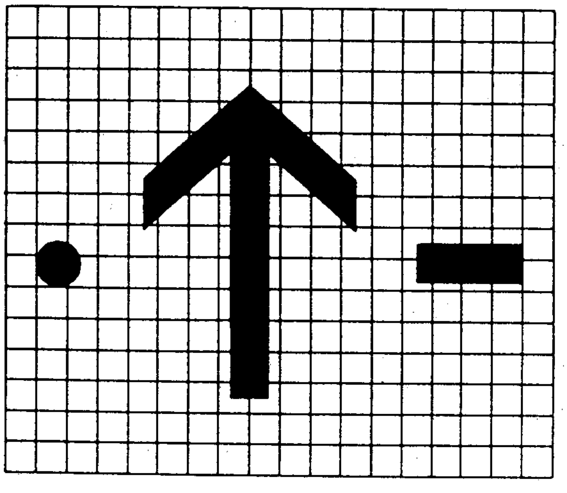
Figure 4.2 (cont.)



Runway vacated sign



NO ENTRY sign



Arrow, dot and dash

Note 1.— The arrow stroke width, diameter of the dot, and both width and length of the dash shall be proportioned to the character stroke widths.

Note 2.— The dimensions of the arrow shall remain constant for a particular sign size, regardless of orientation.

Figure 4.2 (cont.)

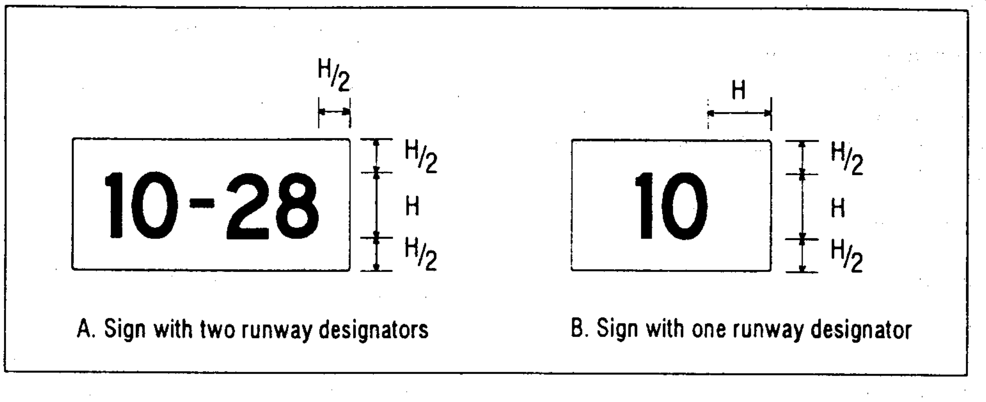


Figure 4.3 Sign dimensions

ATTACHMENT A. GUIDANCE MATERIAL SUPPLEMENTARY TO ANNEX 14, VOLUME I

1. Number, siting and orientation of runways

Siting and orientation of runways

1.1 Many factors should be taken into account in the determination of the siting and orientation of runways. Without attempting to provide an exhaustive list of these factors nor an analysis of their effects, it appears useful to indicate those which most frequently require study. These factors may be classified under four headings:

1.1.1 *Type of operation.* Attention should be paid in particular to whether the aerodrome is to be used in all meteorological conditions or only in visual meteorological conditions, and whether it is intended for use by day and night, or only by day.

1.1.2 *Climatological conditions.* A study of the wind distribution should be made to determine the usability factor. In this regard, the following comments should be taken into account:

a) Wind statistics used for the calculation of the usability factor are normally available in ranges of speed and direction, and the accuracy of the results obtained depends, to a large extent, on the assumed distribution of observations within these ranges. In the absence of any sure information as to the true distribution, it is usual to assume a uniform distribution since, in relation to the most favourable runway orientations, this generally results in a slightly conservative figure for the usability factor.

b) The maximum mean cross-wind components given in Chapter 3, 3.1.2 refer to normal circumstances. There are some factors which may require that a reduction of those maximum values be taken into account at a particular aerodrome. These include:

1) the wide variations which may exist, in handling characteristics and maximum permissible cross-wind components, among diverse types of aeroplanes (including future types) within each of the three groups given in 3.1.2;

2) prevalence and nature of gusts;

3) prevalence and nature of turbulence;

4) the availability of a secondary runway;

5) the width of runways;

6) the runway surface conditions — water, snow and ice on the runway materially reduce the allowable cross-wind component; and

7) the strength of the wind associated with the limiting cross-wind component.

A study should also be made of the occurrence of poor visibility and/or low cloud base. Account should be taken of their frequency as well as the accompanying wind direction and speed.

1.1.3 *Topography of the aerodrome site, its approaches, and surroundings,* particularly:

a) compliance with the obstacle limitation surfaces;

b) current and future land use. The orientation and layout should be selected so as to protect as far as possible the particularly sensitive areas such as residential, school and hospital zones from the discomfort caused by aircraft noise;

c) current and future runway lengths to be provided;

d) construction costs; and

e) possibility of installing suitable non-visual and visual aids for approach-to-land.

1.1.4 *Air traffic in the vicinity of the aerodrome,* particularly:

a) proximity of other aerodromes or ATS routes;

b) traffic density; and

c) air traffic control and missed approach procedures.

Number of runways in each direction

1.2 The number of runways to be provided in each direction depends on the number of aircraft movements to be catered to.

2. Clearways and stopways

2.1 The decision to provide a stopway and/or a clearway as an alternative to an increased length of runway will depend on the physical characteristics of the area beyond the runway end, and on the operating performance requirements of the prospective aeroplanes. The runway, stopway and clearway lengths to be provided are determined by the aeroplane take-off performance, but a check should also be made of the landing distance required by the aeroplanes using the runway to ensure that adequate runway length is provided for landing. The length of a clearway, however, cannot exceed half the length of take-off run available.

2.2 The aeroplane performance operating limitations require a length which is enough to ensure that the aeroplane can, after starting a take-off, either be brought safely to a stop or complete the take-off safely. For the purpose of discussion it is supposed that the runway, stopway and clearway lengths provided at the aerodrome are only just adequate for the aeroplane requiring the longest take-off and accelerate-stop distances, taking into account its take-off mass, runway characteristics and ambient atmospheric conditions. Under these circumstances there is, for each take-off, a speed, called the decision speed; below this speed, the take-off must be abandoned if an engine fails, while above it the take-off must be completed. A very long take-off run and take-off distance would be required to complete a take-off when an engine fails before the decision speed is reached, because of the insufficient speed and the reduced power available. There would be no difficulty in stopping in the remaining accelerate-stop distance available provided action is taken immediately. In these circumstances the correct course of action would be to abandon the take-off.

On the other hand, if an engine fails after the decision speed is reached, the aeroplane will have sufficient speed and power available to complete the take-off safely in the remaining take-off distance available. However, because of the high speed, there would be difficulty in stopping the aeroplane in the remaining accelerate-stop distance available.

2.3 The decision speed is not a fixed speed for any aeroplane, but can be selected by the pilot within limits to suit the accelerate-stop and take-off distance available, aeroplane take-off mass, runway characteristics, and ambient atmospheric conditions at the aerodrome. Normally, a higher decision speed is selected as the accelerate-stop distance available increases.

2.4 A variety of combinations of accelerate-stop distances required and take-off distances required can be obtained to accommodate a particular aeroplane, taking into account the aeroplane take-off mass, runway characteristics, and ambient atmospheric conditions. Each combination requires its particular length of take-off run.

2.5 The most familiar case is where the decision speed is such that the take-off distance required is equal to the accelerate-stop distance required; this value is known as the balanced field length. Where stopway and clearway are not provided, these distances are both equal to the runway length. However, if landing distance is for the moment ignored, runway is not essential for the whole of the balanced field length, as the take-off run required is, of course, less than the balanced field length. The balanced field length can, therefore, be provided by a runway supplemented by an equal length of clearway and stopway, instead of wholly as a runway. If the runway is used for take-off in both directions, an equal length of clearway and stopway has to be provided at each runway end. The saving in runway length is, therefore, bought at the cost of a greater over-all length.

2.6 In case economic considerations preclude the provision of stopway and, as a result, only runway and clearway are to be provided, the runway length (neglecting landing requirements) should be equal to the accelerate-stop distance required or the take-off run required, whichever is the greater. The take-off distance available will be the length of the runway plus the length of clearway.

2.7 The minimum runway length and the maximum stopway or clearway length to be provided may be determined as follows, from the data in the aeroplane flight manual for the aeroplane considered to be critical from the viewpoint of runway length requirements:

a) if a stopway is economically possible, the lengths to be provided are those for the balanced field length. The runway length is the take-off run required or the landing distance required, whichever is the greater. If the accelerate-stop distance required is greater than the runway length so determined, the excess may be provided as stopway, usually at each end of the runway. In addition, a clearway of the same length as the stopway must also be provided;

b) if a stopway is not to be provided, the runway length is the landing distance required, or if it is greater, the accelerate-stop distance required, which corresponds to the lowest practical value of the decision speed. The excess of the take-off distance required over the runway length may be provided as clearway, usually at each end of the runway.

2.8 In addition to the above consideration, the concept of clearways in certain circumstances can be applied to a situation where the take-off distance required for all engines operating exceeds that required for the engine failure case.

2.9 The economy of a stopway can be entirely lost if, after each usage, it must be regraded and compacted. Therefore, it should be designed to withstand at least a certain number of loadings of the aeroplane which the stopway is intended to serve without inducing structural damage to the aeroplane.

3. Calculation of declared distances

3.1 The declared distances to be calculated for each runway direction comprise: the take-off run available (TORA), take-off distance available (TODA), accelerate-stop distance available (ASDA), and landing distance available (LDA).

3.2 Where a runway is not provided with a stopway or clearway and the threshold is located at the extremity of the runway, the four declared distances should normally be equal to the length of the runway, as shown in Figure A-1 (A).

3.3 Where a runway is provided with a clearway (CWY), then the TODA will include the length of clearway, as shown in Figure A-1 (B).

3.4 Where a runway is provided with a stopway (SWY), then the ASDA will include the length of stopway, as shown in Figure A-1 (C).

3.5 Where a runway has a displaced threshold, then the LDA will be reduced by the distance the threshold is displaced, as shown in Figure A-1 (D). A displaced threshold affects only the LDA for approaches made to that threshold; all declared distances for operations in the reciprocal direction are unaffected.

3.6 Figures A-1 (B) through A-1 (D) illustrate a runway provided with a clearway or a stopway or having a displaced threshold. Where more than one of these features exist, then more than one of the declared distances will be modified — but the modification will follow the same principle illustrated. An example showing a situation where all these features exist is shown in Figure A-1 (E).

3.7 A suggested format for providing information on declared distances is given in Figure A-1 (F). If a runway direction cannot be used for take-off or landing, or both, because it is operationally forbidden, then this should be declared and the words "not usable" or the abbreviation "NU" entered.

4. Slopes on a runway

4.1 Distance between slope changes

The following example illustrates how the distance between slope changes is to be determined (see Figure A-2):

D for a runway where the code number is 3 should be at least:

$15\,000\,(|x-y| + |y-z|)$ m
$|x-y|$ being the absolute numerical value of $x-y$
$|y-z|$ being the absolute numerical value of $y-z$

Assuming $x = +0.01$
$y = -0.005$
$z = +0.005$
then $|x-y| = 0.015$
$|y-z| = 0.01$

To comply with the specifications, D should be not less than:

$15\,000\,(0.015 + 0.01)$ m,
that is, $15\,000 \times 0.025 = 375$ m

4.2 Consideration of longitudinal and transverse slopes

When a runway is planned that will combine the extreme values for the slopes and changes in slope permitted under Chapter 3, 3.1.12 to 3.1.18, a study should be made to ensure that the resulting surface profile will not hamper the operation of aeroplanes.

4.3 Radio altimeter operating area

In order to accommodate aeroplanes making auto-coupled approaches and automatic landings (irrespective of weather conditions) it is desirable that slope changes be avoided or kept to a minimum, on a rectangular area at least 300 m long before the threshold of a precision approach runway. The area should be symmetrical about the extended centre line, 120 m wide. When special circumstances so warrant, the width may be reduced to no less than 60 m if an aeronautical study indicates that such reduction would not affect the safety of operations of aircraft. This is desirable because these aeroplanes are equipped with a radio altimeter for final height and flare guidance, and when the aeroplane is above the terrain immediately prior to the threshold, the radio altimeter will begin to provide information to the automatic pilot for auto-flare. Where slope changes cannot be avoided, the rate of change between two consecutive slopes should not exceed 2 per cent per 30 m.

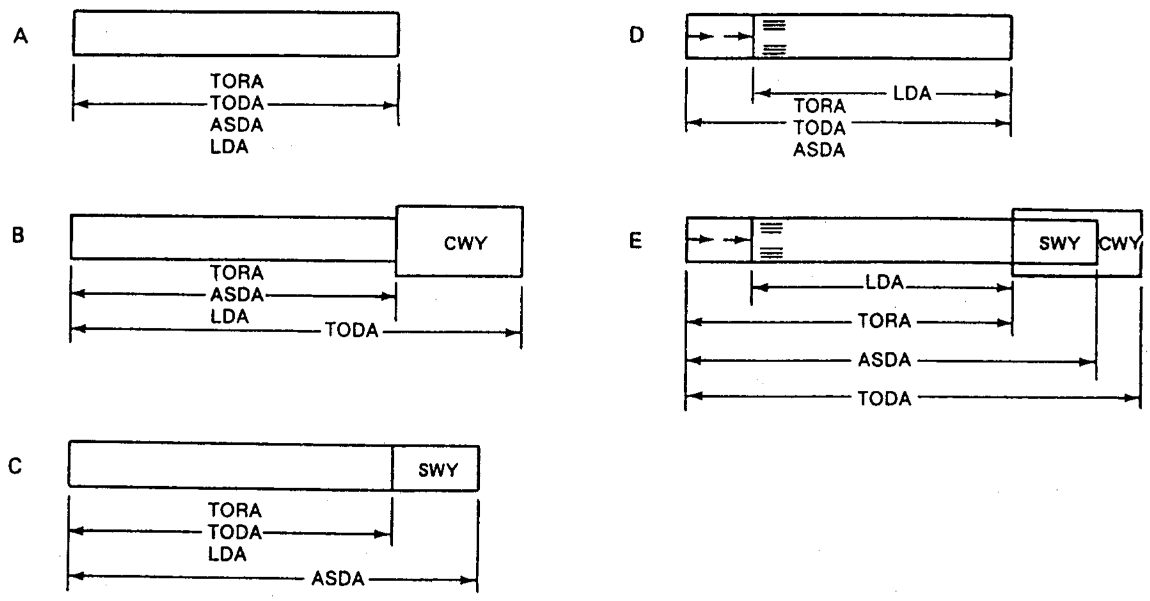
5. Runway surface evenness

5.1 In adopting tolerances for runway surface irregularities, the following standard of construction is achievable for short distances of 3 m and conforms to good engineering practice:

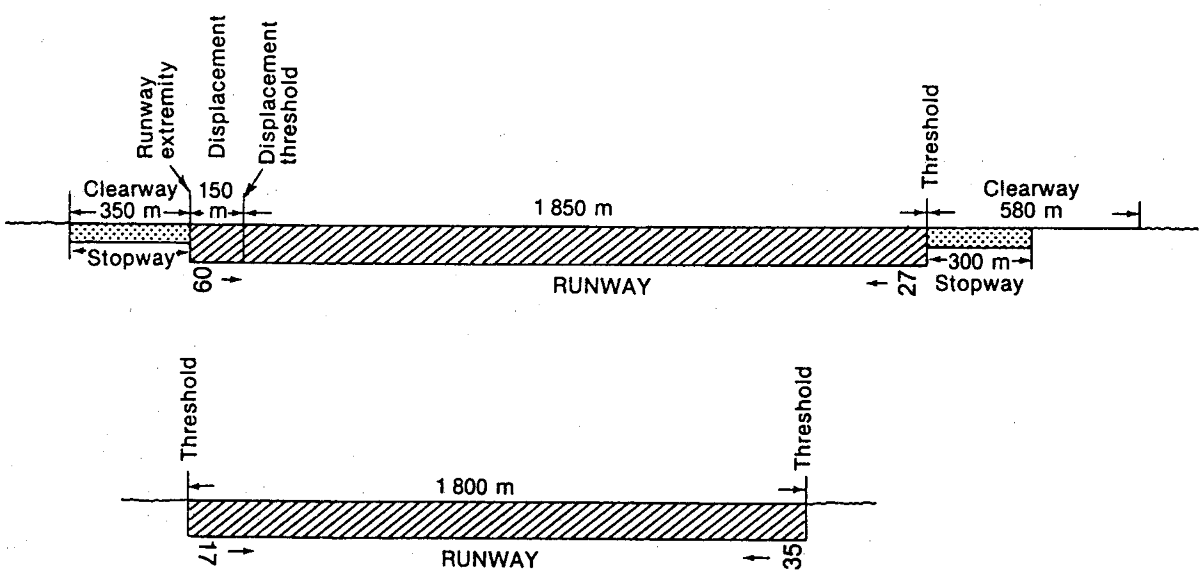
> Except across the crown of a camber or across drainage channels, the finished surface of the wearing course is to be of such regularity that, when tested with a 3 m straight-edge placed anywhere in any direction on the surface, there is no deviation greater than 3 mm between the bottom of the straight-edge and the surface of the pavement anywhere along the straight edge.

5.2 Caution should also be exercised when inserting runway lights or drainage grilles in runway surfaces to ensure that adequate smoothness of the surface is maintained.

5.3 The operation of aircraft and differential settlement of surface foundations will eventually lead to increases in surface irregularities. Small deviations in the above tolerances will not seriously hamper aircraft operations. In general, isolated irregularities of the order of 2.5 cm to 3 cm over a 45 m distance are tolerable. Exact information of the maximum acceptable deviation cannot be given, as it varies with the type and speed of an aircraft.



Note.— All declared distances are illustrated for operations from left to right



RUNWAY	TORA	ASDA	TODA	LDA
	m	m	m	m
09	2 000	2 300	2 580	1 850
27	2 000	2 350	2 350	2 000
17	NU	NU	NU	1 800
35	1 800	1 800	1 800	NU

Figure A-1. Illustration of declared distances

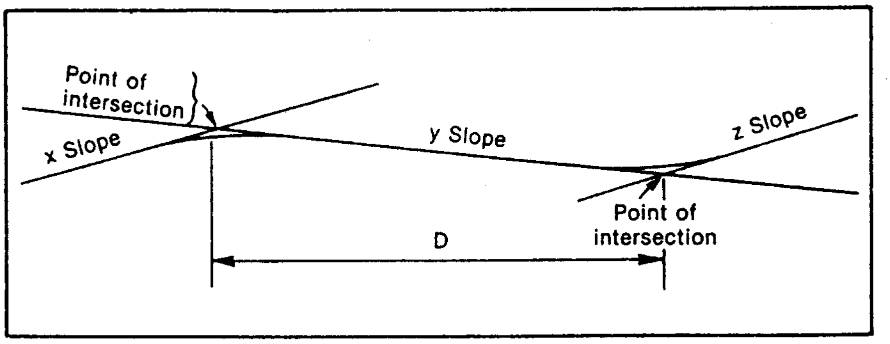


Figure A-2. Profile on centre line of runway

5.4 Deformation of the runway with time may also increase the possibility of the formation of water pools. Pools as shallow as approximately 3 mm in depth, particularly if they are located where they are likely to be encountered at high speed by landing aeroplanes, can induce aquaplaning, which can then be sustained on a wet runway by a much shallower depth of water. Improved guidance regarding the significant length and depth of pools relative to aquaplaning is the subject of further research. It is, of course, especially necessary to prevent pools from forming whenever there is a possibility that they might become frozen.

6. Determining and expressing the friction characteristics of snow- and ice-covered paved surfaces

6.1 There is an operational need for reliable and uniform information concerning the friction characteristics of ice- and snow-covered runways. Accurate and reliable indications of surface friction characteristics can be obtained by friction measuring devices; however, further experience is required to correlate the results obtained by such equipment with aircraft performance, owing to the many variables involved, such as: aircraft mass, speed, braking mechanism, tire and undercarriage characteristics.

6.2 The friction coefficient should be measured if a runway is covered wholly or partly by snow or ice and repeated as conditions change. Friction measurements and/or braking action assessments on surfaces other than runways should be made when an unsatisfactory friction condition can be expected on such surfaces.

6.3 The measurement of the friction coefficient provides the best basis for determining surface friction conditions. The value of surface friction should be the maximum value which occurs when a wheel is slipping but still rolling. Various friction measuring devices may be used. As there is an operational need for uniformity in the method of assessing and reporting runway friction conditions, the measurements should preferably be made with equipment which provides continuous measuring of the maximum friction along the entire runway. Measuring techniques and information on limitations of the various friction measuring devices and precautions to be observed are given in the *Airport Services Manual*, Part 2.

6.4 A chart, based on results of tests conducted on selected ice- or snow-covered surfaces, showing the correlation between certain friction measuring devices on ice- or snow-covered surfaces is presented in the *Airport Services Manual*, Part 2.

6.5 The friction conditions of a runway should be expressed as "braking action information" in terms of the measured friction coefficient μ or estimated braking action. Specific numerical μ values are necessarily related to the design and construction of each friction measuring device as well as to the surface being measured and the speed employed.

6.6 The table below with associated descriptive terms was developed from friction data collected only in compacted snow and ice and should not therefore be taken to be absolute values applicable in all conditions. If the surface is affected by snow or ice and the braking action is reported as "good", pilots should not expect to find conditions as good as on a clean dry runway (where the available friction may well be greater than that needed in any case). The value "good" is a comparative value and is intended to mean that aeroplanes should not experience directional control or braking difficulties, especially when landing.

Measured coefficient	*Estimated braking action*	*Code*
0.40 and above	Good	5
0.39 to 0.36	Medium to good	4
0.35 to 0.30	Medium	3
0.29 to 0.26	Medium to poor	2
0.25 and below	Poor	1

6.7 It has been found necessary to provide surface friction information for each third of a runway. The thirds are called

A, B and C. For the purpose of reporting information to aeronautical service units, section A is always the section associated with the lower runway designation number. When giving landing information to a pilot before landing, the sections are however referred to as first, second or third part of the runway. The first part always means the first third of the runway as seen in the direction of landing. Friction measurements are made along two lines parallel to the runway, i.e. along a line on each side of the centre line approximately 3 m or that distance from the centre line at which most operations take place. The objective of the tests is to determine the mean friction value for sections A, B and C. In cases where a continuous friction measuring device is used, the mean values are obtained from the friction values recorded for each section. The distance between each test point should be approximately 10 per cent of the usable length of the runway. If it is decided that a single test line on one side of the runway centre line gives adequate coverage of the runway, then it follows that each third of the runway should have three tests carried out on it. Test results and calculated mean friction values are entered in a special form (see *Airport Services Manual*, Part 2).

Note.— Where applicable, figures for stopway friction value should also be made available on request.

6.8 A continuous friction measuring device (e.g. Skiddometer, Surface Friction Tester, Mu-meter, Runway Friction Tester or Grip Tester), can be used for measuring the friction values for compacted snow- and ice-covered runways. A decelerometer (e.g. Tapley Meter or Brakemeter — Dynometer) may be used on certain surface conditions, e.g. compacted snow, ice and very thin layers of dry snow. Other friction measuring devices can be used, provided they have been correlated with at least one of the types mentioned above. A decelerometer should not be used in loose snow or slush, as it can give misleading friction values. Other friction measuring devices can also give misleading friction values under certain combinations of contaminants and air/pavement temperature.

6.9 The *Airport Services Manual*, Part 2 provides guidance on the uniform use of test equipment to achieve compatible test results and other information on removal of surface contamination and improvement of friction conditions.

7. Determination of friction characteristics of wet paved runways

7.1 The friction of a wet paved runway should be measured to:

a) verify the friction characteristics of new or resurfaced paved runways when wet (Chapter 3, 3.1.23);

b) assess periodically the slipperiness of paved runways when wet (Chapter 9, 9.4.4);

c) determine the effect on friction when drainage characteristics are poor (Chapter 9, 9.4.4); and

d) determine the friction of paved runways that become slippery under unusual conditions (Chapter 2, 2.9.8).

7.2 Runways should be evaluated when first constructed or after resurfacing to determine the wet runway surface friction characteristics. Although it is recognized that friction reduces with use, this value will represent the friction of the relatively long central portion of the runway that is uncontaminated by rubber deposits from aircraft operations and is therefore of operational value. Evaluation tests should be made on clean surfaces. If it is not possible to clean a surface before testing, then for purposes of preparing an initial report a test could be made on a portion of clean surface in the central part of the runway.

7.3 Friction tests of existing surface conditions should be taken periodically in order to identify runways with low friction when wet. A State should define what minimum friction level it considers acceptable before a runway is classified as slippery when wet and publish this value in the State's aeronautical information publication (AIP). When the friction of a runway is found to be below this reported value, then such information should be promulgated by NOTAM. The State should also establish a maintenance planning level, below which, appropriate corrective maintenance action should be initiated to improve the friction. However, when the friction characteristics for either the entire runway or a portion thereof are below the minimum friction level, corrective maintenance action must be taken without delay. Friction measurements should be taken at intervals that will ensure identification of runways in need of maintenance or special surface treatment before the condition becomes serious. The time interval between measurements will depend on factors such as: aircraft type and frequency of usage, climatic conditions, pavement type, and pavement service and maintenance requirements.

7.4 For uniformity and to permit comparison with other runways, friction tests of existing, new or resurfaced runways should be made with a continuous friction measuring device provided with a smooth tread tire. The device should have a capability of using self-wetting features to enable measurements of the friction characteristics of the surface to be made at a water depth of at least 1 mm.

7.5 When it is suspected that the friction characteristics of a runway may be reduced because of poor drainage, owing to inadequate slopes or depressions, then an additional test should be made, but this time under natural conditions representative of a local rain. This test differs from the previous one in that water depths in the poorly cleared areas are normally greater in a local rain condition. The test results are thus more apt to identify problem areas having low friction values that could induce aquaplaning than the previous test. If circumstances do not permit tests to be conducted during natural conditions representative of a rain, then this condition may be simulated.

7.6 Even when the friction has been found to be above the level set by the State to define a slippery runway, it may be known that under unusual conditions, such as after a long dry period, the runway may have become slippery. When such a condition is known to exist, then a friction measurement should be made as soon as it is suspected that the runway may have become slippery.

7.7 When the results of any of the measurements identified in 7.3 through 7.6 indicate that only a particular portion of a runway surface is slippery, then action to promulgate this information and, if appropriate, take corrective action is equally important.

7.8 When conducting friction tests on wet runways, it is important to note that, unlike compacted snow and ice conditions, in which there is very limited variation of the friction coefficient with speed, a wet runway produces a drop in friction with an increase in speed. However, as the speed increases, the rate at which the friction is reduced becomes less. Among the factors affecting the friction coefficient between the tire and the runway surface, texture is particularly important. If the runway has a good macro-texture allowing the water to escape beneath the tire, then the friction value will be less affected by speed. Conversely, a low macro-texture surface will produce a larger drop in friction with increase in speed. Accordingly, when testing runways to determine their friction characteristics and whether maintenance action is necessary to improve it, a speed high enough to reveal these friction/speed variations should be used.

7.9 Annex 14, Volume I requires States to specify two friction levels as follows:

a) a maintenance friction level below which corrective maintenance action should be initiated; and

b) a minimum friction level below which information that a runway may be slippery when wet should be made available.

Furthermore, States should establish criteria for the friction characteristics of new or resurfaced runway surfaces. Table A-1 provides guidance on establishing the design objective for new runway surfaces and maintenance planning and minimum friction levels for runway surfaces in use.

7.10 The friction values given above are absolute values and are intended to be applied without any tolerance. These values were developed from a research study conducted in a State. The two friction measuring tires mounted on the Mu-meter were smooth tread and had a special rubber formulation, i.e. Type A. The tires were tested at a 15 degree included angle of alignment along the longitudinal axis of the trailer. The single friction measuring tires mounted on the Skiddometer, Surface Friction Tester, Runway Friction Tester and TATRA were smooth tread and used the same rubber formulation, i.e. Type B. The GRIPTESTER was tested with a single smooth tread tire having the same rubber formulation as Type B but the size was smaller, i.e. Type C. The specifications of these tires (i.e. Types A, B and C) are contained in the *Airport Services Manual,* Part 2. Friction measuring devices using rubber formulation, tire tread/groove patterns, water depth, tire pressures, or test speeds different from those used in the programme described above, cannot be directly equated with the friction values given in the table. The values in columns (5), (6) and (7) are averaged values representative of

Table A-1.

Test equipment	Test tire: Type	Test tire: Pressure (kPa)	Test speed (km/h)	Test water depth (mm)	Design objective for new surface	Maintenance planning level	Minimum friction level
(1)	(2)		(3)	(4)	(5)	(6)	(7)
Mu-meter Trailer	A	70	65	1.0	0.72	0.52	0.42
	A	70	95	1.0	0.66	0.38	0.26
Skiddometer Trailer	B	210	65	1.0	0.82	0.60	0.50
	B	210	95	1.0	0.74	0.47	0.34
Surface Friction	B	210	65	1.0	0.82	0.60	0.50
Tester Vehicle	B	210	95	1.0	0.74	0.47	0.34
Runway Friction	B	210	65	1.0	0.82	0.60	0.50
Tester Vehicle	B	210	95	1.0	0.74	0.54	0.41
TATRA Friction	B	210	65	1.0	0.76	0.57	0.48
Tester Vehicle	B	210	95	1.0	0.67	0.52	0.42
GRIPTESTER	C	140	65	1.0	0.74	0.53	0.43
Trailer	C	140	95	1.0	0.64	0.36	0.24

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the runway or significant portion thereof. It is considered desirable to test the friction characteristics of a paved runway at more than one speed.

7.11 Other friction measuring devices can be used, provided they have been correlated with at least one test equipment mentioned above. The *Airport Services Manual,* Part 2 provides guidance on the methodology for determining the friction values corresponding to the design objective, maintenance planning level and minimum friction level for a friction tester not identified in the above table.

8. Strips

8.1 Shoulders

8.1.1 The shoulder of a runway or stopway should be prepared or constructed so as to minimize any hazard to an aeroplane running off the runway or stopway. Some guidance is given in the following paragraphs on certain special problems which may arise, and on the further question of measures to avoid the ingestion of loose stones or other objects by turbine engines.

8.1.2 In some cases, the bearing strength of the natural ground in the strip may be sufficient, without special preparation, to meet the requirements for shoulders. Where special preparation is necessary, the method used will depend on local soil conditions and the mass of the aeroplanes the runway is intended to serve. Soil tests will help in determining the best method of improvement (e.g. drainage, stabilization, surfacing, light paving).

8.1.3 Attention should also be paid when designing shoulders to prevent the ingestion of stones or other objects by turbine engines. Similar considerations apply here to those which are discussed for the margins of taxiways in the *Aerodrome Design Manual*, Part 2, both as to the special measures which may be necessary and as to the distance over which such special measures, if required, should be taken.

8.1.4 Where shoulders have been treated specially, either to provide the required bearing strength or to prevent the presence of stones or debris, difficulties may arise because of a lack of visual contrast between the runway surface and that of the adjacent strip. This difficulty can be overcome either by providing a good visual contrast in the surfacing of the runway or strip, or by providing a runway side stripe marking.

8.2 Objects on strips

Within the general area of the strip adjacent to the runway, measures should be taken to prevent an aeroplane's wheel, when sinking into the ground, from striking a hard vertical face. Special problems may arise for runway light fittings or other objects mounted in the strip or at the intersection with a taxiway or another runway. In the case of construction, such as runways or taxiways, where the surface must also be flush with the strip surface, a vertical face can be eliminated by chamfering from the top of the construction to not less than 30 cm below the strip surface level. Other objects, the functions of which do not require them to be at surface level, should be buried to a depth of not less than 30 cm.

8.3 Grading of a strip for precision approach runways

Chapter 3, 3.3.8 recommends that the portion of a strip of an instrument runway within at least 75 m from the centre line should be graded where the code number is 3 or 4. For a precision approach runway, it may be desirable to adopt a greater width where the code number is 3 or 4. Figure A-3 shows the shape and dimensions of a wider strip that may be considered for such a runway. This strip has been designed using information on aircraft running off runways. The portion to be graded extends to a distance of 105 m from the centre line, except that the distance is gradually reduced to 75 m from the centre line at both ends of the strip, for a length of 150 m from the runway end.

9. Runway end safety areas

9.1 Where a runway end safety area is provided in accordance with Chapter 3, consideration should be given to providing an area long enough to contain overruns and undershoots resulting from a reasonably probable combination of adverse operational factors. On a precision approach runway, the ILS localizer is normally the first upstanding obstacle, and the runway end safety area should extend up to this facility. In other circumstances and on a non-precision approach or non-instrument runway, the first upstanding obstacle may be a road, a railroad or other constructed or natural feature. In such circumstances, the runway end safety area should extend as far as the obstacle.

9.2 Where provision of a runway end safety area may involve encroachment in areas where it would be particularly prohibitive to implement, and the appropriate authority considers a runway end safety area essential, consideration may have to be given to reducing some of the declared distances.

10. Location of threshold

10.1 General

10.1.1 The threshold is normally located at the extremity of a runway, if there are no obstacles penetrating above the

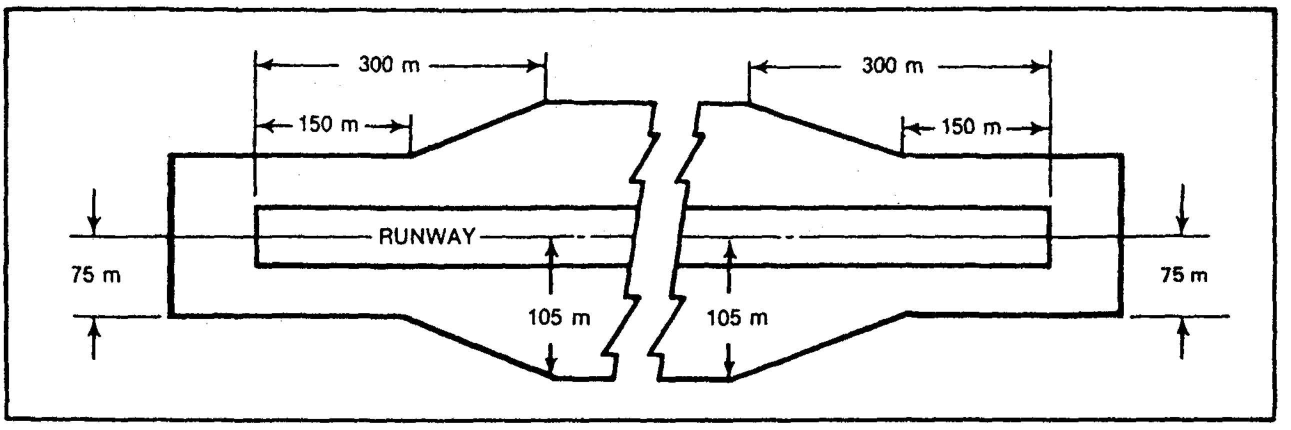

Figure A-3. Graded portion of a strip including a precision approach runway where the code number is 3 or 4

approach surface. In some cases, however, due to local conditions it may be desirable to displace the threshold permanently (see below). When studying the location of a threshold, consideration should also be given to the height of the ILS reference datum and/or MLS approach reference datum and the determination of the obstacle clearance limits. (Specifications concerning the height of the ILS reference datum and MLS approach reference datum are given in Annex 10, Volume I, Part I.)

10.1.2 In determining that no obstacle penetrate above the approach surface, account should be taken of mobile objects (vehicles on roads, trains, etc.) at least within that portion of the approach area within 1 200 m longitudinally from the threshold and of an over-all width of not less than 150 m.

10.2 Displaced threshold

10.2.1 If an object extends above the approach surface and the object cannot be removed, consideration should be given to displacing the threshold permanently.

10.2.2 To meet the obstacle limitation objectives of Chapter 4, the threshold should ideally be displaced down the runway for the distance necessary to provide that the approach surface is cleared of obstacles.

10.2.3 However, displacement of the threshold from the runway extremity will inevitably cause reduction of the landing distance available, and this may be of greater operational significance than penetration of the approach surface by marked and lighted obstacles. A decision to displace the threshold, and the extent of such displacement, should therefore have regard to an optimum balance between the considerations of clear approach surfaces and adequate landing distance. In deciding this question, account will need to be taken of the types of aeroplanes which the runway is intended to serve, the limiting visibility and cloud base conditions under which the runway will be used, the position of the obstacles in relation to the threshold and extended centre line and, in the case of a precision approach runway, the significance of the obstacles to the determination of the obstacle clearance limit.

10.2.4 Notwithstanding the consideration of landing distance available, the selected position for the threshold should not be such that the obstacle-free surface to the threshold is steeper than 3.3 per cent where the code number is 4 or steeper than 5 per cent where the code number is 3.

10.2.5 In the event of a threshold being located according to the criteria for obstacle-free surfaces in the preceding paragraph, the obstacle marking requirements of Chapter 6 should continue to be met in relation to the displaced threshold.

11. Approach lighting systems

11.1 Types and characteristics

11.1.1 The specifications in this volume provide for the basic characteristics for simple and precision approach lighting systems. For certain aspects of these systems, some latitude is permitted, for example, in the spacing between centre line lights and crossbars. The approach lighting patterns that have been generally adopted are shown in Figures A-5 and A-6. A diagram of the inner 300 m of the precision approach category II and III lighting system is shown in Figure 5-8.

11.1.2 The approach lighting configuration is to be provided irrespective of the location of the threshold, i.e. whether the threshold is at the extremity of the runway or displaced from the runway extremity. In both cases, the approach lighting system should extend up to the threshold. However, in the case of a displaced threshold, inset lights are used from the runway extremity up to the threshold to obtain the specified configuration. These inset lights are designed to satisfy the structural requirements specified in Chapter 5, 5.3.1.8, and the photometric requirements specified in Appendix 2, Figure 2.1 or 2.2.

11.1.3 Flight path envelopes to be used in designing the lighting are shown in Figure A-4.

11.2 Installation tolerances

Horizontal

11.2.1 The dimensional tolerances are shown in Figure A-6.

11.2.2 The centre line of an approach lighting system should be as coincident as possible with the extended centre line of the runway with a maximum tolerance of ± 15′.

11.2.3 The longitudinal spacing of the centre line lights should be such that one light (or group of lights) is located in the centre of each crossbar, and the intervening centre line lights are spaced as evenly as practicable between two crossbars or a crossbar and a threshold.

11.2.4 The crossbars and barrettes should be at right angles to the centre line of the approach lighting system with a tolerance of ± 30′, if the pattern in Figure A-6 (A) is adopted or ± 2°, if Figure A-6 (B) is adopted.

11.2.5 When a crossbar has to be displaced from its standard position, any adjacent crossbar should, where possible, be displaced by appropriate amounts in order to reduce the differences in the crossbar spacing.

11.2.6 When a crossbar in the system shown in Figure A-6 (A) is displaced from its standard position, its overall length should be adjusted so that it remains one-twentieth of the actual distance of the crossbar from the point of origin. It is not necessary, however, to adjust the standard 2.7 m spacing between the crossbar lights, but the crossbars should be kept symmetrical about the centre line of the approach lighting.

Vertical

11.2.7 The ideal arrangement is to mount all the approach lights in the horizontal plane passing through the threshold (see Figure A-7), and this should be the general aim as far as local conditions permit. However, buildings, trees, etc., should not obscure the lights from the view of a pilot who is assumed to be 1° below the electronic glide path in the vicinity of the outer marker.

11.2.8 Within a stopway or clearway, and within 150 m of the end of a runway, the lights should be mounted as near to the ground as local conditions permit in order to minimize risk of damage to aeroplanes in the event of an overrun or undershoot. Beyond the stopway and clearway, it is not so necessary for the lights to be mounted close to the ground and therefore undulations in the ground contours can be compensated for by mounting the lights on poles of appropriate height.

11.2.9 It is desirable that the lights be mounted so that, as far as possible, no object within a distance of 60 m on each side of the centre line protrudes through the plane of the approach lighting system. Where a tall object exists within 60 m of the centre line and within 1 350 m from the threshold for a precision approach lighting system, or 900 m for a simple approach lighting system, it may be advisable to install the lights so that the plane of the outer half of the pattern clears the top of the object.

11.2.10 In order to avoid giving a misleading impression of the plane of the ground, the lights should not be mounted below a gradient of 1 in 66 downwards from the threshold to a point 300 m out, and below a gradient of 1 in 40 beyond the 300 m point. For a precision approach category II and III lighting system, more stringent criteria may be necessary, e.g. negative slopes not permitted within 450 m of the threshold.

11.2.11 *Centre line.* The gradients of the centre line in any section (including a stopway or clearway) should be as small as practicable, and the changes in gradients should be as few and small as can be arranged and should not exceed 1 in 60. Experience has shown that as one proceeds outwards from the runway, rising gradients in any section of up to 1 in 66, and falling gradients of down to 1 in 40, are acceptable.

11.2.12 *Crossbars.* The crossbar lights should be so arranged as to lie on a straight line passing through the associated centre line lights, and wherever possible this line should be horizontal. It is permissible, however, to mount the lights on a transverse gradient not more than 1 in 80, if this enables crossbar lights within a stopway or clearway to be mounted nearer to the ground on sites where there is a crossfall.

11.3 Clearance of obstacles

11.3.1 An area, hereinafter referred to as the light plane, has been established for obstacle clearance purposes, and all lights of the system are in this plane. This plane is rectangular in shape and symmetrically located about the approach lighting system's centre line. It starts at the threshold and extends 60 m beyond the approach end of the system, and is 120 m wide.

11.3.2 No objects are permitted to exist within the boundaries of the light plane which are higher than the light plane except as designated herein. All roads and highways are considered as obstacles extending 4.8 m above the crown of the road, except aerodrome service roads where all vehicular traffic is under control of the aerodrome authorities and coordinated with the aerodrome traffic control tower. Railroads, regardless of the amount of traffic, are considered as obstacles extending 5.4 m above the top of the rails.

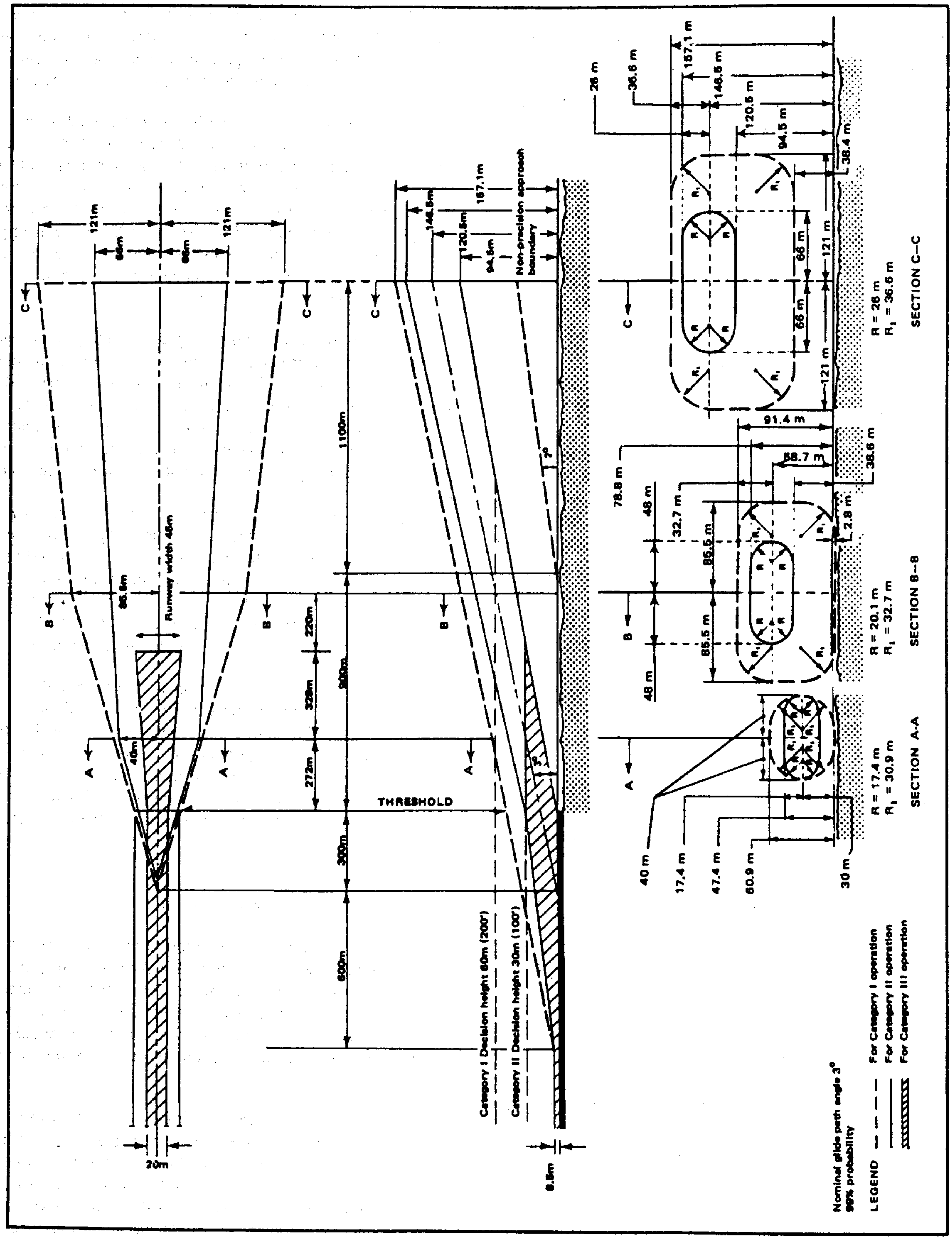

Figure A-4. Flight path envelopes to be used for lighting design for category I, II and III operations

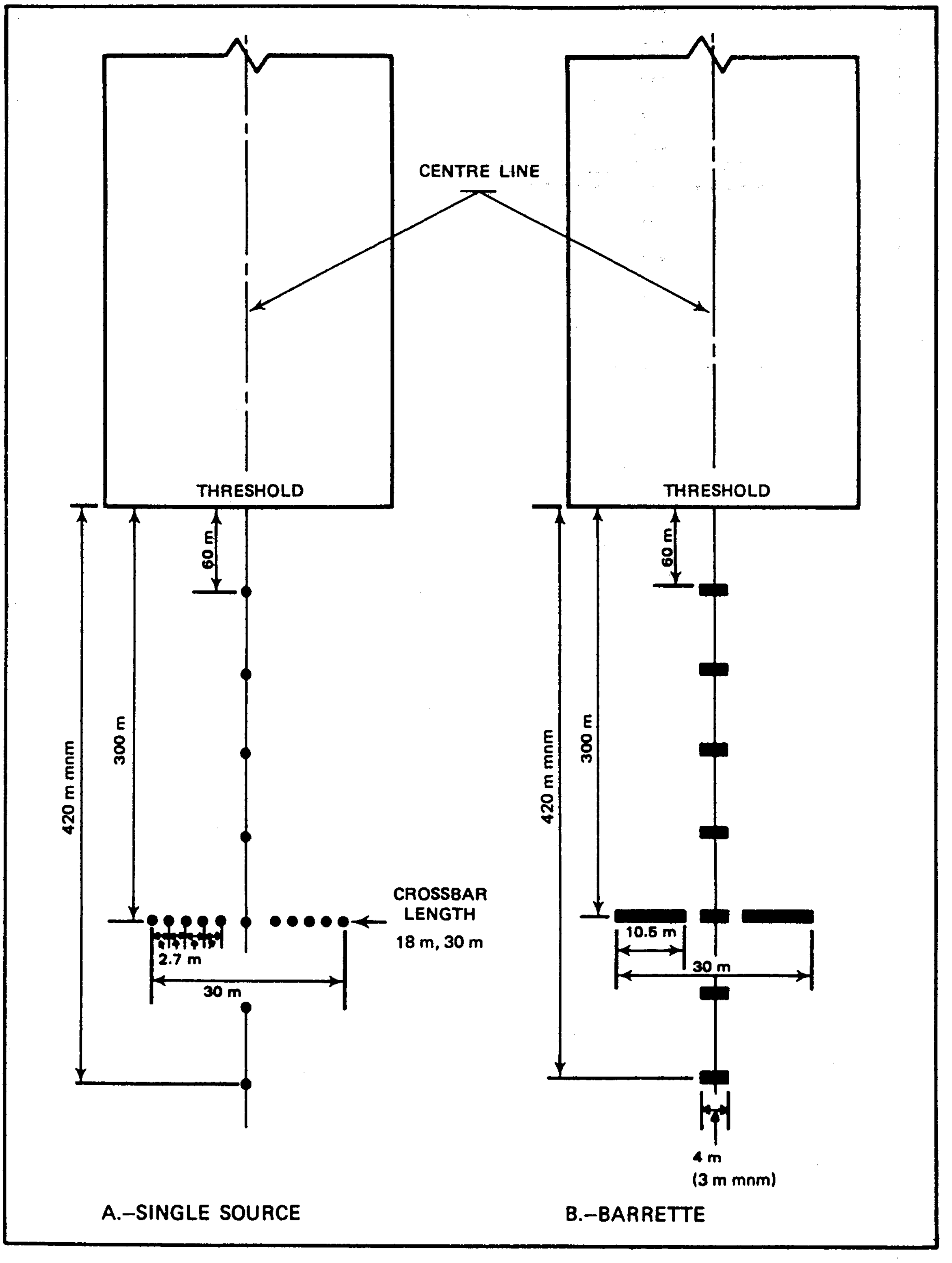

Figure A-5. Simple approach lighting systems

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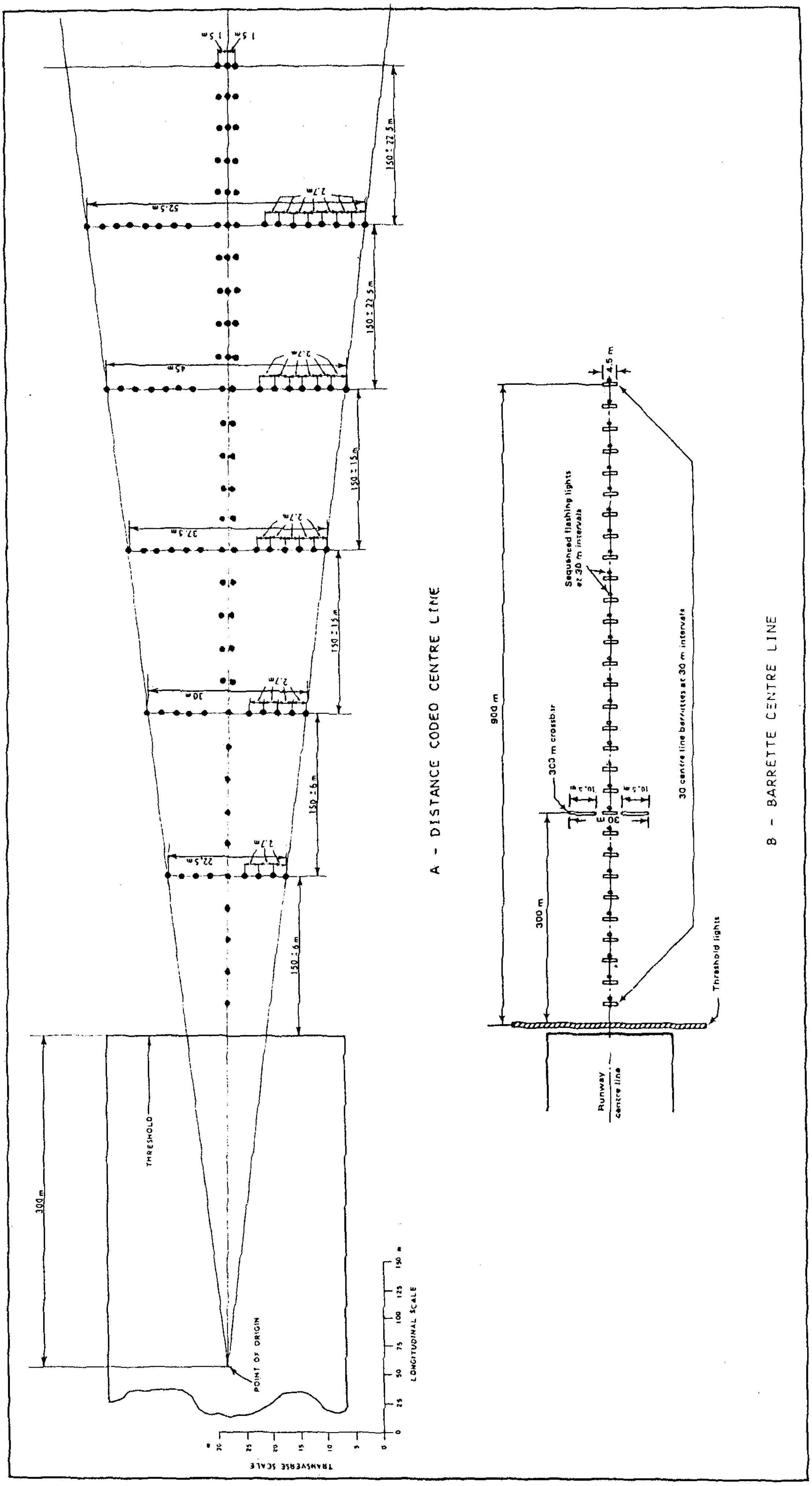

Figure A-6. Precision approach category I lighting systems

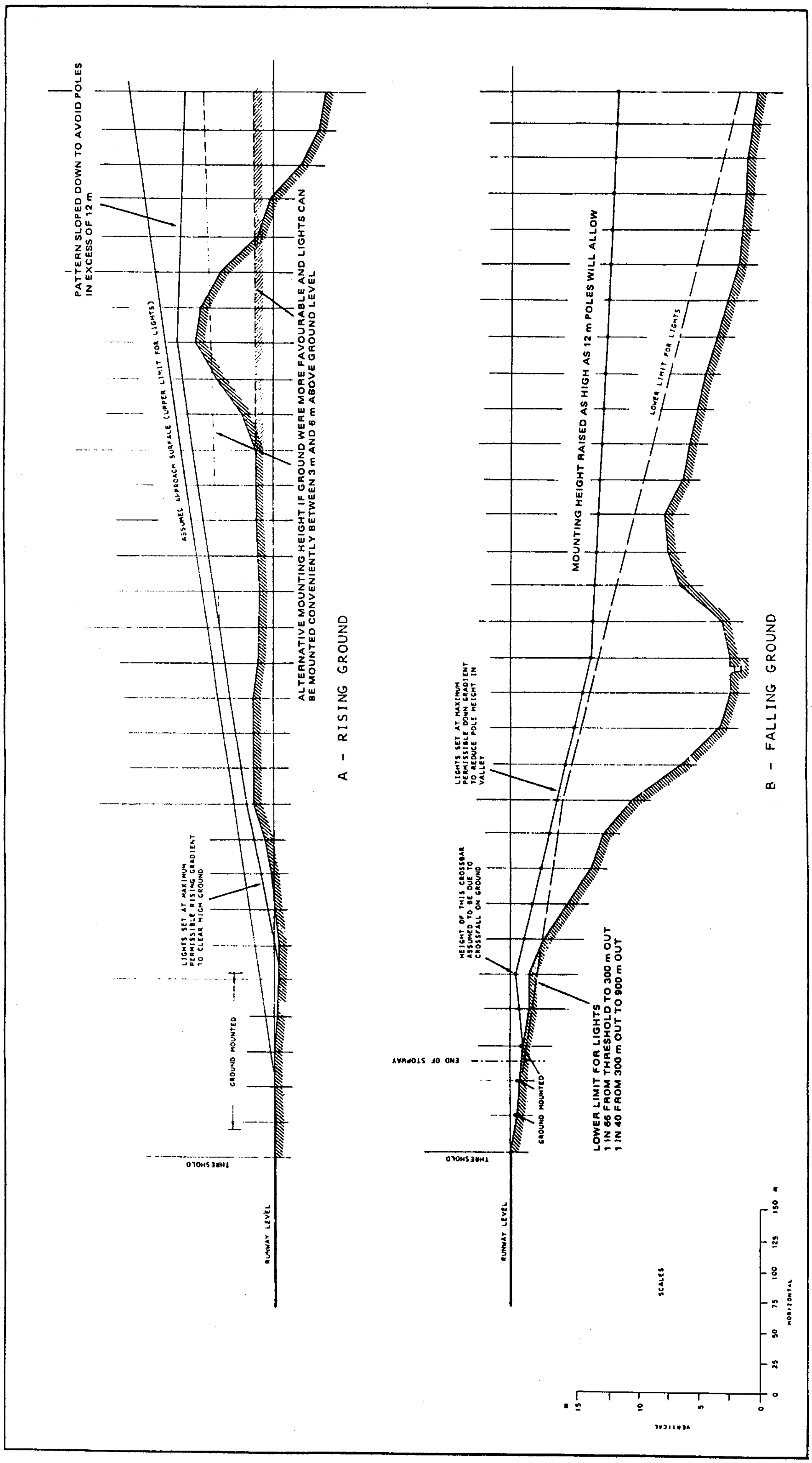

Figure A-7. Vertical installation tolerances

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11.3.3 It is recognized that some components of electronic landing aids systems, such as reflectors, antennas, monitors, etc., must be installed above the light plane. Every effort should be made to relocate such components outside the boundaries of the light plane. In the case of reflectors and monitors, this can be done in many instances.

11.3.4 Where an ILS localizer is installed within the light plane boundaries, it is recognized that the localizer, or screen if used, must extend above the light plane. In such cases the height of these structures should be held to a minimum and they should be located as far from the threshold as possible. In general the rule regarding permissible heights is 15 cm for each 30 m the structure is located from the threshold. As an example, if the localizer is located 300 m from the threshold, the screen will be permitted to extend above the plane of the approach lighting system by 10 × 15 = 150 cm maximum, but preferably should be kept as low as possible consistent with proper operation of the ILS.

11.3.5 In locating an MLS azimuth antenna the guidance contained in Annex 10, Volume I, Attachment G to Part I should be followed. This material, which also provides guidance on collocating an MLS azimuth antenna with an ILS localizer antenna, suggests that the MLS azimuth antenna may be sited within the light plane boundaries where it is not possible or practical to locate it beyond the outer end of the approach lighting for the opposite direction of approach. If the MLS azimuth antenna is located on the extended centre line of the runway, it should be as far as possible from the closest light position to the MLS azimuth antenna in the direction of the runway end. Furthermore, the MLS azimuth antenna phase centre should be at least 0.3 m above the light centre of the light position closest to the MLS azimuth antenna in the direction of the runway end. (This could be relaxed to 0.15 m if the site is otherwise free of significant multipath problems.) Compliance with this requirement, which is intended to ensure that the MLS signal quality is not affected by the approach lighting system, could result in the partial obstruction of the lighting system by the MLS azimuth antenna. To ensure that the resulting obstruction does not degrade visual guidance beyond an acceptable level, the MLS azimuth antenna should not be located closer to the runway end than 300 m and the preferred location is 25 m beyond the 300 m crossbar (this would place the antenna 5 m behind the light position 330 m from the runway end). Where an MLS azimuth antenna is so located, a central part of the 300 m crossbar of the approach lighting system would alone be partially obstructed. Nevertheless, it is important to ensure that the unobstructed lights of the crossbar remain serviceable all the time.

11.3.6 Objects existing within the boundaries of the light plane, requiring the light plane to be raised in order to meet the criteria contained herein, should be removed, lowered or relocated where this can be accomplished more economically than raising the light plane.

11.3.7 In some instances objects may exist which cannot be removed, lowered or relocated economically. These objects may be located so close to the threshold that they cannot be cleared by the 2 per cent slope. Where such conditions exist and no alternative is possible, the 2 per cent slope may be exceeded or a "stair step" resorted to in order to keep the approach lights above the objects. Such "step" or increased gradients should be resorted to only when it is impracticable to follow standard slope criteria, and they should be held to the absolute minimum. Under this criterion no negative slope is permitted in the outermost portion of the system.

11.4 Consideration of the effects of reduced lengths

11.4.1 The need for an adequate approach lighting system to support precision approaches where the pilot is required to acquire visual references prior to landing, cannot be stressed too strongly. The safety and regularity of such operations is dependent on this visual acquisition. The height above runway threshold at which the pilot decides there are sufficient visual cues to continue the precision approach and land will vary, depending on the type of approach being conducted and other factors such as meteorological conditions, ground and airborne equipment, etc. The required length of approach lighting system which will support all the variations of such approaches is 900 m, and this shall always be provided whenever possible.

11.4.2 However, there are some runway locations where it is impossible to provide the 900 m length of approach lighting system to support precision approaches.

11.4.3 In such cases, every effort should be made to provide as much approach lighting system as possible. The appropriate authority may impose restrictions on operations to runways equipped with reduced lengths of lighting. There are many factors which determine at what height the pilot must have decided to continue the approach to land or execute a missed approach. It must be understood that the pilot does not make an instantaneous judgement upon reaching a specified height. The actual decision to continue the approach and landing sequence is an accumulative process which is only concluded at the specified height. Unless lights are available prior to reaching the decision point, the visual assessment process is impaired and the likelihood of missed approaches will increase substantially. There are many operational considerations which must be taken into account by the appropriate authorities in deciding if any restrictions are necessary to any precision approach and these are detailed in Annex 6.

12. Priority of installation of visual approach slope indicator systems

12.1 It has been found impracticable to develop guidance material that will permit a completely objective analysis to be made of which runway on an aerodrome should receive first priority for the installation of a visual approach slope indicator system. However, factors that must be considered when making such a decision are:

a) frequency of use;

b) seriousness of the hazard;

c) presence of other visual and non-visual aids;

d) type of aeroplanes using the runway; and

e) frequency and type of adverse weather conditions under which the runway will be used.

12.2 With respect to the seriousness of the hazard, the order given in the application specifications for a visual approach slope indicator system, 5.3.5.1 b) to e) of Chapter 5 may be used as a general guide. These may be summarized as:

a) inadequate visual guidance because of:

1) approaches over water or featureless terrain, or absence of sufficient extraneous light in the approach area by night;

2) deceptive surrounding terrain;

b) serious hazard in approach;

c) serious hazard if aeroplanes undershoot or overrun; and

d) unusual turbulence.

12.3 The presence of other visual or non-visual aids is a very important factor. Runways equipped with ILS or MLS would generally receive the lowest priority for a visual approach slope indicator system installation. It must be remembered, though, that visual approach slope indicator systems are visual approach aids in their own right and can supplement electronic aids. When serious hazards exist and/or a substantial number of aeroplanes not equipped for ILS or MLS use a runway, priority might be given to installing a visual approach slope indicator on this runway.

12.4 Priority should be given to runways used by turbo-jet aeroplanes.

13. Lighting of unserviceable areas and vehicles

13.1 Unserviceable areas

Where a temporarily unserviceable area exists, it may be marked with steady-red lights. These lights should mark the most potentially dangerous extremities of the area. A minimum of four such lights should be used, except where the area is triangular in shape where a minimum of three lights may be employed. The number of lights should be increased when the area is large or of unusual configuration. At least one light should be installed for each 7.5 m of peripheral distance of the area. If the lights are directional, they should be orientated so that as far as possible their beams are aligned in the direction from which aircraft or vehicles will approach. Where aircraft or vehicles will normally approach from several directions, consideration should be given to adding extra lights or using omnidirectional lights to show the area from these directions. Unserviceable area lights should be frangible. Their height should be sufficiently low to preserve clearance for propellers and for engine pods of jet aircraft.

13.2 Other than follow-me vehicles

The following light characteristics are considered suitable for obstacle lighting under night-time conditions:

a) 360° azimuth coverage in either yellow (service vehicles) or blue (emergency and security vehicles) colour;

b) minimum effective intensity in the horizontal plane not less than 40 cd nor more than 400 cd (the upper cd limit is required to avoid dazzle);

c) the beam spread measured to 1/10 of peak intensity extending from 10° below to 15° above the horizontal; and

d) flash-rate 75 ± 15 flashes per minute.

13.3 Follow-me vehicles

The following light characteristics are considered suitable for obstacle lighting under night-time conditions:

a) 360° azimuth coverage in yellow colour;

b) minimum effective intensity in the horizontal plane not less than 200 cd nor more than 400 cd (the upper cd limit is required to avoid dazzle);

c) vertical light distribution as shown in Figure A-8; and

d) flash-rate 75 ± 15 flashes per minute.

14. Intensity control of approach and runway lights

14.1 The conspicuity of a light depends on the impression received of contrast between the light and its background. If a light is to be useful to a pilot by day when on approach, it must

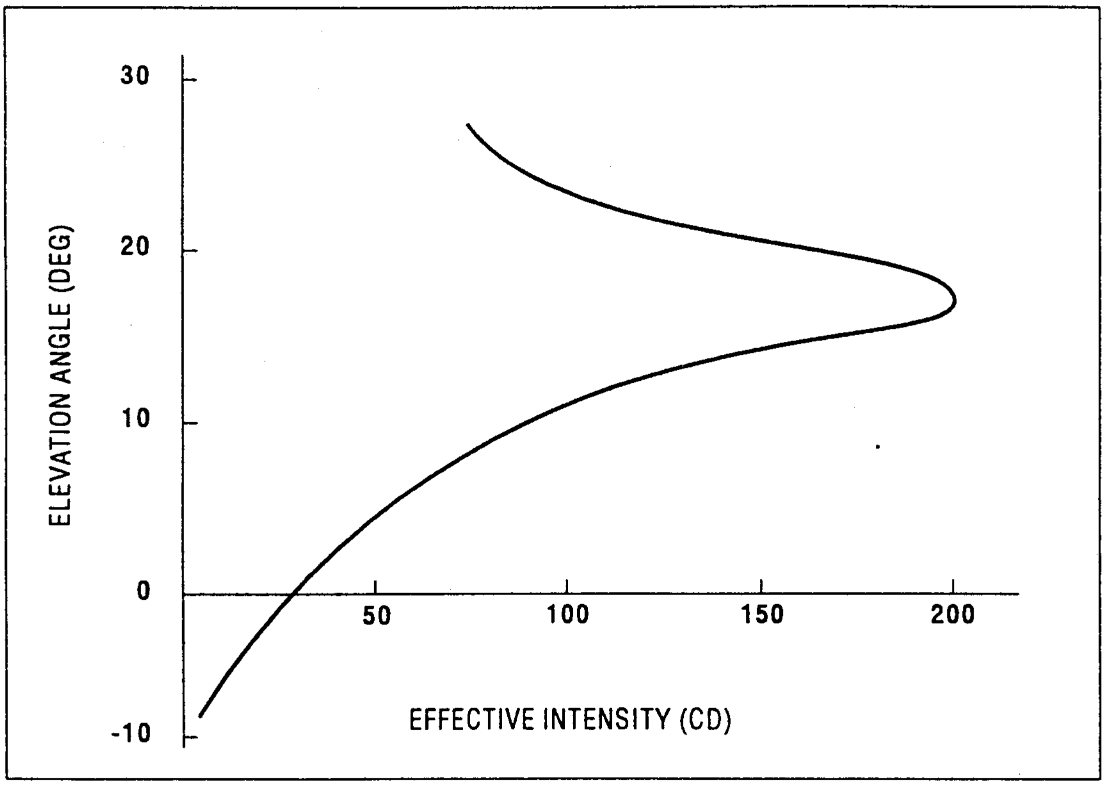

Figure A-8. Follow-me vehicle obstacle light

have an intensity of at least 2 000 or 3 000 cd, and in the case of approach lights an intensity of the order of 20 000 cd is desirable. In conditions of very bright daylight fog it may not be possible to provide lights of sufficient intensity to be effective. On the other hand, in clear weather on a dark night, an intensity of the order of 100 cd for approach lights and 50 cd for the runway edge lights may be found suitable. Even then, owing to the closer range at which they are viewed, pilots have sometimes complained that the runway edge lights seemed unduly bright.

14.2 In fog the amount of light scattered is high. At night this scattered light increases the brightness of the fog over the approach area and runway to the extent that little increase in the visual range of the lights can be obtained by increasing their intensity beyond 2 000 or 3 000 cd. In an endeavour to increase the range at which lights would first be sighted at night, their intensity must not be raised to an extent that a pilot might find excessively dazzling at diminished range.

14.3 From the foregoing will be evident the importance of adjusting the intensity of the lights of an aerodrome lighting system according to the prevailing conditions, so as to obtain the best results without excessive dazzle that would disconcert the pilot. The appropriate intensity setting on any particular occasion will depend both on the conditions of background brightness and the visibility. Detailed guidance material on selecting intensity setting for different conditions is given in the *Aerodrome Design Manual*, Part 4.

15. Signal area

A signal area need be provided only when it is intended to use visual ground signals to communicate with aircraft in flight. Such signals may be needed when the aerodrome does not have an aerodrome control tower or an aerodrome flight information service unit, or when the aerodrome is used by aeroplanes not equipped with radio. Visual ground signals may also be useful in the case of failure of two-way radio communication with aircraft. It should be recognized, however, that the type of information which may be conveyed by visual ground signals should normally be available in AIPs or NOTAM. The potential need for visual ground signals should therefore be evaluated before deciding to provide a signal area.

16. Rescue and fire fighting services

16.1 Administration

16.1.1 The rescue and fire fighting service at an aerodrome should be under the administrative control of the aerodrome management, which should also be responsible for ensuring that the service provided is organized, equipped, staffed, trained and operated in such a manner as to fulfil its proper functions.

16.1.2 In drawing up the detailed plan for the conduct of search and rescue operations in accordance with 4.2.1 of Annex 12, the aerodrome management should co-ordinate its plans with the relevant rescue co-ordination centres to ensure that the respective limits of their responsibilities for an aircraft accident within the vicinity of an aerodrome are clearly delineated.

16.1.3 Co-ordination between the rescue and fire fighting service at an aerodrome and public protective agencies, such as local fire brigade, police force, coast guard and hospitals, should be achieved by prior agreement for assistance in dealing with an aircraft accident.

16.1.4 A grid map of the aerodrome and its immediate vicinity should be provided for the use of the aerodrome services concerned. Information concerning topography, access roads and location of water supplies should be indicated. This map should be conspicuously posted in the control tower and fire station, and available on the rescue and fire fighting vehicles and such other supporting vehicles required to respond to an aircraft accident or incident. Copies should also be distributed to public protective agencies as desirable.

16.1.5 Co-ordinated instructions should be drawn up detailing the responsibilities of all concerned and the action to be taken in dealing with emergencies. The appropriate authority should ensure that such instructions are promulgated and observed.

16.2 Training

The training curriculum should include initial and recurrent instruction in at least the following areas:

a) airport familiarization;

b) aircraft familiarization;

c) rescue and fire fighting personnel safety;

d) emergency communications systems on the aerodrome, including aircraft fire related alarms;

e) use of the fire hoses, nozzles, turrets and other appliances required for compliance with Chapter 9, 9.2;

f) application of the types of extinguishing agents required for compliance with Chapter 9, 9.2;

g) emergency aircraft evacuation assistance;

h) fire fighting operations;

i) adaptation and use of structural rescue and fire fighting equipment for aircraft rescue and fire fighting;

j) dangerous goods;

k) familiarization with fire fighters' duties under the aerodrome emergency plan; and

l) protective clothing and respiratory protection.

16.3 Level of protection to be provided

16.3.1 In accordance with Chapter 9, 9.2 aerodromes should be categorized for rescue and fire fighting purposes and the level of protection provided should be appropriate to the aerodrome category.

16.3.2 However, Chapter 9, 9.2.2 permits a lower level of protection to be provided for a limited period where the number of movements of the aeroplanes in the highest category normally using the aerodrome is less than 700 in the busiest consecutive three months. It is important to note that the concession included in 9.2.2 a) is applicable only where there is a wide range of difference between the dimensions of the aeroplanes included in reaching 700 movements.

16.4 Rescue equipment for difficult environments

16.4.1 Suitable rescue equipment and services should be available at an aerodrome where the area to be covered by the service includes water, swampy areas or other difficult environment that cannot be fully served by conventional wheeled vehicles. This is particularly important where a significant portion of approach/departure operations takes place over these areas.

16.4.2 The rescue equipment should be carried on boats or other vehicles such as helicopters and amphibious or air cushion vehicles, capable of operating in the area concerned. The vehicles should be so located that they can be brought into action quickly to respond to the areas covered by the service.

16.4.3 At an aerodrome bordering the water, the boats or other vehicles should preferably be located on the aerodrome, and convenient launching or docking sites provided. If these vehicles are located off the aerodrome, they should preferably be under the control of the aerodrome rescue and fire fighting service or, if this is not practicable, under the control of another competent public or private organization working in close co-ordination with the aerodrome rescue and fire fighting service (such as police, military services, harbour patrol or coast guard).

16.4.4 Boats or other vehicles should have as high a speed as practicable so as to reach an accident site in minimum time. To reduce the possibility of injury during rescue operations, water jet-driven boats are preferred to water propeller-driven boats unless the propellers of the latter boats are ducted. Should the water areas to be covered by the service be frozen for a signficant period of the year, the equipment should be selected accordingly. Vehicles used in this service should be equipped with life rafts and life preservers related to the requirements of the larger aircraft normally using the aerodrome, with two-way radio communication, and with floodlights for night operations. If aircraft operations during periods of low visibility are expected, it may be necessary to provide guidance for the responding emergency vehicles.

16.4.5 The personnel designated to operate the equipment should be adequately trained and drilled for rescue services in the appropriate environment.

16.5 Facilities

16.5.1 The provision of special telephone, two-way radio communication and general alarm systems for the rescue and fire fighting service is desirable to ensure the dependable transmission of essential emergency and routine information. Consistent with the individual requirements of each aerodrome, these facilities serve the following purposes:

a) direct communication between the activating authority and the aerodrome fire station in order to ensure the prompt alerting and dispatch of rescue and fire fighting vehicles and personnel in the event of an aircraft accident or incident;

b) emergency signals to ensure the immediate summoning of designated personnel not on standby duty;

c) as necessary, summoning essential related services on or off the aerodrome; and

d) maintaining communication by means of two-way radio with the rescue and fire fighting vehicles in attendance at an aircraft accident or incident.

16.5.2 The availability of ambulance and medical facilities for the removal and after-care of casualties arising from an aircraft accident should receive the careful consideration of the appropriate authority and should form part of the over-all emergency plan established to deal with such emergencies.

17. Operators of vehicles

17.1 The authorities responsible for the operation of vehicles on the movement area should ensure that the operators are properly qualified. This may include, as appropriate to the driver's function, knowledge of:

a) the geography of the aerodrome;

b) aerodrome signs, markings and lights;

c) radiotelephone operating procedures;

d) terms and phrases used in aerodrome control including the ICAO spelling alphabet;

e) rules of air traffic services as they relate to ground operations;

f) airport rules and procedures; and

g) specialist functions as required, for example, in rescue and fire fighting.

17.2 The operator should be able to demonstrate competency, as appropriate, in:

a) the operation or use of vehicle transmit/receive equipment;

b) understanding and complying with air traffic control and local procedures;

c) vehicle navigation on the aerodrome; and

d) special skills required for the particular function.

In addition, as required for any specialist function, the operator should be the holder of a State driver's licence, a State radio operator's licence or other licences.

17.3 The above should be applied as is appropriate to the function to be performed by the operator and it is not necessary that all operators be trained to the same level, for example, operators whose functions are restricted to the apron.

17.4 If special procedures apply for operations in low visibility conditions, it is desirable to verify an operator's knowledge of the procedures through periodic checks.

18. The ACN-PCN method of reporting pavement strength

18.1 Overload operations

18.1.1 Overloading of pavements can result either from loads too large, or from a substantially increased application rate, or both. Loads larger than the defined (design or evaluation) load shorten the design life, whilst smaller loads extend it. With the exception of massive overloading, pavements in their structural behaviour are not subject to a particular limiting load above which they suddenly or catastrophically fail. Behaviour is such that a pavement can sustain a definable load for an expected number of repetitions during its design life. As a result, occasional minor overloading is acceptable, when expedient, with only limited loss in pavement life expectancy and relatively small acceleration of pavement deterioration. For those operations in which magnitude of overload and/or the frequency of use do not justify a detailed analysis, the following criteria are suggested:

a) for flexible pavements, occasional movements by aircraft with ACN not exceeding 10 per cent above the reported PCN should not adversely affect the pavement;

b) for rigid or composite pavements, in which a rigid pavement layer provides a primary element of the structure, occasional movements by aircraft with ACN not exceeding 5 per cent above the reported PCN should not adversely affect the pavement;

c) if the pavement structure is unknown, the 5 per cent limitation should apply; and

d) the annual number of overload movements should not exceed approximately 5 per cent of the total annual aircraft movements.

18.1.2 Such overload movements should not normally be permitted on pavements exhibiting signs of distress or failure. Furthermore, overloading should be avoided during any periods of thaw following frost penetration, or when the strength of the pavement or its subgrade could be weakened by water. Where overload operations are conducted, the appropriate authority should review the relevant pavement condition regularly, and should also review the criteria for overload operations periodically since excessive repetition of overloads can cause severe shortening of pavement life or require major rehabilitation of pavement.

18.2 ACNs for several aircraft types

For convenience, several aircraft types currently in use have been evaluated on rigid and flexible pavements founded on the four subgrade strength categories in Chapter 2, 2.6.6 b) and the results tabulated in the *Aerodrome Design Manual,* Part 3.

ATTACHMENT B. OBSTACLE LIMITATION SURFACES

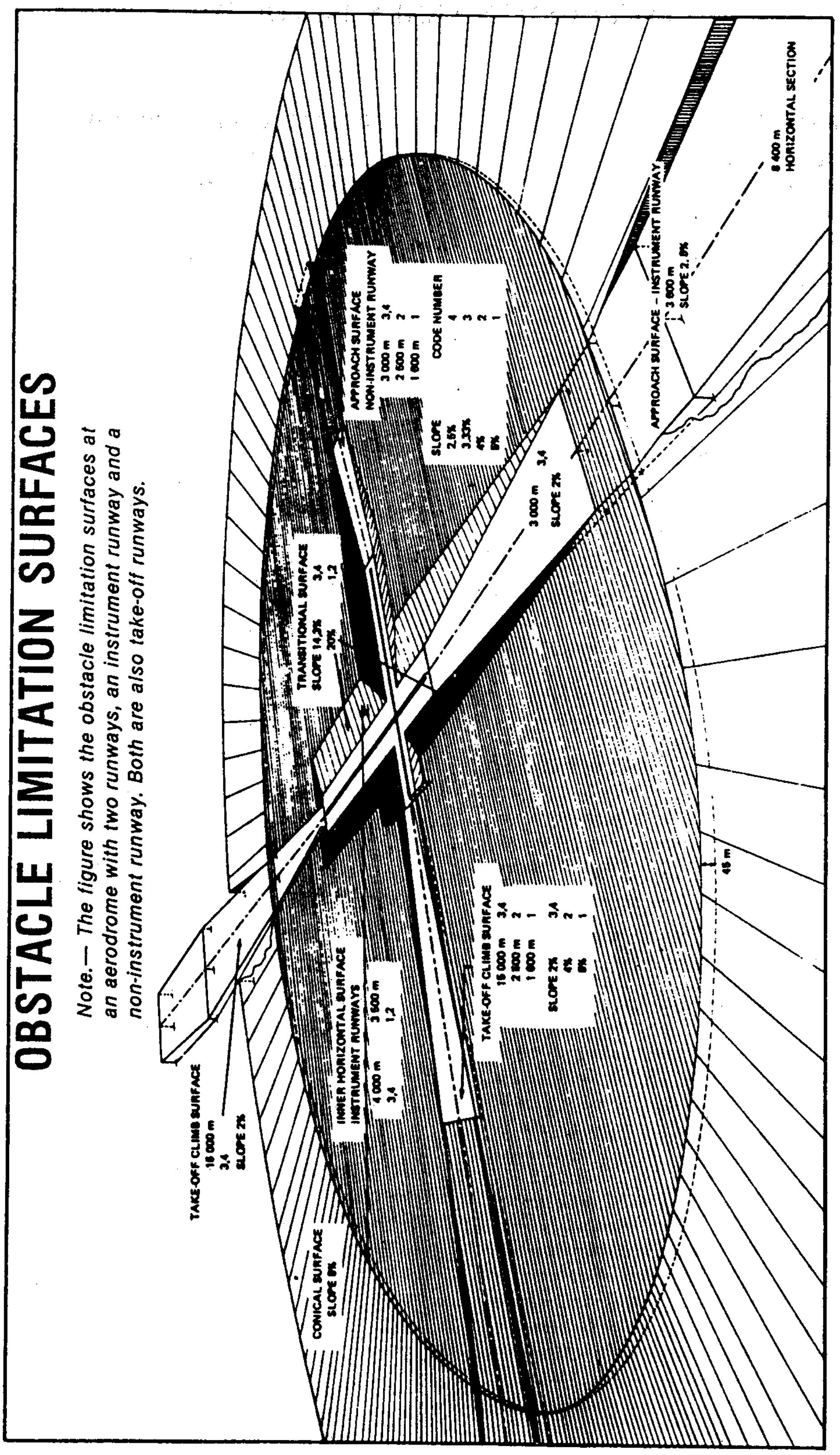

Figure B-1

LIMITED INDEX OF SIGNIFICANT SUBJECTS INCLUDED IN ANNEX 14, VOLUME I

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* Those specifications which relate to the daily operation of an aerodrome as compared with those which relate to its design or facilities to be provided.

MAINTENANCE

MARKER

MARKING

MONITORING

NON-INSTRUMENT RUNWAY

NON-PRECISION APPROACH RUNWAY

OBSTACLE/OBJECT

PAVEMENT STRENGTH

PRECISION APPROACH RUNWAY CATEGORY I

PRECISION APPROACH RUNWAYS CATEGORIES II AND III

RESCUE AND FIRE FIGHTING

RUNWAY

RUNWAY END SAFETY AREA

RUNWAY MEANT FOR TAKE-OFF

RUNWAY SURFACE FRICTION CHARACTERISTICS

SECURITY

STOPWAY

TAXI-HOLDING POSITION

TAXIWAY

VISUAL APPROACH SLOPE INDICATOR SYSTEMS

— END —

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

AERODROMES

ANNEX 14

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME II HELIPORTS

SECOND EDITION — JULY 1995

This edition incorporates all amendments to Annex 14, Volume II, adopted by the Council prior to 14 March 1995 and supersedes on 9 November 1995 all previous editions of Annex 14, Volume II.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword and the relevant clauses in each Chapter

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1	Incorporated in this Edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by
	20/10/95	14/11/95	

TABLE OF CONTENTS

ABBREVIATIONS AND SYMBOLS
(used in Annex 14, Volume II)

Abbreviations

cd	Candela
cm	Centimeter
D	Helicopter largest over-all dimension
FATO	Final approach and take-off area
ft	Foot
HAPI	Helicopter approach path indicator
Hz	Hertz
IMC	Instrument meteorological conditions
kg	Kilogram
km/h	Kilometre per hour
kt	Knot
L	Litre
LDAH	Landing distance available
L/min	Litre per minute
m	Metre

Abbreviations

RD	Diameter of the largest rotor
RTODAH	Rejected take-off distance available
s	Second
TLOF	Touchdown and lift-off area
TODAH	Take-off distance available
VMC	Visual meteorological conditions

Symbols

°	Degree
=	Equals
%	Percentage
±	Plus or minus

MANUALS
(related to the specifications of this Annex)

Aerodrome Design Manual (Doc 9157)
- Part 1 — Runways
- Part 2 — Taxiways, Aprons and Holding Bays
- Part 3 — Pavements
- Part 4 — Visual Aids
- Part 5 — Electrical Systems

Airport Planning Manual (Doc 9184)
- Part 1 — Master Planning
- Part 2 — Land Use and Environmental Control
- Part 3 — Guidelines for Consultant/Construction Services

Airport Services Manual (Doc 9137)
- Part 1 — Rescue and Fire Fighting
- Part 2 — Pavement Surface Conditions
- Part 3 — Bird Control and Reduction
- Part 4 — Fog Dispersal (withdrawn)
- Part 5 — Removal of Disabled Aircraft
- Part 6 — Control of Obstacles
- Part 7 — Airport Emergency Planning
- Part 8 — Airport Operational Services
- Part 9 — Airport Maintenance Practices

Heliport Manual (Doc 9261)

Stolport Manual (Doc 9150)

Manual on the ICAO Bird Strike Information System (IBIS) (Doc 9332)

Manual of Surface Movement Guidance and Control Systems (SMGCS) (Doc 9476)

FOREWORD

Historical background

Standards and Recommended Practices for aerodromes were first adopted by the Council on 29 May 1951 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944) and designated as Annex 14 to the Convention. The document containing these Standards and Recommended Practices is now designated as Annex 14, Volume I to the Convention. In general, Volume I addresses planning, design and operations of aerodromes but is not specifically applicable to heliports.

Therefore, Volume II is being introduced as a means of including provisions for heliports. Proposals for comprehensive Standards and Recommended Practices covering all aspects of heliport planning, design and operations have been developed with the assistance of the ANC Visual Aids Panel and the ANC Helicopter Operations Panel.

Table A shows the origin of the provisions in this volume, together with a list of the principal subjects involved and the dates on which the Annex was adopted by the Council, when it became effective and when it became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specified request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. The establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1. — *Material comprising the Annex proper:*

a) *Standards and Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specifications.

d) *Tables and Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 14, Volume II

Amendment	*Source(s)*	*Subject(s)*	*Adopted* *Effective* *Applicable*
1st Edition	Fourth Meeting of the ANC Helicopter Operations Panel; Eleventh meeting of the ANC Visual Aids Panel and Secretariat	Physical characteristics; obstacle limitation surfaces; visual aids for visual meteorological conditions; rescue and fire fighting services.	9 March 1990 30 July 1900 15 November 1990
1 (2nd Edition)	Twelfth Meeting of the ANC Visual Aids Panel and Secretariat	Standard geodetic reference system (WGS-84); frangibility; visual aids for helicopter non-precision approaches; and visual alignment guidance system.	13 March 1995 24 July 1995 9 November 1995

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. GENERAL

Introductory Note.— Volume II of this Annex contains Standards and Recommended Practices (specifications) that prescribe the physical characteristics and obstacle limitation surfaces to be provided for at heliports, and certain facilities and technical services normally provided at a heliport. It is not intended that these specifications limit or regulate the operation of an aircraft.

The specifications in this volume modify or complement those in Volume I which, where appropriate, are also applicable to heliports. In other words, where a particular issue is a subject of a specification in this volume that specification will supersede any other specification on that particular issue in Volume I. Throughout this volume the term "heliport" is used; however, it is intended that these specifications also apply to areas for the exclusive use of helicopters at an aerodrome primarily meant for the use of aeroplanes.

It is to be noted that provisions for helicopter flight operations are contained in Annex 6, Part III.

1.1 Definitions

When the following terms are used in this volume they have the meanings given below. Annex 14, Volume I contains definitions for those terms which are used in both volumes.

Air taxiway. A defined path on the surface established for the air taxiing of helicopters.

Air transit route. A defined path on the surface established for the air transitting of helicopters.

Declared distances — heliports.

a) *Take-off distance available (TODAH).* The length of the final approach and take-off area plus the length of helicopter clearway (if provided) declared available and suitable for helicopters to complete the take-off.

b) *Rejected take-off distance available (RTODAH).* The length of the final approach and take-off area declared available and suitable for performance class 1 helicopters to complete a rejected take-off.

c) *Landing distance available (LDAH).* The length of the final approach and take-off area plus any additional area declared available and suitable for helicopters to complete the landing manoeuvre from a defined height.

Elevated heliport. A heliport located on a raised structure on land.

Final approach and take-off area (FATO). A defined area over which the final phase of the approach manoeuvre to hover or landing is completed and from which the take-off manoeuvre is commenced. Where the FATO is to be used by performance Class 1 helicopters, the defined area includes the rejected take-off area available.

Helicopter ground taxiway. A ground taxiway for use by helicopters only.

Helicopter clearway. A defined area on the ground or water under the control of the appropriate authority, selected and/or prepared as a suitable area over which a performance class 1 helicopter may accelerate and achieve a specific height.

Helicopter stand. An aircraft stand which provides for parking a helicopter and, where air taxiing operations are contemplated, the helicopter touchdown and lift-off.

Helideck. A heliport located on a floating or fixed off-shore structure.

Heliport. An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Safety area. A defined area on a heliport surrounding the FATO which is free of obstacles, other than those required for air navigation purposes, and intended to reduce the risk of damage to helicopters accidentally diverging from the FATO.

Surface level heliport. A heliport located on the ground or on the water.

Touchdown and lift-off area (TLOF). A load bearing area on which a helicopter may touch down or lift off.

1.2 Applicability

1.2.1 The interpretation of some of the specifications in the Annex expressly requires the exercising of discretion, the taking of a decision or the performance of a function by the appropriate authority. In other specifications, the expression appropriate authority does not actually appear although its inclusion is implied. In both cases, the responsibility for whatever determination or action is necessary shall rest with the State having jurisdiction over the heliport.

1.2.2 The specifications in Annex 14, Volume II shall apply to all heliports intended to be used by helicopters in international civil aviation. The specifications of Annex 14, Volume I shall apply, where appropriate, to these heliports as well.

1.2.3 Wherever a colour is referred to in this volume, the specifications for that colour given in Appendix 1 to Annex 14, Volume I shall apply.

CHAPTER 2. HELIPORT DATA

2.1 Geographical coordinates

2.1.1 Geographical coordinates indicating latitude and longitude shall be determined and reported to the aeronautical information services authority in terms of the World Geodetic System — 1984 (WGS-84) geodetic reference datum, identifying those geographical coordinates which have been transformed into WGS-84 coordinates by mathematical means and whose accuracy of original field work does not meet the requirements in 2.1.2 below.

2.1.2 The order of accuracy of the field work shall be such that the resulting operational navigation data for the phases of flight will be within the maximum deviations, with respect to an appropriate reference frame, as indicated herein:

a) significant obstacles on and in the vicinity of the heliport and positions of radio navigation aids located on the heliport: three metres;

b) geometric centre of the touchdown and lift-off area, thresholds of the final approach and take-off area (where appropriate): one metre;

c) centre line points of the helicopter ground taxiways, air taxiways and air transit routes and helicopter stands: one-half metre; and

d) heliport reference point: thirty metres.

Note 1.— An appropriate reference frame is that which enables WGS-84 to be realized on a given heliport and with respect to which all coordinate data are related.

Note 2.— Specifications governing the publication of WGS-84 coordinates are given in Annex 4, Chapter 2 and Annex 15, Chapter 3.

2.2 Heliport reference point

2.2.1 A heliport reference point shall be established for a heliport not co-located with an aerodrome.

Note.— When the heliport is co-located with an aerodrome, the established aerodrome reference point serves both aerodrome and heliport.

2.2.2 The heliport reference point shall be located near the initial or planned geometric centre of the heliport and shall normally remain where first established.

2.2.3 The position of the heliport reference point shall be measured and reported to the aeronautical information services authority in degrees, minutes and seconds.

2.3 Heliport elevation

2.3.1 The heliport elevation shall be measured and reported to the aeronautical information services authority to the nearest metre or foot.

2.3.2 For a heliport used by international civil aviation, the elevation of the touchdown and lift-off area and/or the elevation of each threshold of the final approach and take-off area (where appropriate) shall be measured and reported to the aeronautical information services authority to the nearest metre or foot.

2.4 Heliport dimensions and related information

2.4.1 The following data shall be measured or described, as appropriate, for each facility provided on a heliport:

a) heliport type — surface-level, elevated or helideck;

b) touchdown and lift-off area — dimensions, slope, surface type, bearing strength in tonnes (1 000 kg);

c) final approach and take-off area — type of FATO, true bearing, designation number (where appropriate), length, width, slope, surface type;

d) safety area — length, width and surface type;

e) helicopter ground taxiway, air taxiway and air transit route — designation, width, surface type;

f) apron — surface type, helicopter stands;

g) clearway — length, ground profile; and

h) visual aids for approach procedures, marking and lighting of FATO, TLOF, taxiways and aprons.

2.4.2 The geographical coordinates of the geometric centre of the touchdown and lift-off area and/or of each threshold of the final approach and take-off area (where appropriate) shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

2.4.3 The geographical coordinates of appropriate centre line points of helicopter ground taxiways, air taxiways and air transit routes shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

2.4.4 The geographical coordinates of each helicopter stand shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and hundredths of seconds.

2.4.5 The geographical coordinates of significant obstacles on and in the vicinity of a heliport shall be measured and reported to the aeronautical information services authority in degrees, minutes, seconds and tenths of seconds. In addition, the top elevation rounded up to the nearest metre or foot, type, marking and lighting (if any) of the significant obstacles shall be reported to the aeronautical information services authority.

2.5 Declared distances

The following distances shall be declared, where relevant, for a heliport:

a) take-off distance available;

b) rejected take-off distance available; and

c) landing distance available.

CHAPTER 3. PHYSICAL CHARACTERISTICS

3.1 Surface-level heliports

Note.— The following specifications are for surface-level land heliports (except where specified).

Final approach and take-off areas

3.1.1 A surface-level heliport shall be provided with at least one FATO.

Note.— A FATO may be located on or near a runway strip or taxiway strip.

3.1.2 The dimensions of a FATO shall be:

a) for a heliport intended to be used by performance class 1 helicopters, as prescribed in the helicopter flight manual except that, in the absence of width specifications, the width shall be not less than 1.5 times the over-all length/width, whichever is greater, of the longest/widest helicopter the heliport is intended to serve;

b) for a water heliport intended to be used by performance class 1 helicopters, as prescribed in a) above, plus 10 per cent;

c) for a heliport intended to be used by performance class 2 and 3 helicopters, of sufficient size and shape to contain an area within which can be drawn a circle of diameter not less than 1.5 times the over-all length/width, whichever is greater, of the longest/widest helicopter the heliport is intended to serve; and

d) for a water heliport intended to be used by performance class 2 and 3 helicopters, of sufficient size to contain an area within which can be drawn a circle of diameter not less than two times the over-all length/width, whichever is greater, of the longest/widest helicopter the heliport is intended to serve.

Note.— Local conditions, such as elevation and temperature, may need to be considered when determining the size of a FATO. Guidance is given in the Heliport Manual.

3.1.3 The over-all slope in any direction on the FATO shall not exceed 3 per cent. No portion of a FATO shall have a local slope exceeding:

a) 5 per cent where the heliport is intended to be used by performance class 1 helicopters; and

b) 7 per cent where the heliport is intended to be used by performance class 2 and 3 helicopters.

3.1.4 The surface of the FATO shall:

a) be resistant to the effects of rotor downwash;

b) be free of irregularities that would adversely affect the take-off or landing of helicopters; and

c) have bearing strength sufficient to accommodate a rejected take-off by performance class 1 helicopters.

3.1.5 **Recommendation.—** *The FATO should provide ground effect.*

Helicopter clearways

3.1.6 When it is necessary to provide a helicopter clearway, it shall be located beyond the upwind end of the rejected take-off area available.

3.1.7 **Recommendation.—** *The width of a helicopter clearway should not be less than that of the associated safety area.*

3.1.8 **Recommendation.—** *The ground in a helicopter clearway should not project above a plane having an upward slope of 3 per cent, the lower limit of this plane being a horizontal line which is located on the periphery of the FATO.*

3.1.9 **Recommendation.—** *An object situated on a helicopter clearway which may endanger helicopters in the air should be regarded as an obstacle and should be removed.*

Touchdown and lift-off areas

3.1.10 At least one touchdown and lift-off area shall be provided at a heliport.

Note.— The touchdown and lift-off area may or may not be located within the FATO.

3.1.11 The touchdown and lift-off area (TLOF) shall be of sufficient size to contain a circle of diameter 1.5 times the length or width of the undercarriage, whichever is the greater, of the largest helicopter the area is intended to serve.

Note.— A touchdown and lift-off area may be any shape.

3.1.12 Slopes on a touchdown and lift-off area shall be sufficient to prevent accumulation of water on the surface of the area, but shall not exceed 2 per cent in any direction.

3.1.13 A touchdown and lift-off area shall be capable of withstanding the traffic of helicopters that the area is intended to serve.

Safety areas

3.1.14 A FATO shall be surrounded by a safety area.

3.1.15 A safety area surrounding a FATO intended to be used in visual meteorological conditions (VMC) shall extend outwards from the periphery of the FATO for a distance of at least 3 m or 0.25 times the over-all length/width, whichever is greater, of the longest/widest helicopter the area is intended to serve.

3.1.16 A safety area surrounding a FATO intended to be used by helicopter operations in instrument meteorological conditions (IMC) shall extend:

a) laterally to a distance of at least 45 m on each side of the centre line; and

b) longitudinally to a distance of at least 60 m beyond the ends of the FATO.

Note.— See Figure 3-1.

3.1.17 No fixed object shall be permitted on a safety area, except for frangible objects, which, because of their function, must be located on the area. No mobile object shall be permitted on a safety area during helicopter operations.

3.1.18 Objects whose functions require them to be located on the safety area shall not exceed a height of 25 cm when located along the edge of the FATO nor penetrate a plane originating at a height of 25 cm above the edge of the FATO and sloping upwards and outwards from the edge of the FATO at a gradient of 5 per cent.

3.1.19 The surface of the safety area shall not exceed an upward slope of 4 per cent outwards from the edge of the FATO.

3.1.20 The surface of the safety area shall be treated to prevent flying debris caused by rotor downwash.

3.1.21 The surface of the safety area abutting the FATO shall be continuous with the FATO and be capable of supporting, without structural damage, the helicopters that the heliport is intended to serve.

Helicopter ground taxiways

Note.— A helicopter ground taxiway is intended to permit the surface movement of a wheeled helicopter under its own power. The specifications for taxiways, taxiway shoulders and taxiway strips included in Annex 14, Volume I are equally applicable to heliports as modified below. When a taxiway is intended for use by aeroplanes and helicopters, the provisions for taxiways and helicopter ground taxiways will be examined and the more stringent requirements will be applied.

3.1.22 The width of a helicopter ground taxiway shall not be less than:

Helicopter main gear span	Helicopter ground taxiway width
Up to but not including 4.5 m	7.5 m
4.5 m up to but not including 6 m	10.5 m
6 m up to but not including 10 m	15 m
10 m and over	20 m

3.1.23 The separation distance between a helicopter ground taxiway and another helicopter ground taxiway, an air taxiway, an object or helicopter stand shall not be less than the appropriate dimension specified in Table 3-1.

3.1.24 The longitudinal slope of a helicopter ground taxiway shall not exceed 3 per cent.

3.1.25 **Recommendation.—** *A helicopter ground taxiway should be capable of withstanding the traffic of helicopters that the helicopter ground taxiway is intended to serve.*

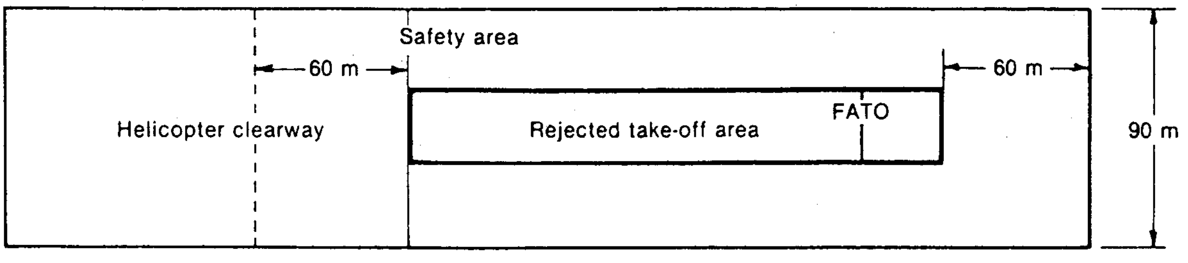


Figure 3-1. Safety area for instrument FATO

3.1.26 **Recommendation.**— *A helicopter ground taxiway should be provided with shoulders which extend symmetrically on each side of the helicopter ground taxiway for at least one-half the greatest over-all width of the helicopters that the helicopter ground taxiway is intended to serve.*

3.1.27 The helicopter ground taxiway and its shoulder shall provide rapid drainage but the helicopter ground taxiway transverse slope shall not exceed 2 per cent.

3.1.28 **Recommendation.**— *The surface of a helicopter ground taxiway shoulder should be resistant to the effect of rotor downwash.*

Air taxiways

Note.— An air taxiway is intended to permit the movement of a helicopter above the surface at a height normally associated with ground effect and at groundspeed less than 37 km/h (20 kt).

3.1.29 The width of an air taxiway shall be at least two times the greatest over-all width of the helicopters that the air taxiway is intended to serve.

3.1.30 The surface of an air taxiway shall:

a) be resistant to the effects of rotor downwash; and

b) be suitable for emergency landings.

3.1.31 **Recommendation.**— *The surface of an air taxiway should provide ground effect.*

3.1.32 **Recommendation.**— *The transverse slope of the surface of an air taxiway should not exceed 10 per cent and the longitudinal slope should not exceed 7 per cent. In any event, the slopes should not exceed the slope landing limitations of the helicopters the air taxiway is intended to serve.*

3.1.33 The separation distance between an air taxiway and another air taxiway, a helicopter ground taxiway, an object or a helicopter stand shall not be less than the appropriate dimension in Table 3-1.

Air transit route

Note.— An air transit route is intended to permit the movement of a helicopter above the surface, normally at heights not above 30 m (100 ft) above ground level and at ground speeds exceeding 37 km/h (20 kt).

3.1.34 The width of an air transit route shall not be less than:

a) 7.0 times RD when the air transit route is intended for use by day only; and

b) 10.0 times RD when the air transit route is intended for use at night;

when RD is the diameter of the largest rotor of the helicopters that the air transit route is intended to serve.

3.1.35 Any variation in the direction of the centre line of an air transit route shall not exceed 120° and be designed so as not to necessitate a turn of radius less than 270 m.

Note.— It is intended that air transit routes be selected so as to permit autorotative or one-engine-inoperative landings such that, as a minimum requirement, injury to persons on the ground or water, or damage to property are minimized.

Aprons

Note.— The specifications for aprons included in Chapter 3 of Annex 14, Volume I are equally applicable to heliports as modified below.

Table 3-1. Helicopter ground taxiway and air taxiway separation distances (expressed in multiples of greatest over-all width of helicopter with rotor turning)

Facility	Helicopter ground taxiway	Air taxiway	Object	Helicopter stand
Helicopter ground taxiway	2 (between edges)	4 (between centre lines)	1 (edge to object)	2 (between edges)
Air taxiway	4 (between centre lines)	4 (between centre lines)	1½ (centre line to object)	4 (centre line to edge)

3.1.36 The slope in any direction on a helicopter stand shall not exceed 2 per cent.

3.1.37 The minimum clearance between a helicopter using a helicopter stand and an object or any aircraft on another stand shall not be less than half the greatest over-all width of the helicopters that the stand is intended to serve.

Note.— Where simultaneous hover operations are to be provided for, the separation distances specified in Table 3-1 between two air taxiways are to be applied.

3.1.38 A helicopter stand shall be of sufficient size to contain a circle of diameter of at least the largest over-all dimension of the largest helicopter the stand is expected to serve.

Location of a final approach and take-off area in relation to a runway or taxiway

3.1.39 Where a FATO is located near a runway or taxiway, and simultaneous VMC operations are planned, the separation distance between the edge of a runway or taxiway and the edge of a FATO shall not be less than the appropriate dimension in Table 3-2.

3.1.40 **Recommendation.—** *A FATO should not be located:*

a) near taxiway intersections or holding points where jet engine efflux is likely to cause high turbulence; or

b) near areas where aeroplane vortex wake generation is likely to exist.

Table 3-2. FATO minimum separation distance

If aeroplane mass and/or helicopter mass are	Distance between FATO edge and runway edge or taxiway edge
up to but not including 2 720 kg	60 m
2 720 kg up to but not including 5 760 kg	120 m
5 760 kg up to but not including 100 000 kg	180 m
100 000 kg and over	250 m

3.2 Elevated heliports

Final approach and take-off area and touchdown and lift-off area

Note.— On elevated heliports it is presumed that the FATO and the touchdown and lift-off area will be coincidental.

3.2.1 An elevated heliport shall be provided with at least one FATO.

3.2.2 The dimensions of the FATO shall be:

a) for a heliport intended to be used by performance class 1 helicopters, as prescribed in the helicopter flight manual except that, in the absence of width specifications, the width shall be not less than 1.5 times the over-all length/width, whichever is greater, of the longest/widest helicopter the heliport is intended to serve; and

b) for a heliport intended to be used by performance class 2 helicopters, of sufficient size and shape to contain an area within which can be drawn a circle of diameter not less than 1.5 times the over-all length/width, whichever is greater, of the longest/widest helicopter the heliport is intended to serve.

3.2.3 **Recommendation.—** *The slope requirements for elevated heliports should conform to the requirements for surface level heliports specified in 3.1.3.*

3.2.4 The FATO shall be capable of withstanding the traffic of helicopters the heliport is intended to serve. Design considerations shall take into account additional loading resulting from the presence of personnel, snow, freight, refuelling, fire fighting equipment, etc.

Note.— Guidance on structural design for elevated heliports is given in the Heliport Manual.

Safety area

3.2.5 The FATO shall be surrounded by a safety area.

3.2.6 The safety area shall extend outwards from the periphery of the FATO for a distance of at least 3 m or 0.25 times the over-all length/width, whichever is greater, of the longest/widest helicopter intended to use the elevated heliport.

3.2.7 No fixed object shall be permitted on a safety area, except for frangible objects, which, because of their function, must be located on the area. No mobile object shall be permitted on a safety area during helicopter operations.

3.2.8 Objects whose function require them to be located on the safety area shall not exceed a height of 25 cm when located along the edge of the FATO nor penetrate a plane originating at a height of 25 cm above the edge of the FATO and sloping upwards and outwards from the edge of the FATO at a gradient of 5 per cent.

3.2.9 The surface of the safety area shall not exceed an upward slope of 4 per cent outwards from the edge of the FATO.

3.2.10 The surface of the safety area abutting the FATO shall be continuous with the FATO and be capable of supporting, without structural damage, the helicopters that the heliport is intended to serve.

3.3 Helidecks

Note.— The following specifications are for helidecks located on structures engaged in such activities as mineral exploitation, research or construction. See 3.4 for shipboard heliport provisions.

Final approach and take-off area and touchdown and lift-off area

Note.— On helidecks it is presumed that the FATO and the touchdown and lift-off area will be coincidental. Guidance on the effects of airflow direction and turbulence, prevailing wind velocity and high temperatures from gas turbine exhausts or flare radiated heat on the location of the FATO is given in the Heliport Manual.

3.3.1 A helideck shall be provided with at least one FATO.

3.3.2 A FATO may be any shape but shall, for a single main rotor helicopter or side-by-side twin main rotor helicopter, be of sufficient size to contain an area within which can be drawn a circle of diameter not less than 1.0 times D of the largest helicopter the helideck is intended to serve, where D is the largest dimension of the helicopter when the rotors are turning.

3.3.3 Where omnidirectional landings by helicopters having tandem main rotors are intended, the FATO shall be of sufficient size to contain an area within which can be drawn a circle of diameter not less than 0.9 times the distance across the rotors in a fore and aft line. Where these provisions cannot be met, the FATO may be in the form of a rectangle with a small side not less than 0.75 D and a long side not less than 0.9 D but within this rectangle, bi-directional landings only will be permitted in the direction of the 0.9 D dimension.

3.3.4 No fixed object shall be permitted around the edge of the FATO except for frangible objects, which, because of their function, must be located thereon.

3.3.5 Objects whose function require them to be located on the edge of the FATO shall not exceed a height of 25 cm.

3.3.6 The surface of the FATO shall be skid-resistant to both helicopters and persons and be sloped to prevent pooling of liquids. Where the helideck is constructed in the form of a grating, the underdeck design shall be such that ground effect is not reduced.

Note.— Guidance on rendering the surface of the FATO skid-resistant is contained in the Heliport Manual.

3.4 Shipboard heliports

3.4.1 When helicopter operating areas are provided in the bow or stern of a ship or are purpose-built above the ship's structure, they shall be regarded as helidecks and the criteria given in 3.3 shall apply.

Final approach and take-off area and touchdown and lift-off area

Note.— On heliports located in other areas of ships it is presumed that the FATO and the touchdown and lift-off area will be coincidental. Guidance on the effects of airflow direction and turbulence, prevailing wind velocity and high temperature from gas turbine exhausts or flare radiated heat on the location of the FATO is given in the Heliport Manual.

3.4.2 Shipboard heliports shall be provided with at least one FATO.

3.4.3 A FATO on a shipboard heliport shall be circular and shall be of sufficient size to contain a diameter not less than 1.0 times D of the largest helicopter the heliport is intended to serve where D is the largest dimension of the helicopter when the rotors are turning.

3.4.4 The surface of the FATO shall be skid-resistant to both helicopters and persons.

9/11/95

CHAPTER 4. OBSTACLE RESTRICTION AND REMOVAL

Note.— The objectives of the specifications in this chapter are to define the airspace around heliports to be maintained free from obstacles so as to permit the intended helicopter operations at the heliports to be conducted safely and to prevent the heliports becoming unusable by the growth of obstacles around them. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

4.1 Obstacle limitation surfaces and sectors

Approach surface

4.1.1 *Description.* An inclined plane or a combination of planes sloping upwards from the end of the safety area and centred on a line passing through the centre of the FATO.

Note.— See Figure 4-1.

4.1.2 *Characteristics.* The limits of an approach surface shall comprise:

a) an inner edge horizontal and equal in length to the minimum specified width of the FATO plus the safety area, perpendicular to the centre line of the approach surface and located at the outer edge of the safety area;

b) two side edges originating at the ends of the inner edge and:

1) for other than a precision approach FATO, diverging uniformly at a specified rate from the vertical plane containing the centre line of the FATO,

2) for a precision approach FATO, diverging uniformly at a specified rate from the vertical plane containing the centre line of the FATO, to a specified height above FATO, and then diverging uniformly at a specified rate to a specified final width and continuing thereafter at that width for the remaining length of the approach surface; and

c) an outer edge horizontal and perpendicular to the centre line of the approach surface and at a specified height above the elevation of the FATO.

4.1.3 The elevation of the inner edge shall be the elevation of the safety area at the point on the inner edge that is intersected by the centre line of the approach surface.

4.1.4 The slope(s) of the approach surface shall be measured in the vertical plane containing the centre line of the surface.

Note.— For heliports used by performance class 2 and 3 helicopters, it is intended that approach paths be selected so as to permit safe forced landing or one-engine-inoperative landings such that, as a minimum requirement, injury to persons on the ground or water or damage to property are minimized. Provisions for forced landing areas are expected to minimize risk of injury to the occupants of the helicopter. The most critical helicopter type for which the heliport is intended and the ambient conditions will be factors in determining the suitability of such areas.

Transitional surface

4.1.5 *Description.* A complex surface along the side of the safety area and part of the side of the approach surface, that slopes upwards and outwards to the inner horizontal surface or a predetermined height.

Note.— See Figure 4-1.

4.1.6 *Characteristics.* The limits of a transitional surface shall comprise:

a) a lower edge beginning at the intersection of the side of the approach surface with the inner horizontal surface, or beginning at a specified height above the lower edge when an inner horizontal surface is not provided, and extending down the side of the approach surface to the inner edge of the approach surface and from there along the length of the side of the safety area parallel to the centre line of the FATO; and

b) an upper edge located in the plane of the inner horizontal surface, or at a specified height above the lower edge when an inner horizontal surface is not provided.

4.1.7 The elevation of a point on the lower edge shall be:

a) along the side of the approach surface — equal to the elevation of the approach surface at that point; and

b) along the safety area — equal to the elevation of the centre line of the FATO opposite that point.

Note.— As a result of b) the transitional surface along the safety area will be curved if the profile of the FATO is curved, *or a plane if the profile is a straight line. The intersection of the transitional surface with the inner horizontal surface, or upper edge when an inner horizontal surface is not provided, will also be a curved or a straight line depending on the profile of the FATO.*

4.1.8 The slope of the transitional surface shall be measured in a vertical plane at right angles to the centre line of the FATO.

Inner horizontal surface

Note.— The intent of the inner horizontal surface is to allow safe visual manoeuvring.

4.1.9 *Description.* A circular surface located in a horizontal plane above a FATO and its environs.

Note.— See Figure 4-1.

4.1.10 *Characteristics.* The radius of the inner horizontal surface shall be measured from the mid-point of the FATO.

4.1.11 The height of the inner horizontal surface shall be measured above an elevation datum established for such purpose.

Note.— Guidance or determining the elevation datum is contained in the Heliport Manual.

Conical surface

4.1.12 *Description.* A surface sloping upwards and outwards from the periphery of the inner horizontal surface, or from the outer limit of the transitional surface if an inner horizontal surface is not provided.

Note.— See Figure 4-1.

4.1.13 *Characteristics.* The limits of the conical surface shall comprise:

a) a lower edge coincident with the periphery of the inner horizontal surface, or outer limit of the transitional surface if an inner horizontal surface is not provided; and

b) an upper edge located at a specified height above the inner horizontal surface, or above the elevation of the lowest end of the FATO if an inner horizontal surface is not provided.

4.1.14 The slope of the conical surface shall be measured above the horizontal.

Take-off climb surface

4.1.15 *Description.* An inclined plane, a combination of planes or, when a turn is involved, a complex surface sloping upwards from the end of the safety area and centred on a line passing through the centre of the FATO.

Note.— See Figure 4-1.

4.1.16 *Characteristics.* The limits of a take-off climb surface shall comprise:

a) an inner edge horizontal and equal in length to the minimum specified width of the FATO plus the safety area, perpendicular to the centre line of the take-off climb surface and located at the outer edge of the safety area or clearway;

b) two side edges originating at the ends of the inner edge and diverging uniformly at a specified rate from the vertical plane containing the centre line of the FATO; and

c) an outer edge horizontal and perpendicular to the centre line of the take-off climb surface and at a specified height above the elevation of the FATO.

4.1.17 The elevation of the inner edge shall be the elevation of the safety area at the point on the inner edge that is intersected by the centre line of the take-off climb surface, except that when a clearway is provided, the elevation shall be equal to the highest point on the ground on the centre line of the clearway.

4.1.18 In the case of a straight take-off climb surface, the slope shall be measured in the vertical plane containing the centre line of the surface.

4.1.19 In the case of a take-off climb surface involving a turn, the surface shall be a complex surface containing the horizontal normals to its centre line and the slope of the centre line shall be the same as that for a straight take-off climb surface. That portion of the surface between the inner edge and 30 m above the inner edge shall be straight.

4.1.20 Any variation in the direction of the centre line of a take-off climb surface shall be designed so as not to necessitate a turn of radius less than 270 m.

Note.— For heliports used by performance class 2 and 3 helicopters, it is intended that departure paths be selected so as to permit safe forced landings or one-engine-inoperative landings such that, as a minimum requirement, injury to persons on the ground or water or damage to property are minimized. Provisions for forced landing areas are expected to minimize risk of injury to the occupants of the helicopter. The most critical helicopter type for which the heliport is intended and the ambient conditions will be factors in determining the suitability of such areas.

Obstacle-free sector/surface — helidecks

4.1.21 *Description.* A complex surface originating at a reference point on the edge of the FATO of a helideck and extending to a specified distance.

4.1.22 *Characteristics.* An obstacle-free sector/surface shall subtend an arc of specified angle.

4.1.23 For helidecks the obstacle-free sector shall subtend an arc of 210° and extend outwards to a distance compatible with the one-engine inoperative capability of the most critical helicopter the helideck is intended to serve. The surface shall be a horizontal plane level with the elevation of the helideck except that, over an arc of 180° passing through the centre of the FATO, the surface shall be at water level, extending outwards for a distance compatible with the take-off space required for the most critical helicopter the helideck is intended to serve (see Figure 4-2).

Limited obstacle surface — helidecks

4.1.24 *Description.* A complex surface originating at the reference point for the obstacle-free sector and extending over the arc not covered by the obstacle-free sector as shown in Figures 4-3, 4-4 and 4-5 and within which the height of obstacles above the level of the FATO will be prescribed.

4.1.25 *Characteristics.* The limited obstacle surface shall not subtend an arc greater than a specified angle and shall be sufficient to include that area not covered by the obstacle-free sector.

4.2 Obstacle limitation requirements

Note.— The requirements for obstacle limitation surfaces are specified on the basis of the intended use of a FATO, i.e. approach manoeuvre to hover or landing, or take-off manoeuvre and type of approach, and are intended to be applied when such use is made of the FATO. In cases where operations are conducted to or from both directions of a FATO, then the function of certain surfaces may be nullified because of more stringent requirements of another lower surface.

Surface level heliports

4.2.1 The following obstacle limitation surfaces shall be established for a precision approach FATO:

a) take-off climb surface;

b) approach surface;

c) transitional surfaces; and

d) conical surface.

4.2.2 The following obstacle limitation surfaces shall be established for a non-precision approach FATO:

a) take-off climb surface;

b) approach surface;

c) transitional surfaces; and

d) conical surface if an inner horizontal surface is not provided.

4.2.3 The following obstacle limitation surfaces shall be established for a non-instrument FATO:

a) take-off climb surface; and

b) approach surface.

4.2.4 **Recommendation.—** *The following obstacle limitation surfaces should be established for a non-precision approach FATO:*

a) inner horizontal surface; and

b) conical surface.

Note.— An inner horizontal surface may not be required if a straight-in non-precision approach is provided at both ends.

4.2.5 The slopes of the surfaces shall not be greater than, and their other dimensions not less than those specified in Tables 4-1 to 4-4 and shall be located as shown in Figures 4-6 to 4-10.

4.2.6 New objects or extensions of existing objects shall not be permitted above any of the surfaces in 4.2.1 to 4.2.4 above except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

4.2.7 **Recommendation.—** *Existing objects above any of the surfaces in 4.2.1 to 4.2.4 above should, as far as practicable, be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object or after aeronautical study it is determined that the object would not adversely affect the safety or significantly affect the regularity of operations of helicopters.*

Note.— The application of curved take-off climb surfaces as specified in 4.1.19 may alleviate the problems created by objects infringing these surfaces.

4.2.8 A surface level heliport shall have at least two take-off climb and approach surfaces, separated by not less than 150°.

4.2.9 **Recommendation.—** *The number and orientation of take-off climb and approach surfaces should be such that the usability factor of a heliport is not less than 95 per cent for the helicopters the heliport is intended to serve.*

Elevated heliports

4.2.10 The obstacle limitation requirements for elevated heliports shall conform to the requirements for surface level heliports specified in 4.2.1 to 4.2.7.

4.2.11 An elevated heliport shall have at least two take-off climb and approach surfaces separated by not less than 150°.

Helidecks

Note.— The following specifications are for helidecks located on a structure and engaged in such activities as mineral exploitation, research, or construction, but excluding heliports on ships.

4.2.12 A helideck shall have an obstacle-free sector and, where necessary, a limited obstacle sector.

4.2.13 There shall be no fixed obstacles within the obstacle-free sector above the obstacle-free surface.

4.2.14 In the immediate vicinity of the helideck, obstacle protection for helicopters shall be provided below the heliport level. This protection shall extend over an arc of at least 180° with the origin at the centre of the FATO, with a descending gradient having a ratio of one unit horizontally to five units vertically from the edges of the FATO within the 180° sector.

4.2.15 Where a mobile obstacle or combination of obstacles within the obstacle-free sector is essential for the operation of the installation, the obstacle(s) shall not subtend an arc exceeding 30°, as measured from the centre of the FATO.

4.2.16 For single-main-rotor and side-by-side twin rotor helicopters, within the 150° limited obstacle surface/sector out to a distance of 0.62 D, measured from the centre of the FATO, objects shall not exceed a height of 0.05 D above the FATO. Beyond that arc, out to an over-all distance of 0.83 D the limited obstacle surface rises at a rate of one unit vertically for each two units horizontally (see Figure 4-3).

4.2.17 For omnidirectional operations by tandem-main-rotor helicopters within the 150° limited obstacle surface/sector out to a distance of 0.62 D, measured from the centre of the FATO, there shall be no fixed obstacles. Beyond that arc, out to an over-all distance of 0.83 D, objects shall not penetrate a level surface which has a height equivalent to 0.05 D above the FATO (see Figure 4-4).

4.2.18 For bi-directional operations by tandem-main-rotor helicopters, within the 0.62 D arc in the 150° limited obstacle surface/sector, objects shall not penetrate a level surface which has a height equivalent to 1.1 m above the FATO (see Figure 4-5).

Shipboard heliports

Amidships location

4.2.19 Forward and aft of the FATO shall be two symmetrically located sectors, each covering an arc of 150°, with their apexes on the periphery of the FATO D reference circle. Within the area enclosed by these two sectors, there shall be no objects rising above the level of the FATO, except those aids essential for the safe operation of a helicopter and then only up to a maximum height of 25 cm.

4.2.20 To provide further protection from obstacles fore and aft of the FATO, rising surfaces with gradients of one unit vertically to five units horizontally shall extend from the entire length of the edges of the two 150° sectors. These surfaces shall extend for a horizontal distance equal to at least the diameter of the FATO and shall not be penetrated by any obstacle (see Figure 4-11).

Ship's side location

4.2.21 From the fore and aft mid-points of the D reference circle, an area shall extend to the ship's rail to a fore and aft distance of 1.5 times the diameter of the FATO, located symmetrically about the athwartships bisector of the reference circle. Within this sector there shall be no objects rising above the level of the FATO, except those aids essential to the safe operation of the helicopter and then only up to a maximum height of 25 cm (see Figure 4-12).

4.2.22 A horizontal surface shall be provided, at least 0.25 times the diameter of the D reference circle, which shall surround the FATO and the obstacle-free sector, at a height of 0.05 times the diameter of the reference circle, which no object shall penetrate.

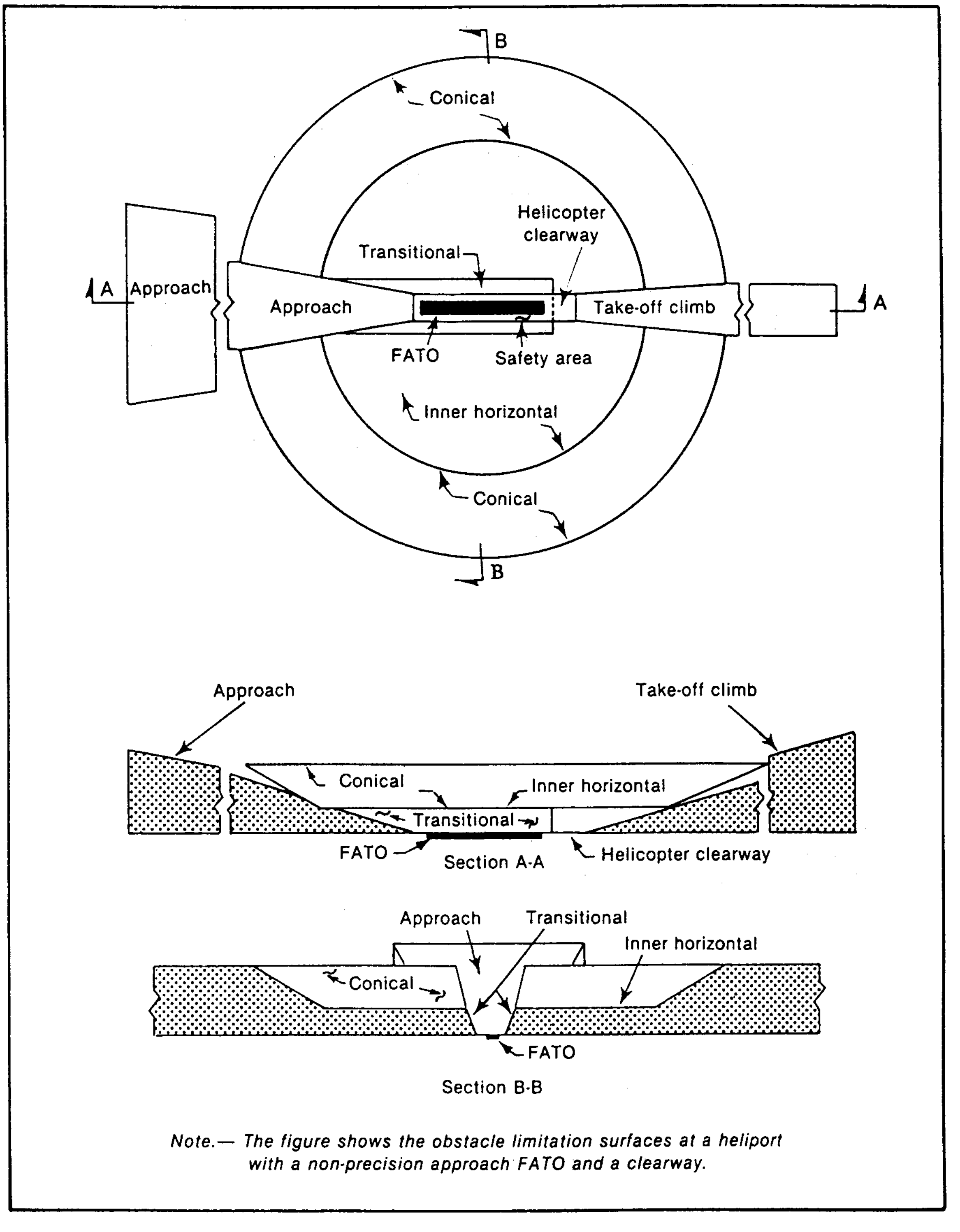


Figure 4-1. Obstacle limitation surfaces

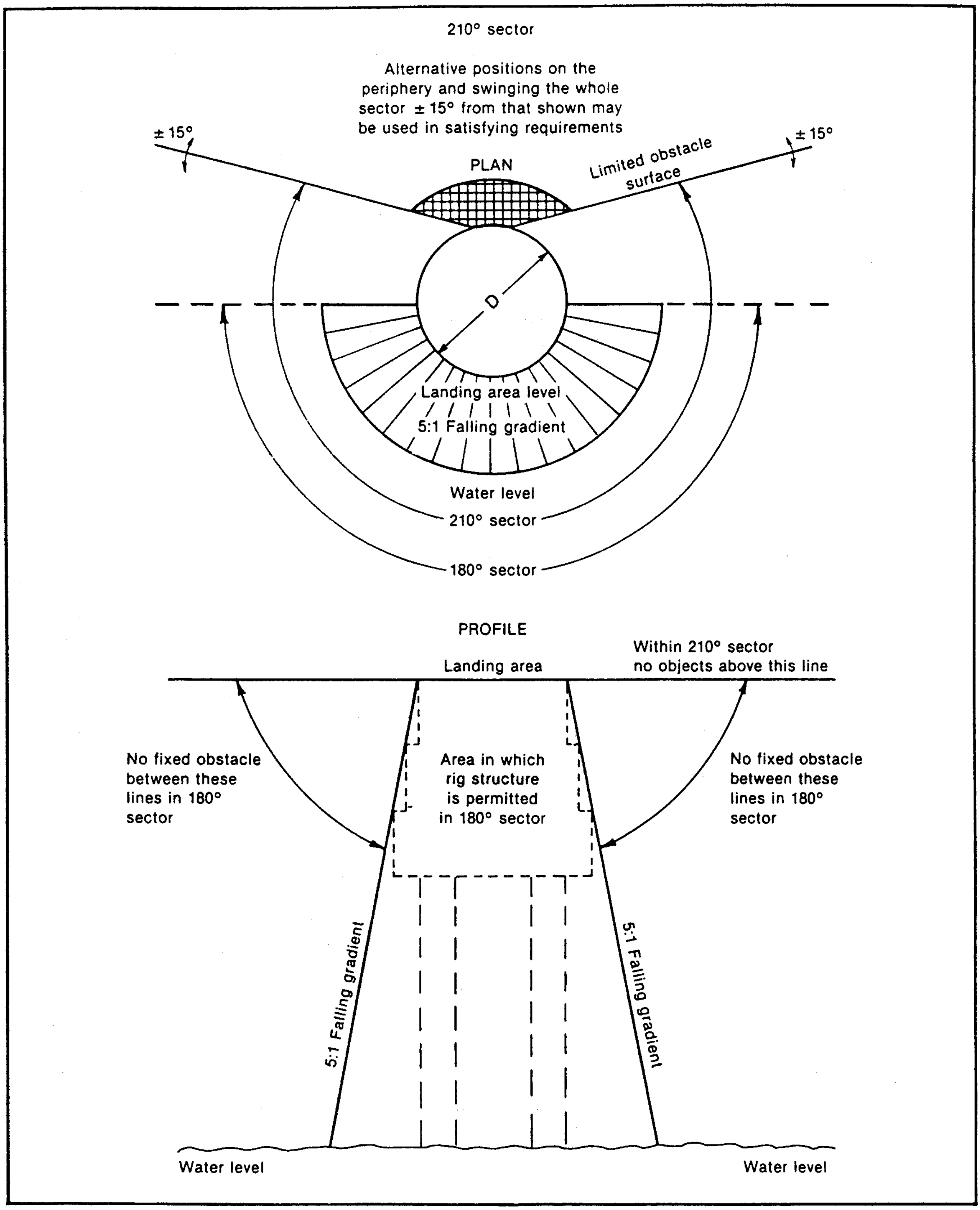


Figure 4-2. Helideck obstacle-free sector

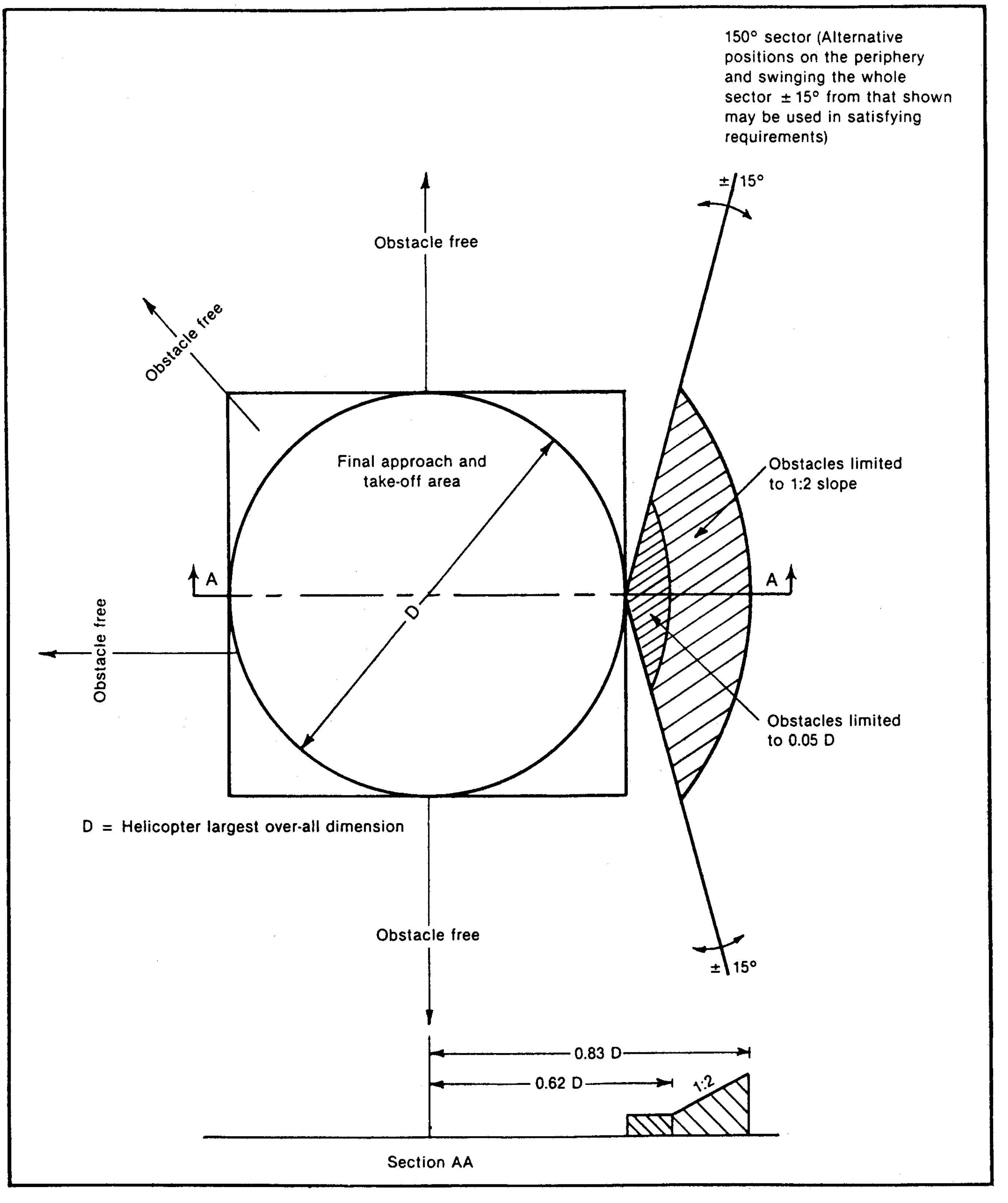


Figure 4-3. Helideck obstacle limitation sectors
Single-main-rotor and side-by-side twin rotor helicopters

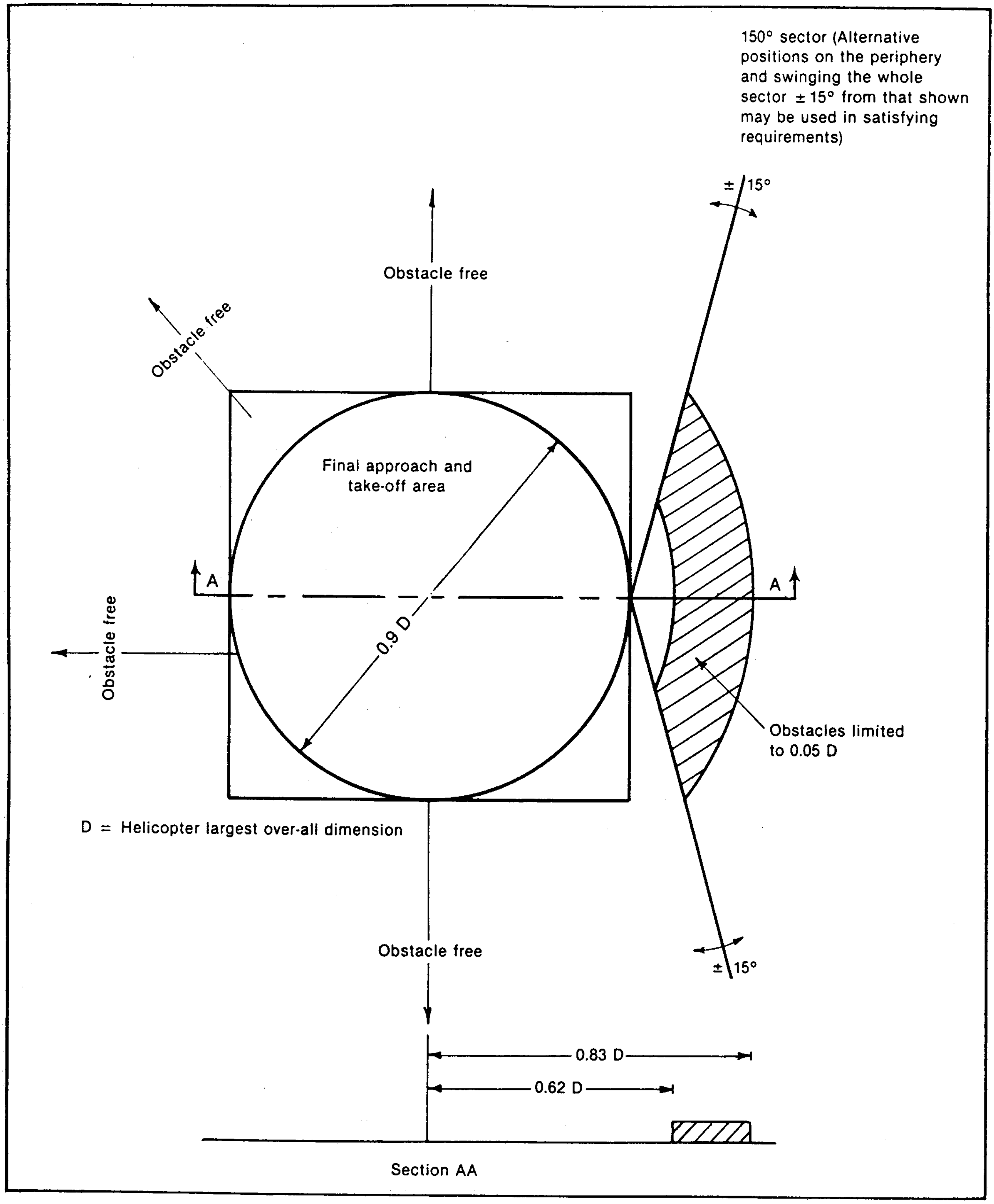


Figure 4-4. Helideck obstacle limitation sectors
Tandem-main-rotor helicopters — Omnidirectional operations

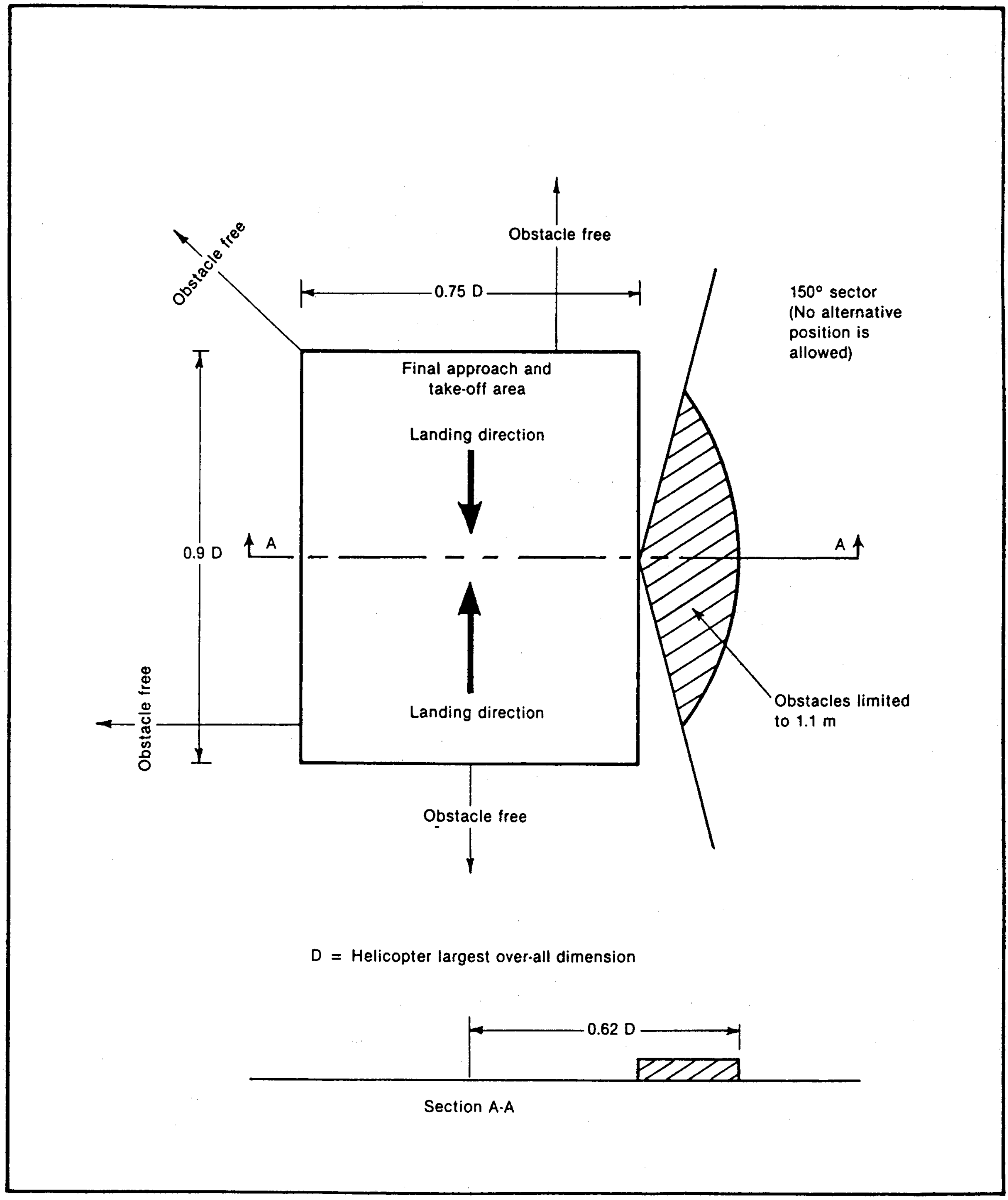


Figure 4-5. Helideck obstacle limitation sectors
Tandem-main-rotor helicopters — Bi-directional operations

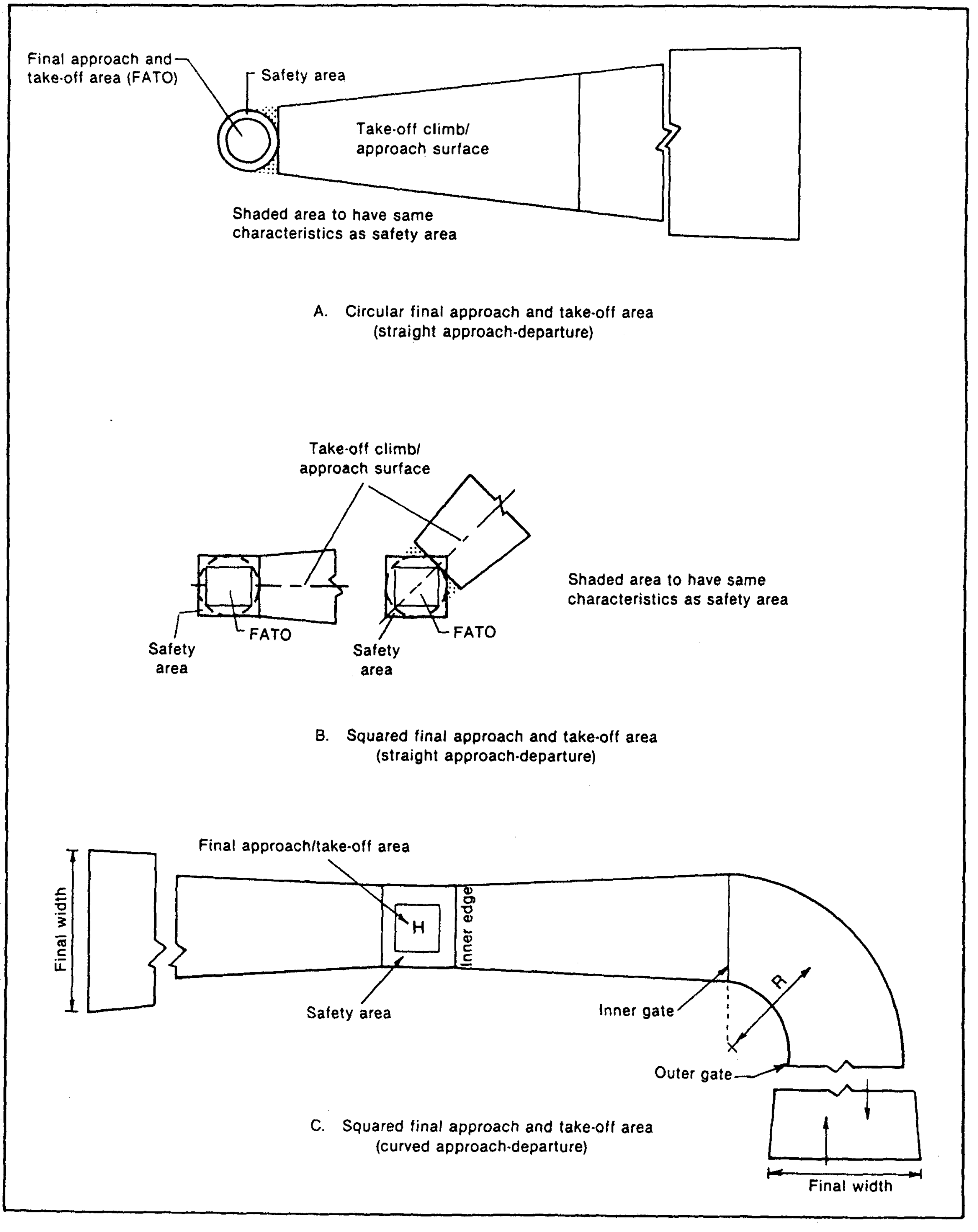


Figure 4-6. Take-off climb/approach surface (non-instrument FATO)

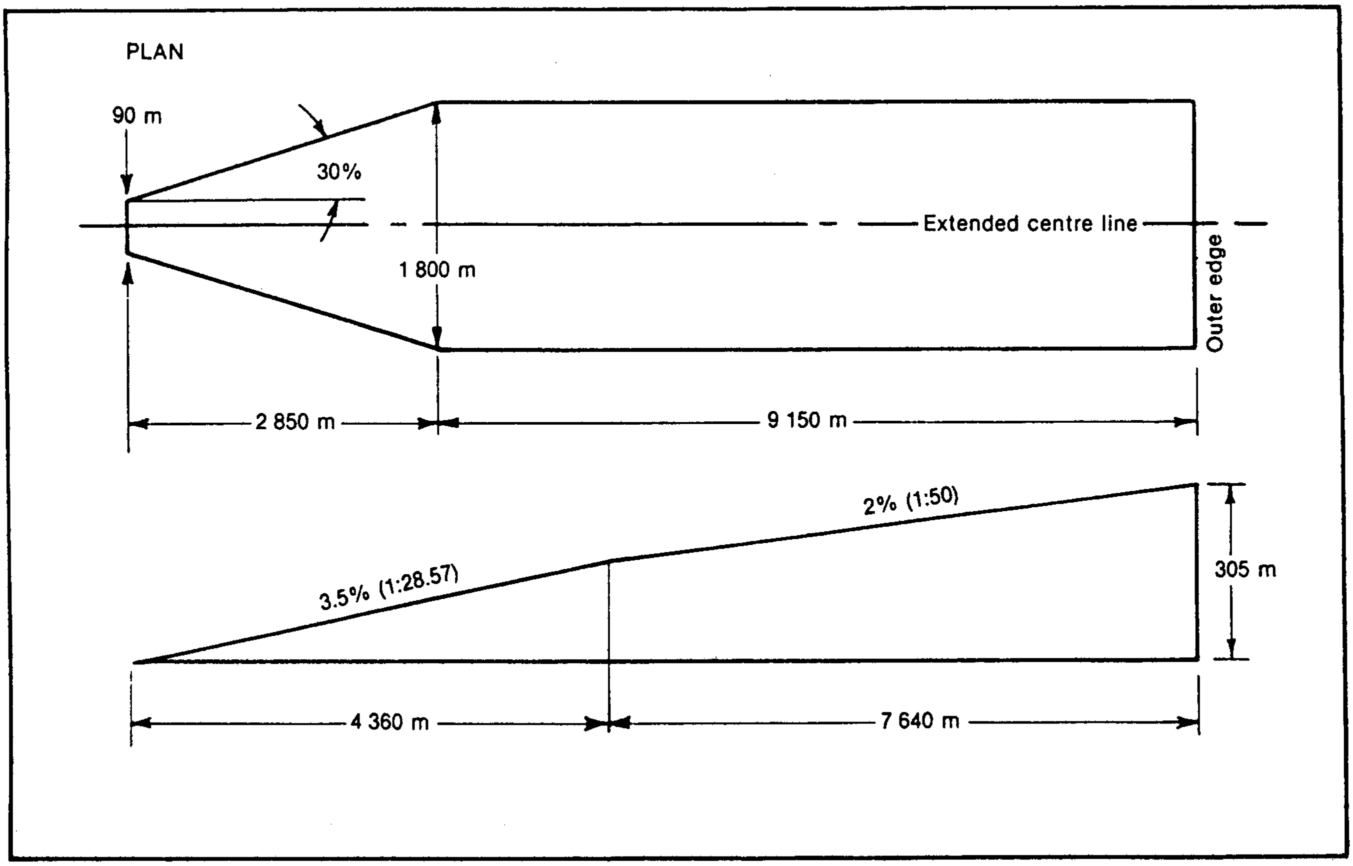


Figure 4-7. Take-off climb surface for instrument FATO

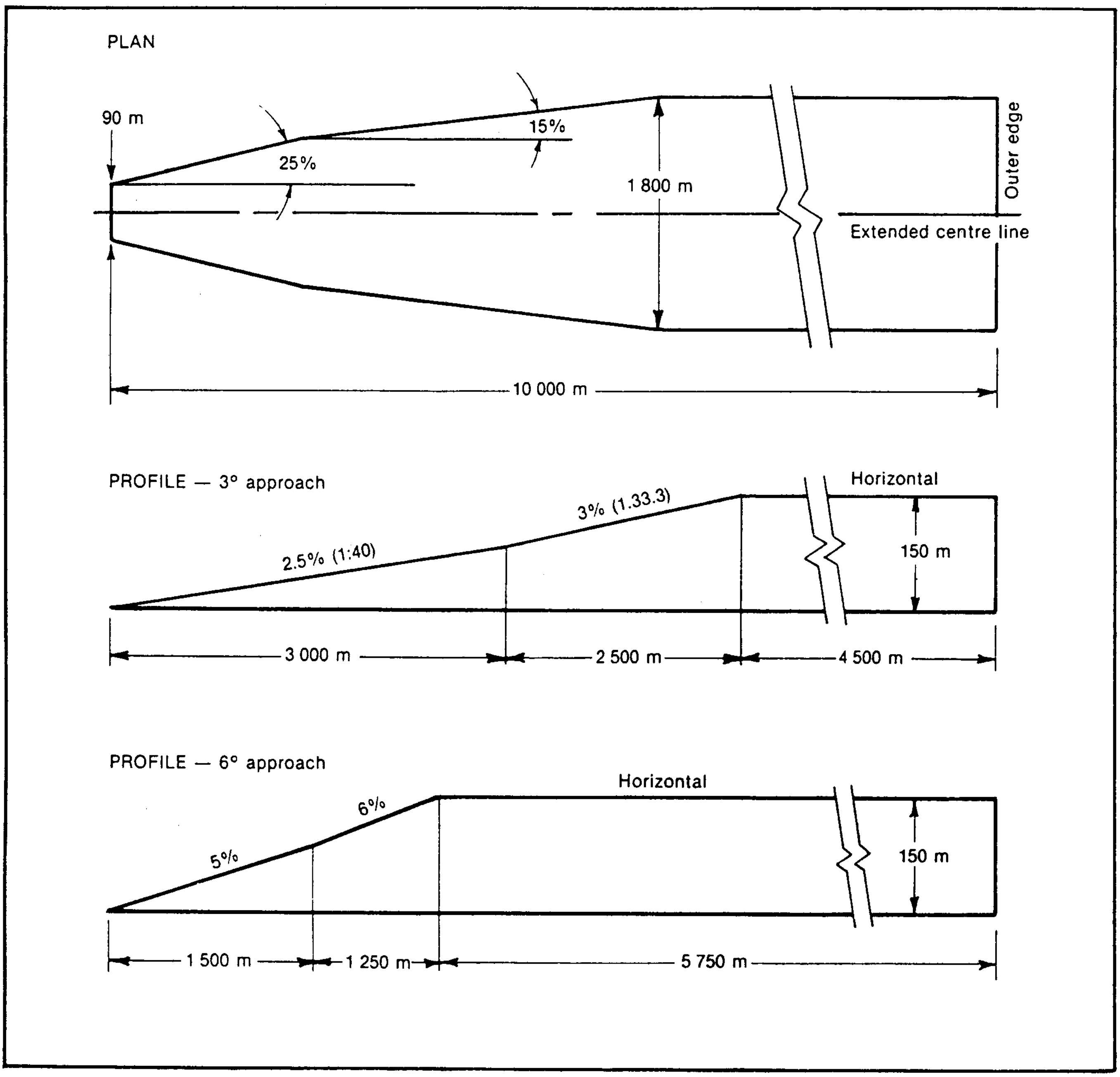


Figure 4-8. Approach surface for precision approach FATO

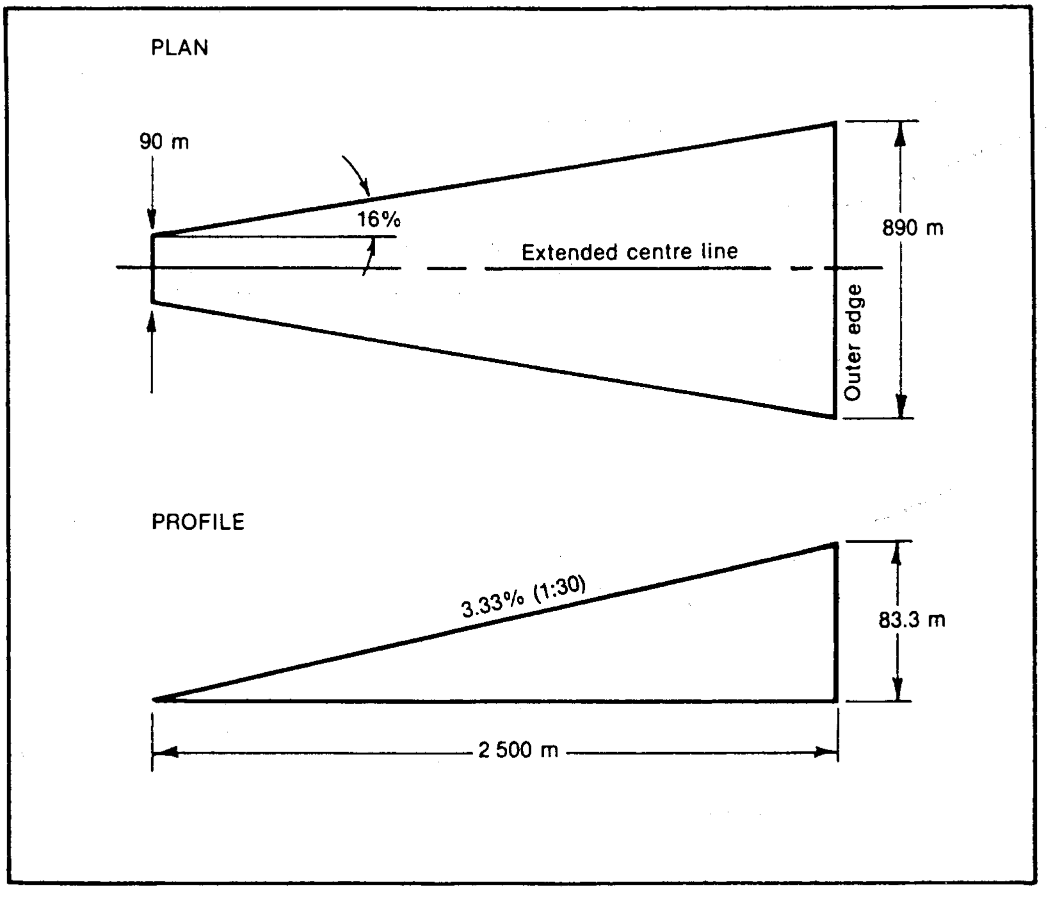


Figure 4-9. Approach surface for non-precision approach FATO

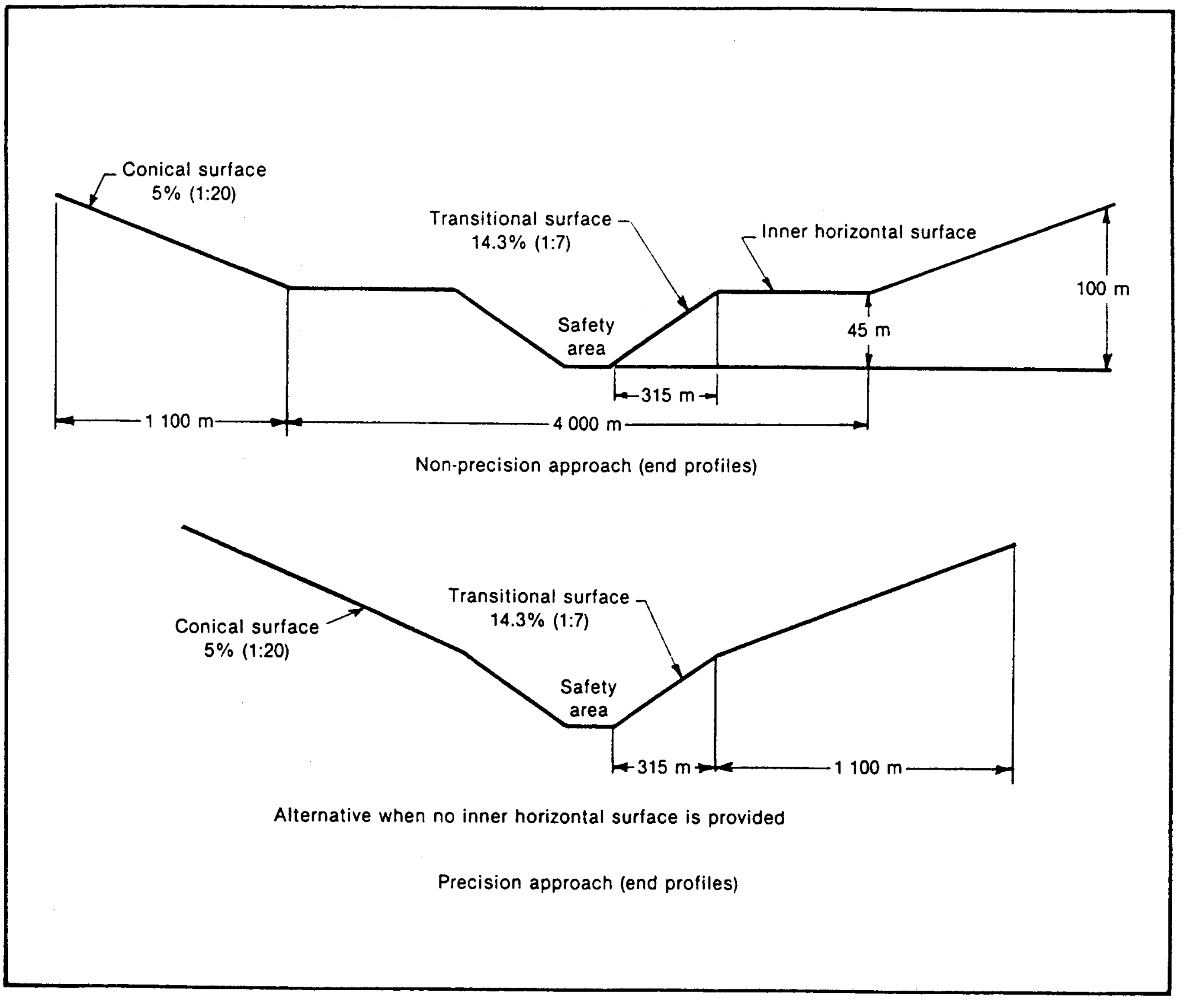


Figure 4-10. Transitional, inner horizontal and conical obstacle limitation surfaces

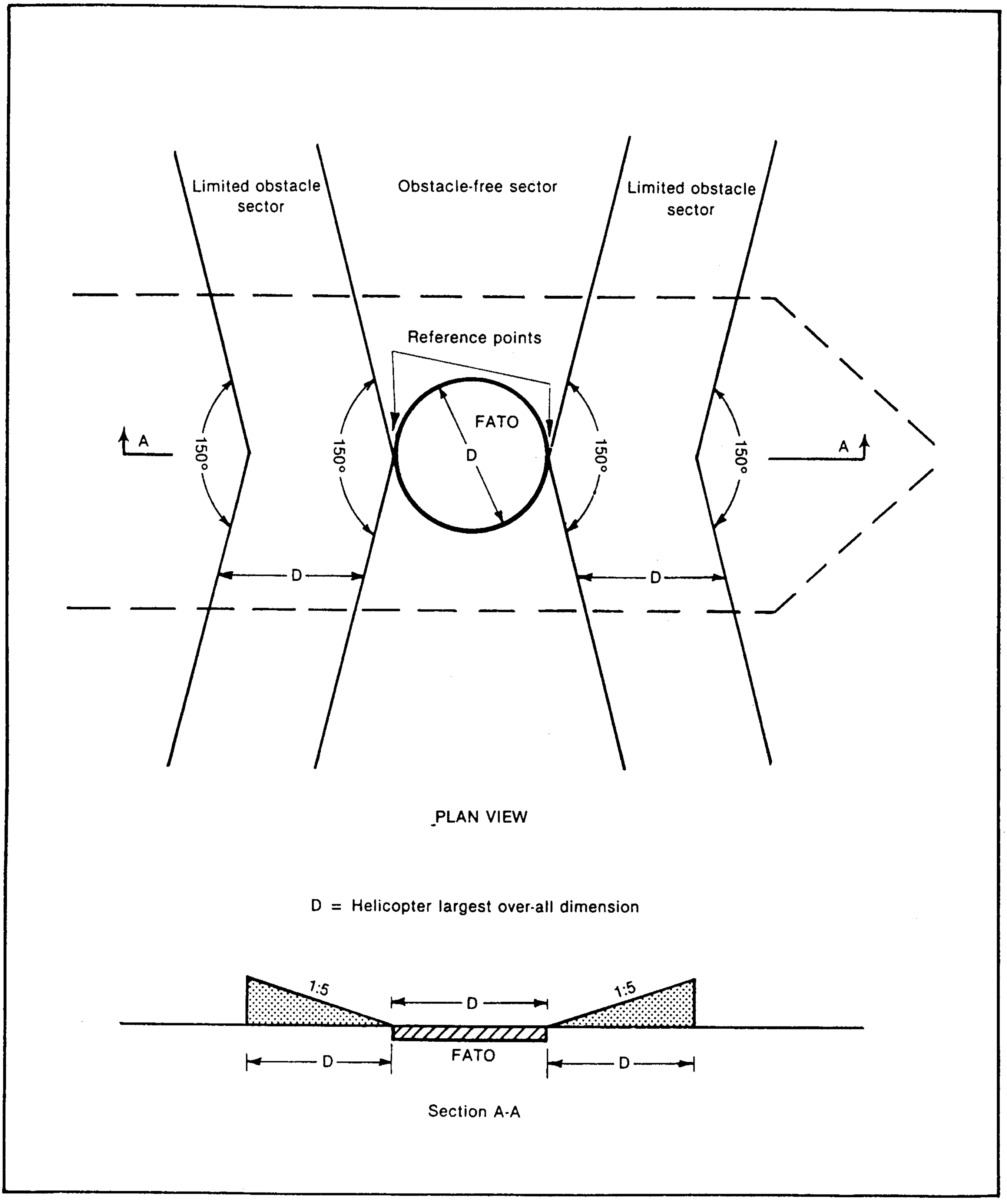


Figure 4-11. Midship non-purpose built heliport obstacle limitation surfaces

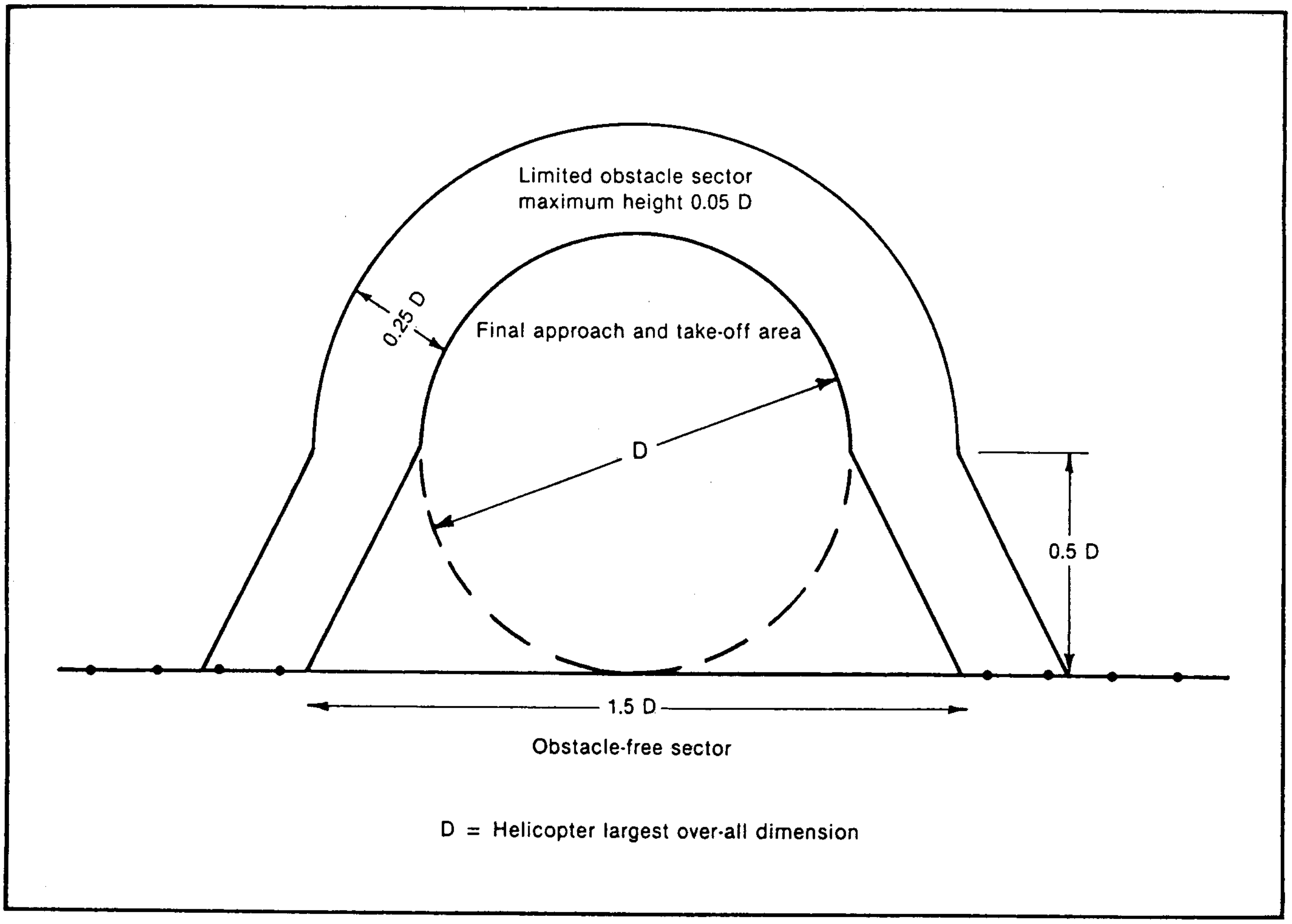


Figure 4-12. Ships-side non-purpose built heliport
obstacle limitation surfaces

Table 4-1. Dimensions and slopes of obstacle limitation surfaces

NON-INSTRUMENT AND NON-PRECISION FATO

Surface and dimensions		Non-instrument (visual) FATO — Helicopter performance class 1	2	3	Non-precision (instrument approach) FATO
APPROACH SURFACE					
Width of inner edge			Width of safety area		Width of safety area
Location of inner edge			Boundary		Boundary
First section					
Divergence	— day	10%	10%	10%	16%
	— night	15%	15%	15%	
Length	— day	245 m[a]	245 m[a]	245 m[a]	2 500 m
	— night	245 m[a]	245 m[a]	245 m[a]	
Outer width	— day	49 m[b]	49 m[b]	49 m[b]	890 m
	— night	73.5 m[b]	73.5 m[b]	73.5 m[b]	
Slope (maximum)		8%[a]	8%[a]	8%[a]	3.33%
Second section					
Divergence	— day	10%	10%	10%	—
	— night	15%	15%	15%	
Length	— day	c	c	c	—
	— night	c	c	c	
Outer width	— day	d	d	d	—
	— night	d	d	d	
Slope (maximum)		12.5%	12.5%	12.5%	—
Third section					
Divergence		parallel	parallel	parallel	—
Length	— day	e	e	e	—
	— night	e	e	e	
Outer width	— day	d	d	d	—
	— night	d	d	d	
Slope (maximum)		15%	15%	15%	—
INNER HORIZONTAL					
Height		—	—	—	45 m
Radius		—	—	—	2 000 m
CONICAL					
Slope		—	—	—	5%
Height		—	—	—	55 m
TRANSITIONAL					
Slope		—	—	—	20%
Height		—	—	—	45 m

a. Slope and length enables helicopters to decelerate for landing while observing "avoid" areas.
b. The width of the inner edge shall be added to this dimension.
c. Determined by the distance from the inner edge to the point where the divergence produces a width of 7 rotor diameters for day operations or 10 rotor diameters for night operations.
d. Seven rotor diameters over-all width for day operations or 10 rotor diameters over-all width for night operations.
e. Determined by the distance from inner edge to where the approach surface reaches a height of 150 m above the elevation of the inner edge.

Table 4-2. Dimensions and slopes of obstacle limitation surfaces

INSTRUMENT (PRECISION APPROACH) FATO

Surface and dimensions	3° approach Height above FATO 90 m (300 ft)	3° approach Height above FATO 60 m (200 ft)	3° approach Height above FATO 45 m (150 ft)	3° approach Height above FATO 30 m (100 ft)	6° approach Height above FATO 90 m (300 ft)	6° approach Height above FATO 60 m (200 ft)	6° approach Height above FATO 45 m (150 ft)	6° approach Height above FATO 30 m (100 ft)
APPROACH SURFACE								
Length of inner edge	90 m	90 m	90 m	90 m	90 m	90 m	90 m	90 m
Distance from end of FATO	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60m
Divergence each side to height above FATO	25%	25%	25%	25%	25%	25%	25%	25%
Distance to height above FATO	1 745 m	1 163 m	872 m	581 m	870 m	580 m	435 m	290 m
Width at height above FATO	962 m	671 m	526 m	380 m	521 m	380 m	307.5 m	235 m
Divergence to parallel section	15%	15%	15%	15%	15%	15%	15%	15%
Distance to parallel section	2 793 m	3 763 m	4 246 m	4 733 m	4 250 m	4 733 m	4 975 m	5 217 m
Width of parallel section	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m
Distance to outer edge	5 462 m	5 074 m	4 882 m	4 686 m	3 380 m	3 187 m	3 090 m	2 993 m
Width at outer edge	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m	1 800 m
Slope of first section	2.5% (1:40)	2.5% (1:40)	2.5% (1:40)	2.5% (1:40)	5% (1:20)	5% (1:20)	5% (1:20)	5% (1:20)
Length of first section	3 000 m	3 000 m	3 000 m	3 000 m	1 500 m	1 500 m	1 500 m	1 500 m
Slope of second section	3% (1:33.3)	3% (1:33.3)	3% (1:33.3)	3% (1:33.3)	6% (1:16.66)	6% (1:16.66)	6% (1:16.66)	6% (1:16.66)
Length of second section	2 500 m	2 500 m	2 500 m	2 500 m	1 250 m	1 250 m	1 250 m	1 250 m
Total length of surface	10 000 m	10 000 m	10 000 m	10 000 m	8 500 m	8 500 m	8 500 m	8 500 m
CONICAL								
Slope	5%	5%	5%	5%	5%	5%	5%	5%
Height	55 m	55 m	55 m	55 m	55 m	55 m	55 m	55 m
TRANSITIONAL								
Slope	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
Height	45 m	45 m	45 m	45 m	45 m	45 m	45 m	45 m

Table 4-3. Dimensions and slopes of obstacle limitation surfaces

STRAIGHT TAKE-OFF

Surface and dimensions		Non-instrument (visual) Helicopter performance class 1	2	3	Instrument
TAKE-OFF CLIMB					
Width of inner edge		Width of safety area			90 m
Location of inner edge		Boundary or end of clearway			Boundary or end of clearway
First section					
Divergence	— day	10%	10%	10%	30%
	— night	15%	15%	15%	
Length	— day	a	245 m[b]	245 m[b]	2 850 m
	— night	a	245 m[b]	245 m[b]	
Outer width	— day	c	49 m[d]	49 m[d]	1 800 m
	— night	c	73.5 m[d]	73.5 m[d]	
Slope (maximum)		4.5%*	8%[b]	8%[b]	3.5%
Second section					
Divergence	— day	parallel	10%	10%	parallel
	— night	parallel	15%	15%	
Length	— day	e	a	a	1 510 m
	— night	e	a	a	
Outer width	— day	c	c	c	1 800 m
	— night	c	c	c	
Slope (maximum)		4.5%*	15%	15%	3.5%*
Third section					
Divergence		—	parallel	parallel	parallel
Length	— day	—	e	e	7 640 m
	— night	—	e	e	
Outer width	— day	—	c	c	1 800 m
	— night	—	c	c	
Slope (maximum)		—	15%	15%	2%

a. Determined by the distance from the inner edge to the point where the divergence produces a width of 7 rotor diameters for day operations or 10 rotor diameters for night operations.
b. Slope and length provides helicopters with an area to accelerate and climb while observing "avoid" areas.
c. Seven rotor diameters over-all width for day operations or 10 rotor diameters over-all width for night operations.
d. The width of the inner edge shall be added to this dimension.
e. Determined by the distance from the inner edge to where the surface reaches a height of 150 m above the elevation of the inner edge.

* This slope exceeds the maximum mass one-engine-inoperative climb gradient of many helicopters which are currently operating.

Table 4-4. Criteria for curved take-off climb/approach area

NON-INSTRUMENT FINAL APPROACH AND TAKE-OFF

Facility	Requirement
Directional change	As required (120° max).
Radius of turn on centre line	Not less than 270 m.
Distance to inner gate*	(a) For performance class 1 helicopters — not less than 305 m from the end of the safety area or helicopter clearway. (b) For performance class 2 and 3 helicopters — not less than 370 m from the end of the FATO.
Width of inner gate — day	Width of the inner edge plus 20% of distance to inner gate.
— night	Width of the inner edge plus 30% of distance to inner gate.
Width of outer gate — day	Width of inner edge plus 20% of distance to inner gate out to minimum width of 7 rotor diameters.
— night	Width of inner edge plus 30% of distance to inner gate out to a minimum width of 10 rotor diameters.
Elevation of inner and outer gates	Determined by the distance from the inner edge and the designated gradient(s).
Slopes	As given in Tables 4-1 and 4-3.
Divergence	As given in Tables 4-1 and 4-3.
Total length of area	As given in Tables 4-1 and 4-3.

* This is the minimum distance required prior to initiating a turn after take-off or completing a turn in the final phase.

Note.— More than one turn may be necessary in the total length of the take-off climb/approach area. The same criteria will apply for each subsequent turn except that the widths of the inner and outer gates will normally be the maximum width of the area.

CHAPTER 5. VISUAL AIDS

5.1 Indicators

5.1.1 Wind direction indicators

Application

5.1.1.1 A heliport shall be equipped with at least one wind direction indicator.

Location

5.1.1.2 A wind direction indicator shall be located so as to indicate the wind conditions over the final approach and take-off area and in such a way as to be free from the effects of airflow disturbances caused by nearby objects or rotor downwash. It shall be visible from a helicopter in flight, in a hover or on the movement area.

5.1.1.3 **Recommendation.—** *Where a touchdown and lift-off area may be subject to a disturbed air flow, then additional wind direction indicators located close to the area should be provided to indicate the surface wind on the area.*

Note.— Guidance on the location of wind direction indicators is given in the Heliport Manual.

Characteristics

5.1.1.4 A wind direction indicator shall be constructed so that it gives a clear indication of the direction of the wind and a general indication of the wind speed.

5.1.1.5 **Recommendation.—** *An indicator should be a truncated cone made of lightweight fabric and should have the following minimum dimensions:*

	Surface level heliports	Elevated heliports and helidecks
Length	*2.4 m*	*1.2 m*
Diameter (larger end)	*0.6 m*	*0.3 m*
Diameter (smaller end)	*0.3 m*	*0.15 m*

5.1.1.6 **Recommendation.—** *The colour of the wind direction indicator should be so selected as to make it clearly visible and understandable from a height of at least 200 m (650 ft) above the heliport, having regard to background. Where practicable, a single colour, preferably white or orange, should be used. Where a combination of two colours is required to give adequate conspicuity against changing backgrounds, they should preferably be orange and white, red and white, or black and white, and should be arranged in five alternate bands the first and last band being the darker colour.*

5.1.1.7 A wind direction indicator at a heliport intended for use at night shall be illuminated.

5.2 Markings and markers

Note.— See Annex 14, Volume I, 5.2.1.4, Note 1, concerning improving conspicuity of markings.

5.2.1 Winching area marking

Application

5.2.1.1 **Recommendation.—** *A winching area marking should be provided at a winching area.*

Location

5.2.1.2 A winching area marking shall be located so that its centre coincides with the centre of the clear zone of the winching area.

Characteristics

5.2.1.3 A winching area marking shall consist of a solid circle of not less than 5 m in diameter and painted yellow.

5.2.2 Heliport identification marking

Application

5.2.2.1 A heliport identification marking shall be provided at a heliport.

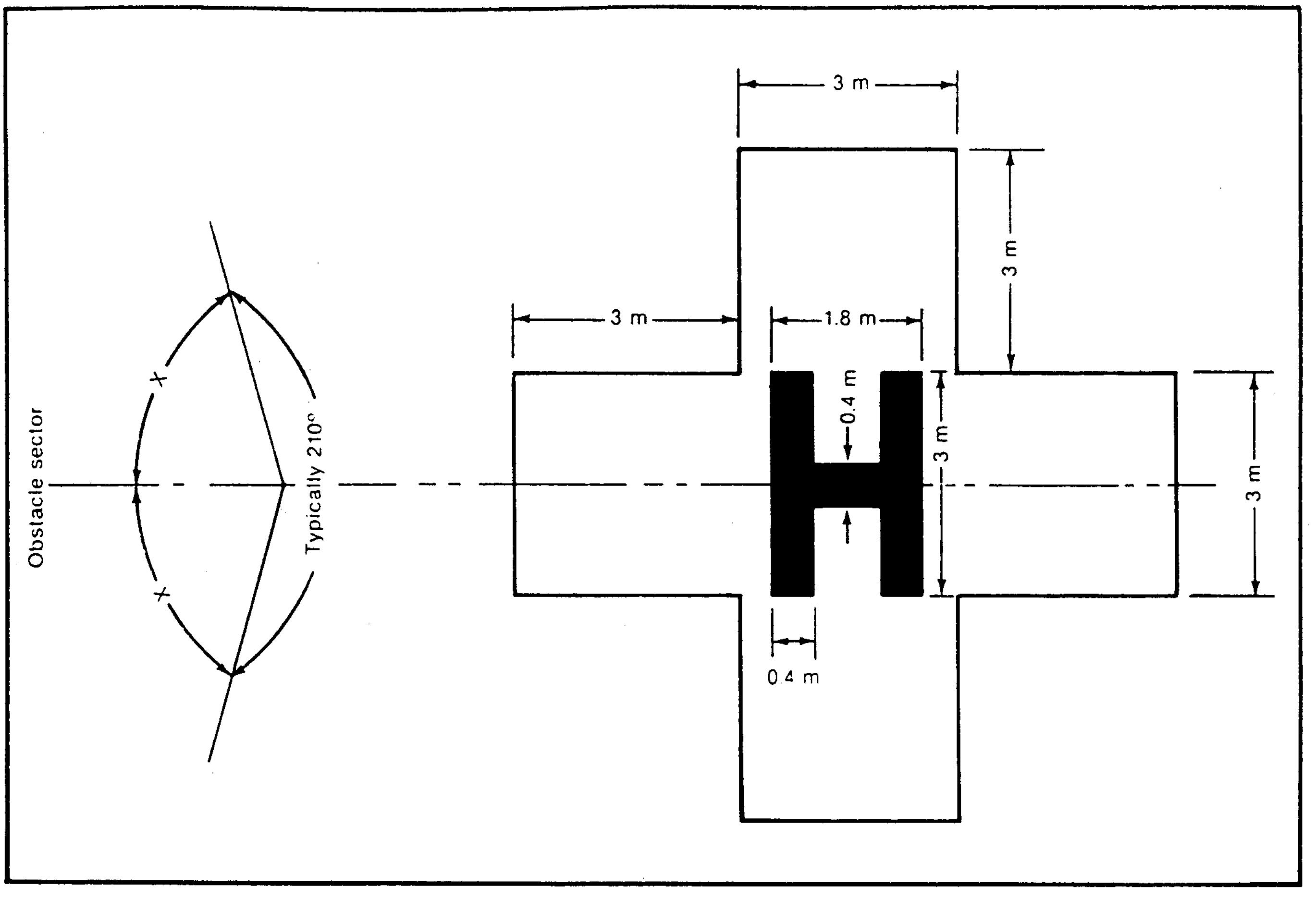


Figure 5-1. Heliport identification marking (shown with hospital cross and orientation with obstacle-free sector)

Location

5.2.2.2 A heliport identification marking shall be located within the final approach and take-off area, at or near the centre of the area or when used in conjunction with runway designation markings at each end of the area.

Characteristics

5.2.2.3 A heliport identification marking, except for a heliport at a hospital, shall consist of a letter H, white in colour. The dimensions of the marking shall be no less than those shown in Figure 5-1 and where the marking is used in conjunction with the final approach and take-off area designation marking specified in 5.2.5 its dimensions shall be increased by a factor of 3.

Note.— On a helideck covered with a rope netting, it may be advantageous to increase the height of the marking to 4 m and the other dimensions proportionally.

5.2.2.4 A heliport identification marking for a heliport at a hospital shall consist of a letter H, red in colour, on a white cross made of squares adjacent to each of the sides of a square containing the H as shown in Figure 5-1.

5.2.2.5 A heliport identification marking shall be oriented with the cross arm of the H at right angles to the preferred final approach direction. For a helideck the cross arm shall be on or parallel to the bisector of the obstacle-free sector as shown in Figure 5-1.

5.2.3 Maximum allowable mass marking

Application

5.2.3.1 **Recommendation.—** *A maximum allowable mass marking should be displayed at an elevated heliport and at a helideck.*

Location

5.2.3.2 **Recommendation.—** *A maximum allowable mass marking should be located within the touchdown and lift-off area and so arranged as to be readable from the preferred final approach direction.*

Characteristics

5.2.3.3 A maximum allowable mass marking shall consist of a two digit number followed by a letter "t" to indicate the allowable helicopter mass in tonnes (1 000 kg).

5.2.3.4 **Recommendation.—** *The numbers and the letter of the marking should have a colour contrasting with the background and should be in the form and proportion shown in Figure 5-2.*

5.2.4 Final approach and take-off area marking or marker

Application

5.2.4.1 Final approach and take-off area marking or markers shall be provided at a surface level heliport on ground where the extent of the final approach and take-off area is not self-evident.

Location

5.2.4.2 Final approach and take-off area marking or markers shall be located on the boundary of the final approach and take-off area.

Characteristics

5.2.4.3 Final approach and take-off area marking or markers shall be spaced:

a) for a square or rectangular area at equal intervals of not more than 50 m with at least three markings or markers on each side including a marking or marker at each corner; and

b) for any other shaped area, including a circular area, at equal intervals of not more than 10 m with a minimum number of five markings or markers.

5.2.4.4 A final approach and take-off area marking shall be a rectangular stripe with a length of 9 m or one-fifth of the side of the final approach and take-off area which it defines and a width of 1 m. Where a marker is used its characteristics shall conform to those specified in Annex 14, Volume I, 5.5.8.3 except that the height of the marker shall not exceed 25 cm above ground or snow level.

5.2.4.5 A final approach and take-off area marking shall be white.

5.2.5 Final approach and take-off area designation marking

Application

5.2.5.1 **Recommendation.—** *A final approach and take-off area designation marking should be provided where it is necessary to designate the final approach and take-off area to the pilot.*

Location

5.2.5.2 A final approach and take-off area designation marking shall be located at the beginning of the final approach and take-off area as shown in Figure 5-3.

Characteristics

5.2.5.3 A final approach and take-off area designation marking shall consist of a runway designation marking described in Annex 14, Volume I, 5.2.2.4 and 5.2.2.5 supplemented by an H, specified in 5.2.2 above, and as shown in Figure 5-3.

5.2.6 Aiming point marking

Application

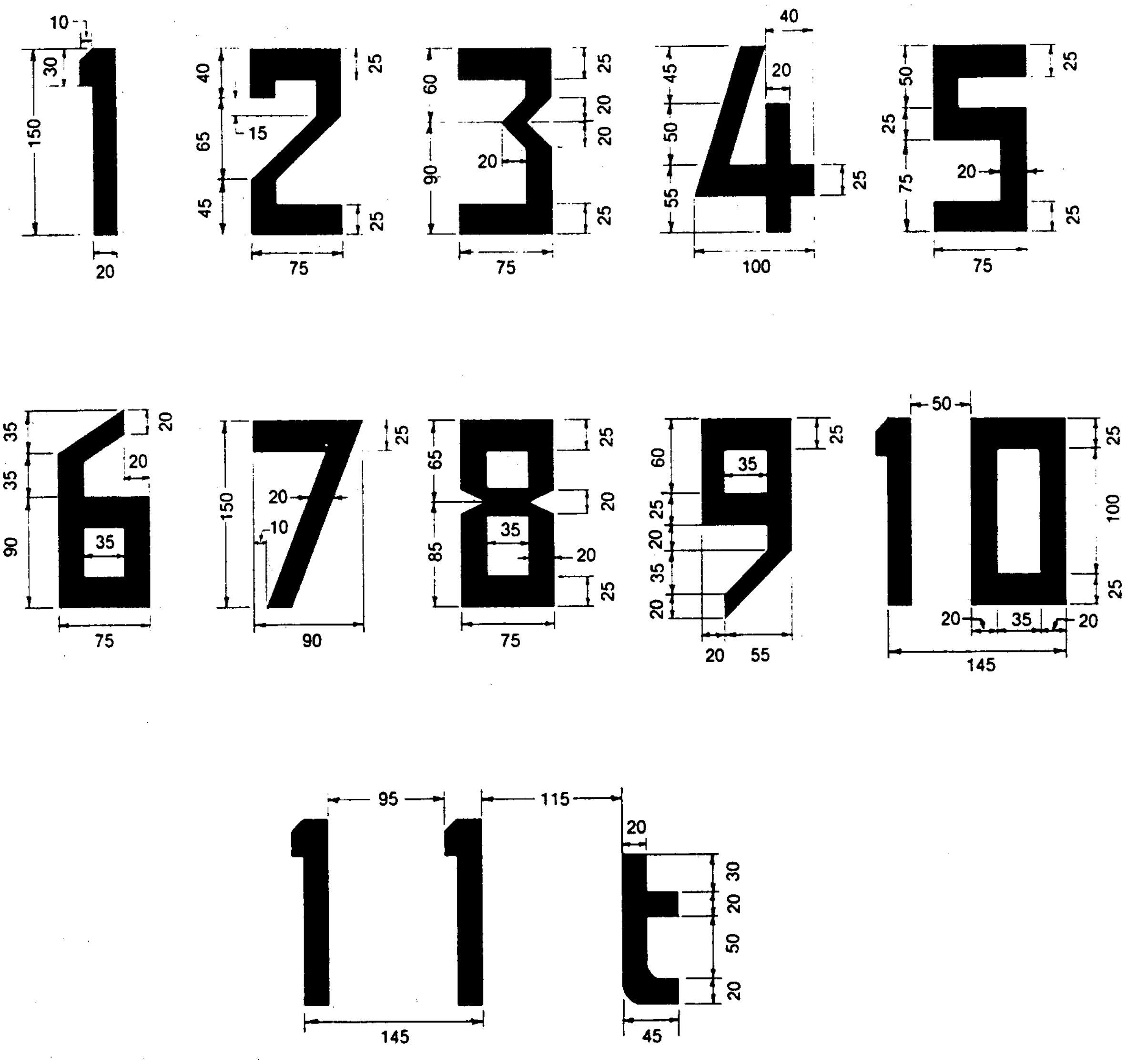
5.2.6.1 **Recommendation.—** *An aiming point marking should be provided at a heliport where it is necessary for a pilot to make an approach to a particular point before proceeding to the touchdown and lift-off area.*

Location

5.2.6.2 The aiming point marking shall be located within the final approach and take-off area.

Characteristics

5.2.6.3 The aiming point marking shall be an equilateral triangle with the bisector of one of the angles aligned with the preferred approach direction. The marking shall consist of continuous white lines and the dimensions of the marking shall conform to those shown in Figure 5-4.



Note.— All units are expressed in centimetres.

Figure 5-2. Form and proportions of numbers and letter for maximum allowable mass marking

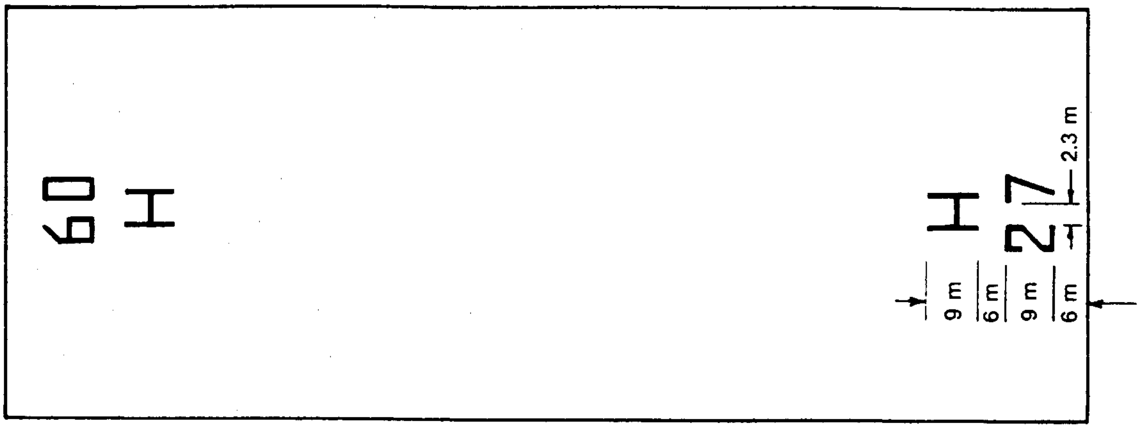


Figure 5-3. Final approach and take-off area designation marking

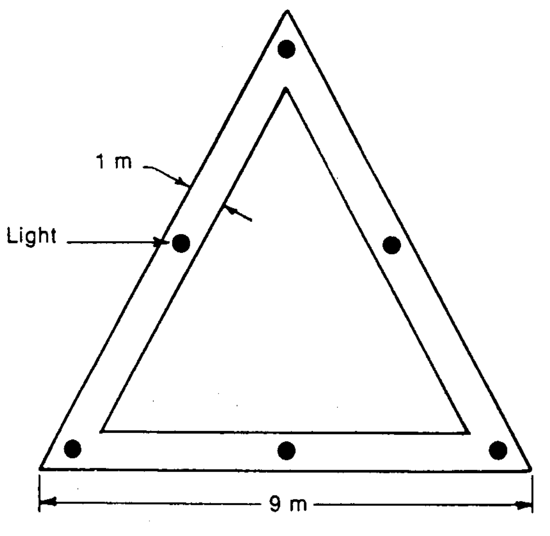


Figure 5-4. Aiming point marking

5.2.7 Touchdown and lift-off area marking

Application

5.2.7.1 A touchdown and lift-off area marking shall be provided on a helideck.

5.2.7.2 **Recommendation.—** *A touchdown and lift-off area marking should be provided on a heliport other than a helideck if the perimeter of the touchdown and lift-off area is not self-evident.*

Location

5.2.7.3 The touchdown and lift-off area marking shall be located along the perimeter of the touchdown and lift-off area.

Characteristics

5.2.7.4 A touchdown and lift-off area marking shall consist of a continuous white line with a width of at least 30 cm.

5.2.8 Touchdown marking

Application

5.2.8.1 **Recommendation.**— *A touchdown marking should be provided where it is necessary for a helicopter to touch down in a specific position.*

Location

5.2.8.2 A touchdown marking shall be located so that when a helicopter for which the marking is intended is positioned, with the main undercarriage inside the marking and the pilot situated over the marking, all parts of the helicopter will be clear of any obstacle by a safe margin.

5.2.8.3 On a helideck or on an elevated heliport the centre of the touchdown marking shall be located at the centre of the touchdown and lift-off area except that the marking may be offset away from the origin of the obstacle-free sector by no more than 0.1 D where an aeronautical study indicates such offsetting to be necessary and that a marking so offset would not adversely affect the safety.

Characteristics

5.2.8.4 A touchdown marking shall be a yellow circle and have a line width of at least 0.5 m. For a helideck the line width shall be at least 1 m.

5.2.8.5 On helidecks the inner diameter of the circle shall be half the D value of the helideck or 6 m whichever is the greater.

5.2.9 Heliport name marking

Application

5.2.9.1 **Recommendation.**— *A heliport name marking should be provided at a heliport where there is insufficient alternative means of visual identification.*

Location

5.2.9.2 **Recommendation.**— *The heliport name marking should be placed on the heliport so as to be visible, as far as practicable, at all angles above the horizontal. Where an obstacle sector exists the marking should be located on the obstacle side of the H identification marking.*

Characteristics

5.2.9.3 A heliport name marking shall consist of the name or the alphanumeric designator of the heliport as used in the R/T communications.

5.2.9.4 **Recommendation.**— *The characters of the marking should be not less than 3 m in height at surface level heliports and not less than 1.2 m on elevated heliports and helidecks. The colour of the marking should contrast with the background.*

5.2.9.5 A heliport name marking intended for use at night or during conditions of poor visibility shall be illuminated, either internally or externally.

5.2.10 Helideck obstacle-free sector marking

Application

5.2.10.1 **Recommendation.**— *A helideck obstacle-free sector marking should be provided at a helideck.*

Location

5.2.10.2 A helideck obstacle-free sector marking shall be located on the touchdown and lift-off area marking.

Characteristics

5.2.10.3 The helideck obstacle-free sector marking shall indicate the origin of the obstacle free sector, the directions of the limits of the sector and the D value of the helideck as shown in Figure 5-5 for a hexagonal-shaped helideck.

Note.— D is the largest dimension of the helicopter when the rotors are turning.

5.2.10.4 The height of the chevron shall equal the width of the touchdown and lift-off area marking.

5.2.10.5 The chevron shall be black.

5.2.11 Marking for taxiways

Note.— The specifications for taxiway centre line marking and taxi-holding position markings in Annex 14, Volume I, 5.2.8 and 5.2.9 are equally applicable to taxiways intended for ground taxiing of helicopters.

5.2.12 Air taxiway markers

Application

5.2.12.1 **Recommendation.—** *An air taxiway should be marked with air taxiway markers.*

Note.— These markers are not meant to be used on helicopter ground taxiways.

Location

5.2.12.2 Air taxiway markers shall be located along the centre line of the air taxiway and shall be spaced at intervals of not more than 30 m on straight sections and 15 m on curves.

Characteristics

5.2.12.3 An air taxiway marker shall be frangible and when installed shall not exceed 35 cm above ground or snow level. The surface of the marker as viewed by the pilot shall be a rectangle with a height to width ratio of approximately 3 to 1 and shall have a minimum area of 150 cm^2 as shown in Figure 5-6.

5.2.12.4 An air taxiway marker shall be divided into three equal, horizontal bands coloured yellow, green and yellow, respectively. If the air taxiway is to be used at night, the markers shall be internally illuminated or retro-reflective.

5.2.13 Air transit route markers

Application

5.2.13.1 **Recommendation.—** *When established an air transit route should be marked with air transit route markers.*

Location

5.2.13.2 Air transit route markers shall be located along the centre line of the air transit route and shall be spaced at intervals of not more than 60 m on straight sections and 15 m on curves.

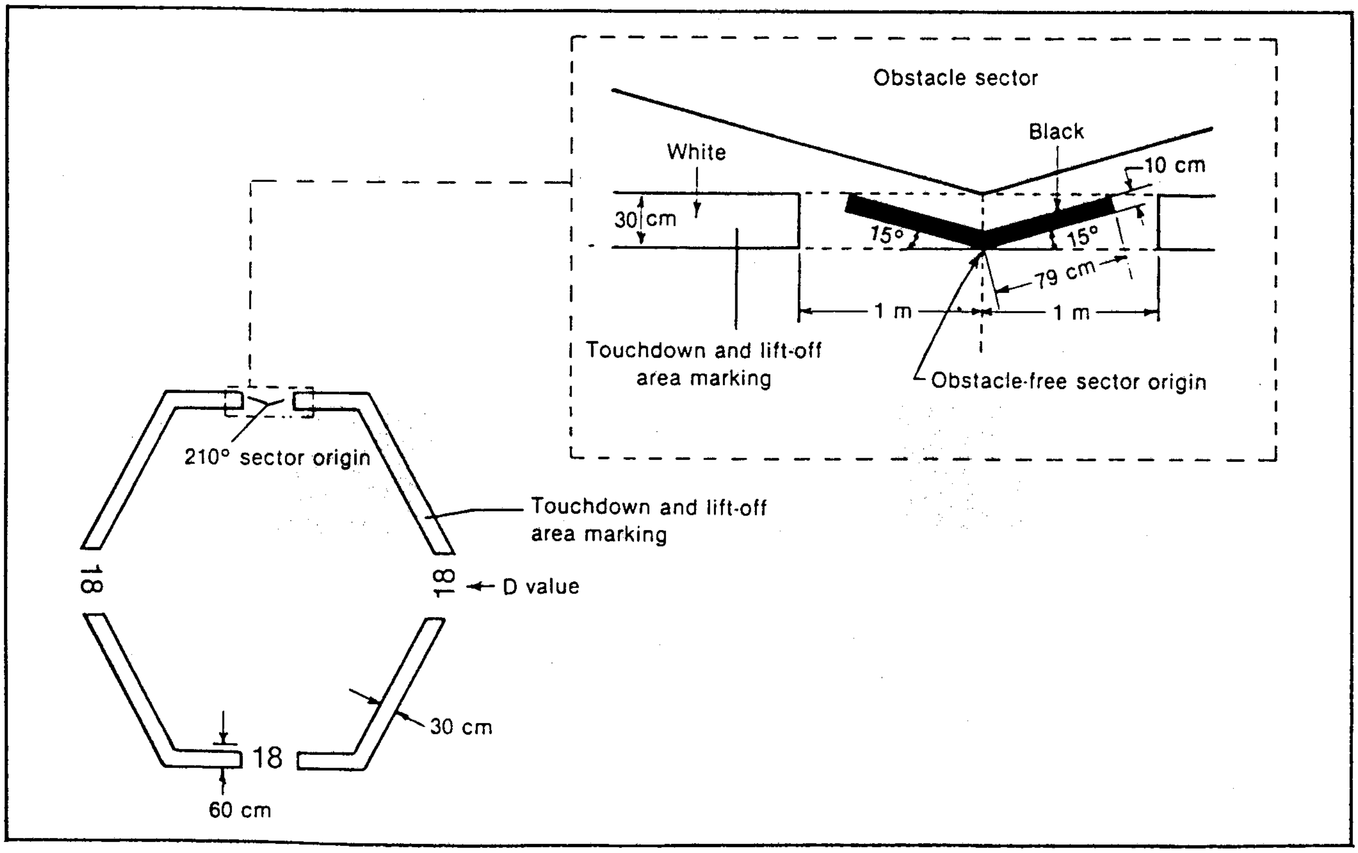


Figure 5-5. Helideck obstacle-free sector marking

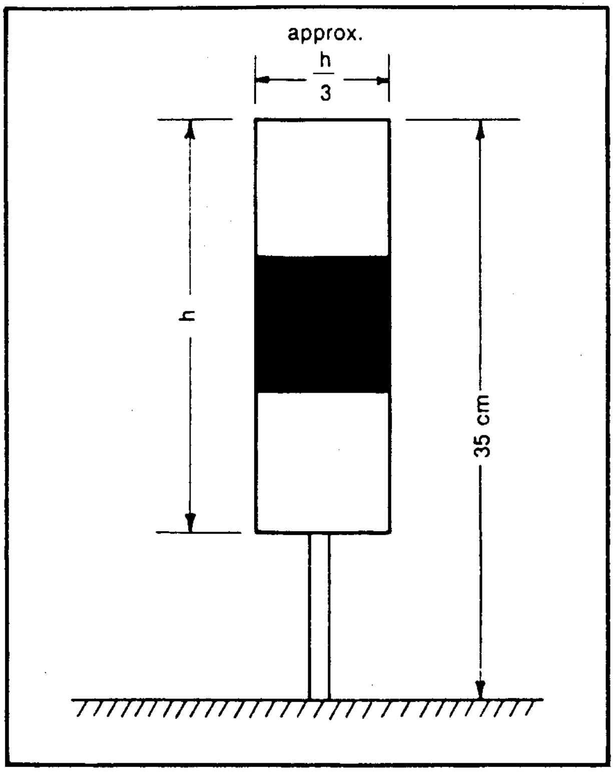


Figure 5-6. Air taxiway marker

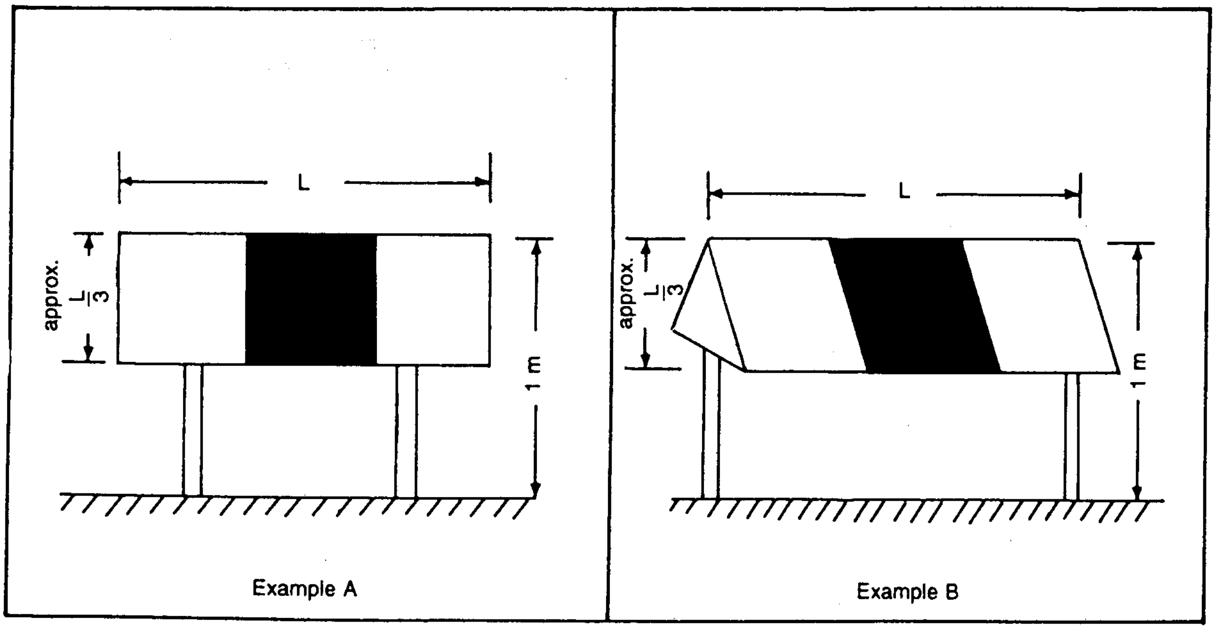


Figure 5-7. Air transit route marker

Characteristics

5.2.13.3 An air transit route marker shall be frangible and when installed shall not exceed 1 m above ground or snow level. The surface of the marker as viewed by the pilot shall be a rectangle with a height to width ratio of approximately 1 to 3 and shall have a minimum area of 1 500 cm^2 as shown in the examples in Figure 5-7.

5.2.13.4 An air transit route marker shall be divided into three equal, vertical bands coloured yellow, green and yellow, respectively. If the air transit route is to be used by night, the marker shall be internally illuminated or retro-reflective.

5.3 Lights

5.3.1 General

Note 1.— See Annex 14, Volume I, 5.3.1 concerning specifications on screening of non-aeronautical ground lights. and design of elevated and inset lights.

Note 2.— In the case of helidecks and heliports located near navigable waters, consideration needs to be given to ensuring that aeronautical ground lights do not cause confusion to mariners.

Note 3.— As helicopters will generally come very close to extraneous light sources, it is particularly important to ensure that, unless such lights are navigation lights exhibited in accordance with international regulations, they are screened or located so as to avoid direct and reflected glare.

Note 4.— The following specifications have been developed for systems intended for use in conjunction with a non-instrument or non-precision final approach and take-off area.

5.3.2 Heliport beacon

Application

5.3.2.1 **Recommendation.—** *A heliport beacon should be provided at a heliport where:*

a) long-range visual guidance is considered necessary and is not provided by other visual means; or

b) identification of the heliport is difficult due to surrounding lights.

Location

5.3.2.2 The heliport beacon shall be located on or adjacent to the heliport preferably at an elevated position and so that it does not dazzle a pilot at short range.

Note.— Where a heliport beacon is likely to dazzle pilots at short range it may be switched off during the final stages of the approach and landing.

Characteristics

5.3.2.3 The heliport beacon shall emit repeated series of equispaced short duration white flashes in the format in Figure 5-8.

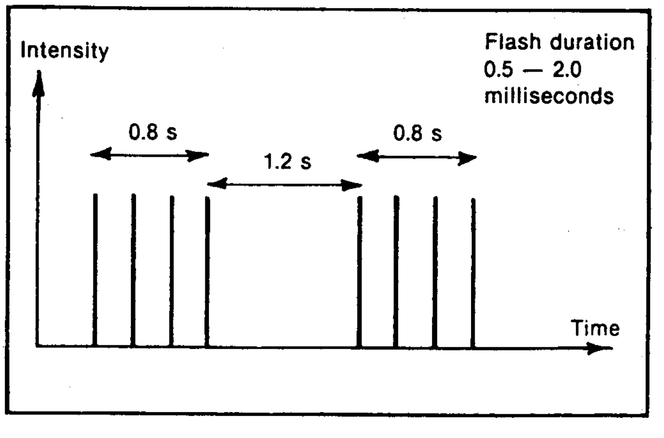


Figure 5-8. Heliport beacon flash characteristics

5.3.2.4 The light from the beacon shall show at all angles of azimuth.

5.3.2.5 **Recommendation.—** *The effective light intensity distribution of each flash should be as shown in Figure 5-9, Illustration 1.*

Note.— Where brilliancy control is desired, settings of 10 per cent and 3 per cent have been found to be satisfactory. In addition, shielding may be necessary to ensure that pilots are not dazzled during the final stages of the approach and landing.

5.3.3 Approach lighting system

Application

5.3.3.1 **Recommendation.—** *An approach lighting system should be provided at a heliport where it is desirable and practicable to indicate a preferred approach direction.*

Location

5.3.3.2 The approach lighting system shall be located in a straight line along the preferred direction of approach.

Characteristics

5.3.3.3 **Recommendation.—** *An approach lighting system should consist of a row of three lights spaced uniformly at 30 m intervals and of a crossbar 18 m in length at a distance of 90 m from the perimeter of the final approach and take-off area as shown in Figure 5-10. The lights forming the crossbar should be as nearly as practicable in a horizontal straight line at right angles to, and bisected by, the line of the centre line lights and spaced at 4.5 m intervals. Where there is the need to make the final approach course more conspicuous additional lights spaced uniformly at 30 m intervals should be added beyond the crossbar. The lights beyond the crossbar may be steady or sequenced flashing, depending upon the environment.*

Note.— Sequenced flashing lights may be useful where identification of the approach lighting system is difficult due to surrounding lights.

5.3.3.4 **Recommendation.—** *Where an approach lighting system is provided for a non-precision final approach and take-off area, the system should not be less than 210 m in length.*

5.3.3.5 The steady lights shall be omnidirectional white lights.

5.3.3.6 **Recommendation.—** *The light distribution of steady lights should be as indicated in Figure 5-9, Illustration 2 except that the intensity should be increased by a factor of 3 for a non-precision final approach and take-off area.*

5.3.3.7 Sequenced flashing lights shall be omnidirectional white lights.

5.3.3.8 **Recommendation.—** *The flashing lights should have a flash frequency of one per second and their light distribution should be as shown in Figure 5-9, Illustration 3. The flash sequence should commence from the outermost light and progress towards the crossbar.*

5.3.3.9 **Recommendation.—** *A suitable brilliancy control should be incorporated to allow for àdjustment of light intensity to meet the prevailing conditions.*

Note.— The following intensity settings have been found suitable:

a) steady lights — 100 per cent, 30 per cent and 10 per cent; and

b) flashing lights — 100 per cent, 10 per cent and 3 per cent.

5.3.4 Visual alignment guidance system

Application

5.3.4.1 **Recommendation.—** *A visual alignment guidance system should be provided to serve the approach to a heliport where one or more of the following conditions exist especially at night:*

a) obstacle clearance, noise abatement or traffic control procedures require a particular direction to be flown;

b) the environment of the heliport provides few visual surface cues; and

c) it is physically impracticable to install an approach lighting system.

Location

5.3.4.2 The visual alignment guidance system shall be located such that a helicopter is guided along the prescribed track towards the final approach and take-off area.

5.3.4.3 **Recommendation.—** *The system should be located at the downwind edge of the final approach and take-off area and aligned along the preferred approach direction.*

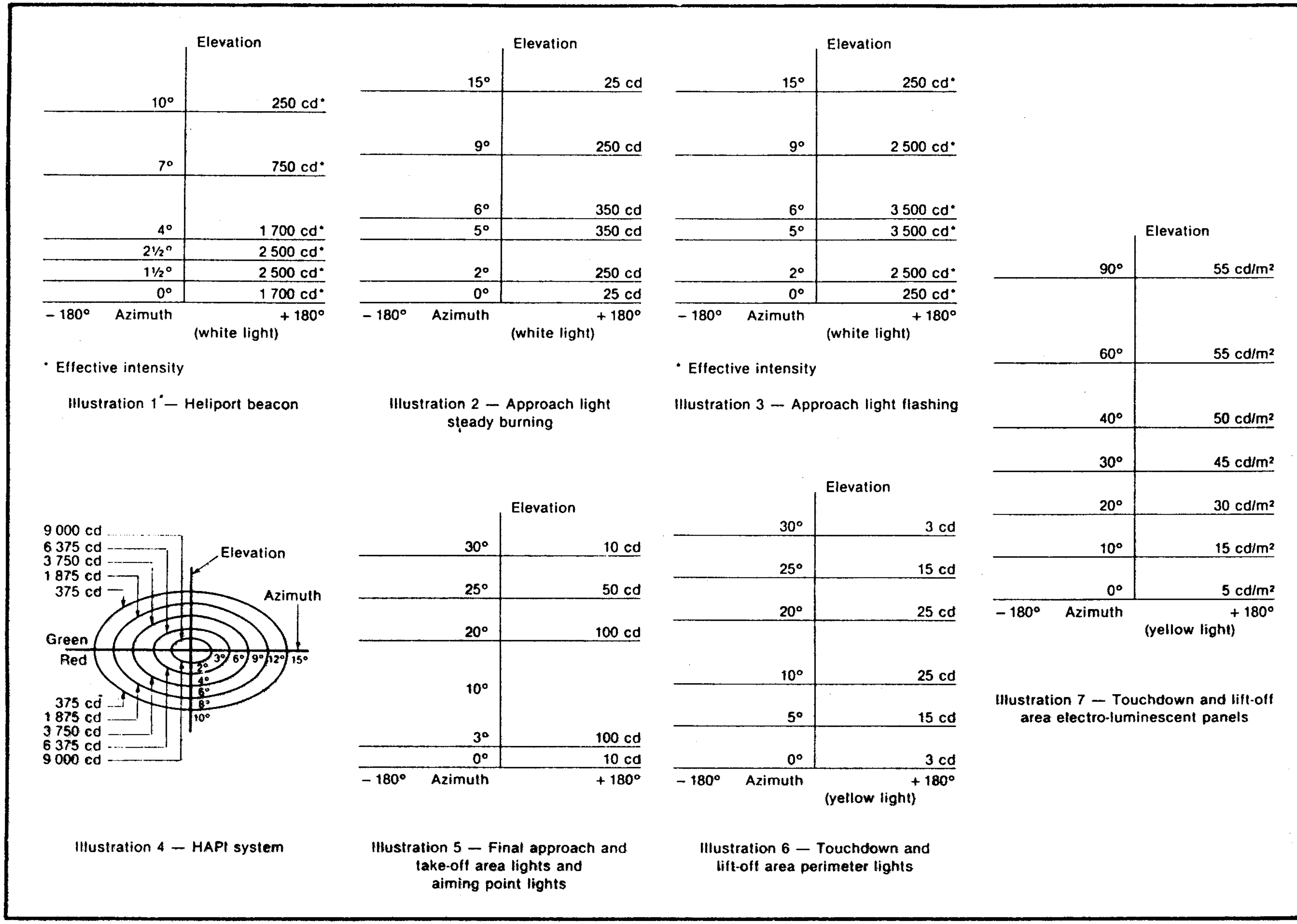


Figure 5-9. Isocandela diagrams of lights meant for helicopter non-instrument and non-precision approaches

5.3.4.4 The light units shall be frangible and mounted as low as possible.

5.3.4.5 Where the lights of the system need to be seen as discrete sources, light units shall be located such that at the extremes of system coverage the angle subtended between units as seen by the pilot shall not be less than 3 minutes of arc.

5.3.4.6 The angles subtended between light units of the system and other units of comparable or greater intensities shall also be not less than 3 minutes of arc.

Note.— Requirements of 5.3.4.5 and 5.3.4.6 can be met for lights on a line normal to the line of sight if the light units are separated by 1 metre for every kilometre of viewing range.

Signal format

5.3.4.7 The signal format of the alignment guidance system shall include a minimum of three discrete signal sectors providing "offset to the right", "on track" and "offset to the left" signals.

5.3.4.8 The divergence of the "on track" sector of the system shall be as shown in Figure 5-11.

5.3.4.9 The signal format shall be such that there is no possibility of confusion between the system and any associated visual approach slope indicator or other visual aids.

5.3.4.10 The system shall avoid the use of the same coding as any associated visual approach slope indicator.

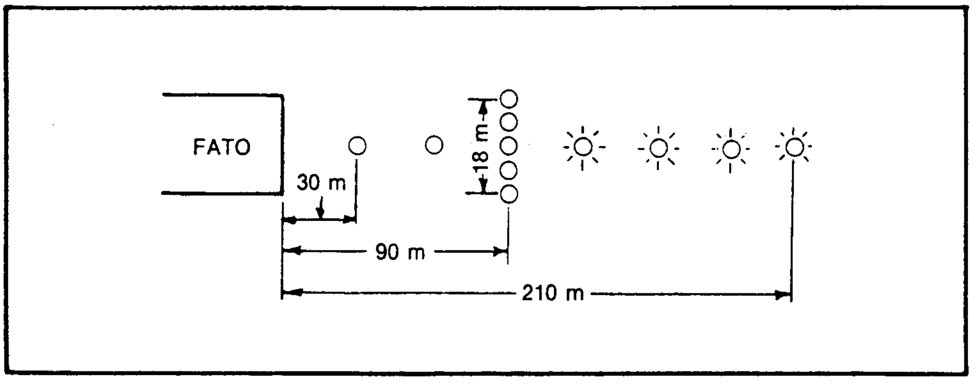


Figure 5-10. Approach lighting system

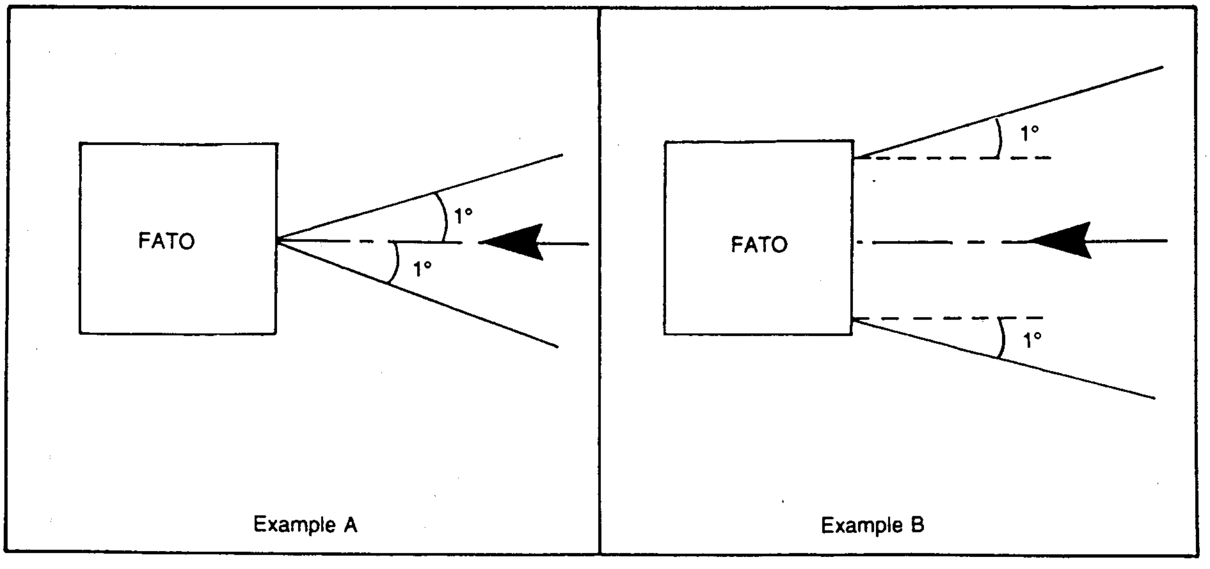


Figure 5-11. Divergence of the "on track" sector

5.3.4.11 The signal format shall be such that the system is unique and conspicuous in all operational environments.

5.3.4.12 The system shall not significantly increase the pilot workload.

Light distribution

5.3.4.13 The useable coverage of the visual alignment guidance system shall be equal to or better than that of the visual approach slope indicator system, with which it is associated.

5.3.4.14 A suitable intensity control shall be provided so as to allow adjustment to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

Approach track and azimuth setting

5.3.4.15 A visual alignment guidance system shall be capable of adjustment in azimuth to within ± 5 minutes of arc of the desired approach path.

5.3.4.16 The angle of azimuth guidance system shall be such that during an approach the pilot of a helicopter at the boundary of the "on track" signal will clear all objects in the approach area by a safe margin.

5.3.4.17 The characteristics of the obstacle protection surface specified in 5.3.5.23, Table 5-1 and Figure 5-13 shall equally apply to the system.

Characteristics of the visual alignment guidance system

5.3.4.18 In the event of the failure of any component affecting the signal format the system shall be automatically switched off.

5.3.4.19 The light units shall be so designed that deposits of condensation, ice, dirt, etc. on optically transmitting or reflecting surfaces will interfere to the least possible extent with the light signal and will not cause spurious or false signals to be generated.

5.3.5 Visual approach slope indicator

Application

5.3.5.1 **Recommendation.—** *A visual approach slope indicator should be provided to serve the approach to a heliport, whether or not the heliport is served by other visual approach aids or by non-visual aids, where one or more of the following conditions exist especially at night:*

a) obstacle clearance, noise abatement or traffic control procedures require a particular slope to be flown;

b) the environment of the heliport provides few visual surface cues; and

c) the characteristics of the helicopter require a stabilized approach.

5.3.5.2 The standard visual approach slope indicator systems for helicopter operations shall consist of the following:

a) PAPI and APAPI systems conforming to the specifications contained in Annex 14, Volume I, 5.3.5.23 to 5.3.5.40 inclusive except that the angular size of the on-slope sector of the systems shall be increased to 45 minutes; or

b) helicopter approach path indicator (HAPI) system conforming to the specifications in 5.3.5.6 to 5.3.5.21 inclusive.

Location

5.3.5.3 A visual approach slope indicator shall be located such that a helicopter is guided to the desired position within the final approach and take-off area and so as to avoid dazzling the pilot during final approach and landing.

5.3.5.4 **Recommendation.—** *A visual approach slope indicator should be located adjacent to the nominal aiming point and aligned in azimuth with the preferred approach direction.*

5.3.5.5 The light unit(s) shall be frangible and mounted as low as possible.

HAPI signal format

5.3.5.6 The signal format of the HAPI shall include four discrete signal sectors, providing an "above slope", an "on slope", a "slightly below" and a "below slope" signal.

5.3.5.7 The signal format of the HAPI shall be as shown in Figure 5-12, Illustrations A and B.

Note.— Care is required in the design of the unit to minimize spurious signals between the signal sectors and at the azimuth coverage limits.

5.3.5.8 The signal repetition rate of the flashing sector of the HAPI shall be at least 2 Hz.

5.3.5.9 **Recommendation.—** *The on-to-off ratio of pulsing signals of the HAPI should be 1 to 1 and the modulation depth should be at least 80 per cent.*

5.3.5.10 The angular size of the "on-slope" sector of the HAPI shall be 45 minutes.

5.3.5.11 The angular size of the "slightly below" sector of the HAPI shall be 15 minutes.

Light distribution

5.3.5.12 **Recommendation.—** *The light intensity distribution of the HAPI in red and green colours should be as shown in Figure 5-9, Illustration 4.*

Note.— A larger azimuth coverage can be obtained by installing the HAPI system on a turntable.

5.3.5.13 Colour transition of the HAPI in the vertical plane shall be such as to appear to an observer at a distance of not less than 300 m to occur within a vertical angle of not more than three minutes.

5.3.5.14 The transmission factor of a red or green filter shall be not less than 15 per cent at the maximum intensity setting.

5.3.5.15 At full intensity the red light of the HAPI shall have a Y-coordinate not exceeding 0.320 and the green light shall be within the boundaries specified in Annex 14, Volume I, Appendix 1, 2.1.3.

5.3.5.16 A suitable intensity control shall be provided so as to allow adjustment to meet the prevailing conditions and to avoid dazzling the pilot during approach and landing.

Approach slope and elevation setting

5.3.5.17 A HAPI system shall be capable of adjustment in elevation at any desired angle between 1 degree and 12 degrees above the horizontal with an accuracy of ±5 minutes of arc.

5.3.5.18 The angle of elevation setting of HAPI shall be such that during an approach, the pilot of a helicopter observing the upper boundary of the "below slope" signal will clear all objects in the approach area by a safe margin.

Characteristics of the light unit

5.3.5.19 The system shall be so designed that:

a) in the event the vertical misalignment of a unit exceeds ± 0.5° (± 30 minutes), the system will switch off automatically; and

b) if the flashing mechanism fails, no light will be emitted in the failed flashing sector(s).

Table 5-1. Dimensions and slopes of the obstacle protection surface

SURFACE AND DIMENSIONS	NON-INSTRUMENT FATO		NON-PRECISION FATO
Length of inner edge	Width of safety area		Width of safety area
Distance from end of FATO	3 m minimum		60 m
Divergence	10%		15%
Total length	2 500 m		2 500 m
Slope	PAPI	A[a] - 0.57°	A[a] - 0.57°
	HAPI	A[b] - 0.65°	A[b] - 0.65°
	APAPI	A[a] - 0.9°	A[a] -0.9°

a. As indicated in Annex 14, Volume I, Figure 5-13.
b. The angle of the upper boundary of the "below slope" signal.

Sector	Format
Above	Flashing green
On slope	Green
Slightly below	Red
Below	Flashing red

Illustration A

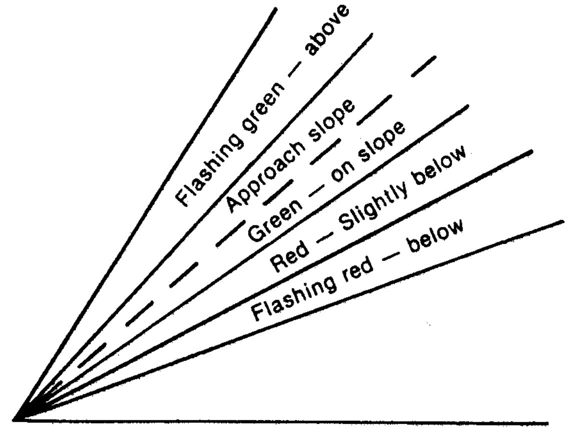


Illustration B

Figure 5-12. HAPI signal format

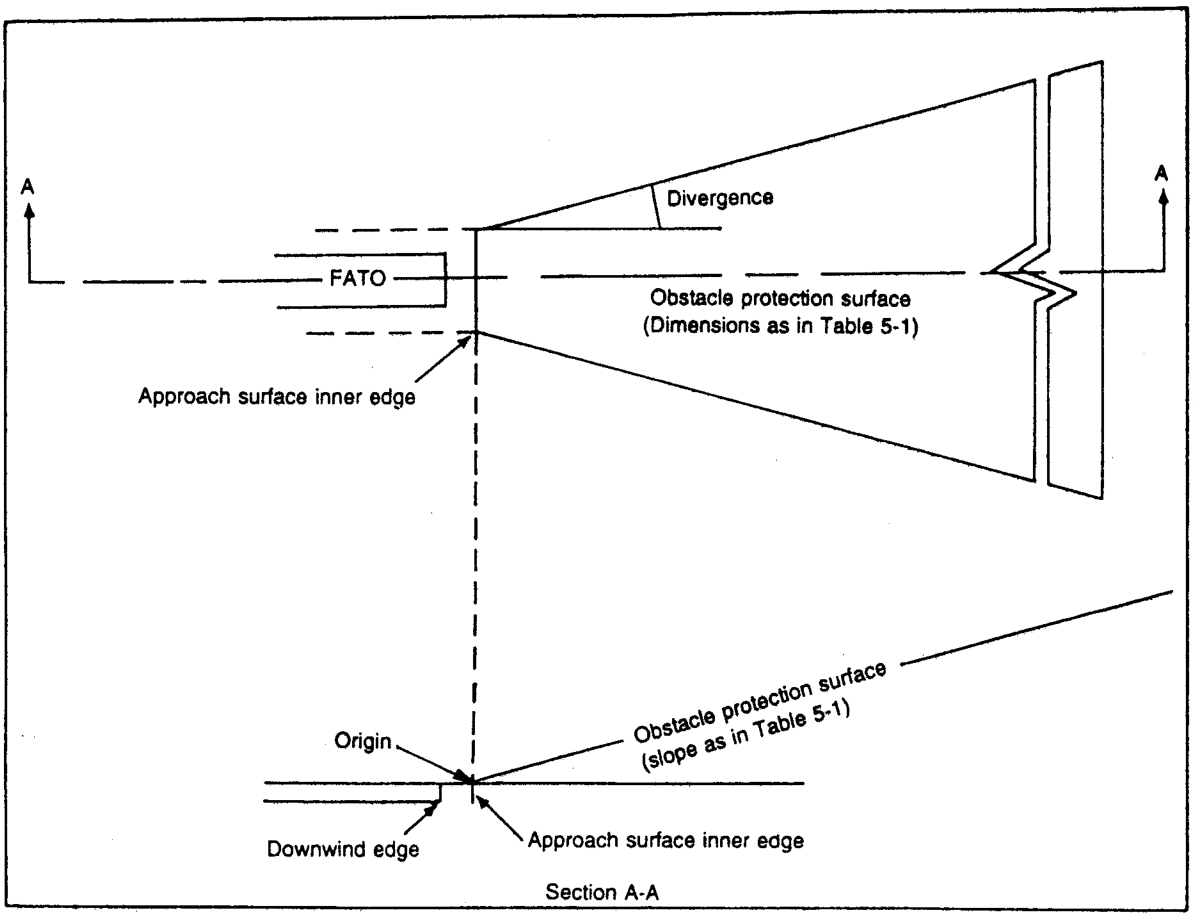


Figure 5-13. Obstacle protection surface
for visual approach slope indicator systems

5.3.5.20 The light unit of the HAPI shall be so designed that deposits of condensation, ice, dirt, etc. on optically transmitting or reflecting surfaces will interfere to the least possible extent with the light signal and will not cause spurious or false signals to be generated.

5.3.5.21 **Recommendation.—** *A HAPI system intended for installation on a floating helideck should afford a stabilization of the beam to an accuracy of ± 1/4° within ± 3° pitch and roll movement of the heliport.*

Obstacle protection surface

Note.— The following specifications apply to PAPI, APAPI and HAPI.

5.3.5.22 An obstacle protection surface shall be established when it is intended to provide a visual approach slope indicator system.

5.3.5.23 The characteristics of the obstacle protection surface, i.e. origin, divergence, length and slope shall correspond to those specified in the relevant column of Table 5-1 and in Figure 5-13.

5.3.5.24 New objects or extensions of existing objects shall not be permitted above an obstacle protection surface except when, in the opinion of the appropriate authority, the new object or extension would be shielded by an existing immovable object.

Note.— Circumstances in which the shielding principle may reasonably be applied are described in the Airport Services Manual, *Part 6.*

5.3.5.25 Existing objects above an obstacle protection surface shall be removed except when, in the opinion of the appropriate authority, the object is shielded by an existing immovable object, or after aeronautical study it is determined that the object would not adversely affect the safety of operations of helicopters.

5.3.5.26 Where an aeronautical study indicates that an existing object extending above an obstacle protection surface could adversely affect the safety of operations of helicopters one or more of the following measures shall be taken:

a) suitably raise the approach slope of the system;

b) reduce the azimuth spread of the system so that the object is outside the confines of the beam;

c) displace the axis of the system and its associated obstacle protection surface by no more than 5°;

d) suitably displace the final approach and take-off area; and

e) install a visual alignment guidance system specified in 5.3.4.

Note.— Guidance on this issue is contained in the Heliport Manual.

5.3.6 Final approach and take-off area lights

Application

5.3.6.1 Where a final approach and take-off area is established at a surface level heliport on ground intended for use at night, final approach and take-off area lights shall be provided except that they may be omitted where the final approach and take-off area and the touchdown and lift-off area are nearly coincidental or the extent of the final approach and take-off area is self-evident.

Location

5.3.6.2 Final approach and take-off area lights shall be placed along the edges of the final approach and take-off area. The lights shall be uniformly spaced as follows:

a) for an area in the form of a square or rectangle, at intervals of not more than 50 m with a minimum of four lights on each side including a light at each corner; and

b) for any other shaped area, including a circular area, at intervals of not more than 5 m with a minimum of ten lights.

Characteristics

5.3.6.3 Final approach and take-off area lights shall be fixed omnidirectional lights showing white. Where the intensity of the lights is to be varied the lights shall show variable white.

5.3.6.4 **Recommendation.—** *The light distribution of final approach and take-off area lights should be as shown in Figure 5-9, Illustration 5.*

5.3.6.5 **Recommendation.—** *The lights should not exceed a height of 25 cm and should be inset when a light extending above the surface would endanger helicopter operations. Where a final approach and take-off area is not meant for lift-off or touchdown, the lights should not exceed a height of 25 cm above ground or snow level.*

5.3.7 Aiming point lights

Application

5.3.7.1 **Recommendation.—** *Where an aiming point marking is provided at a heliport intended for use at night, aiming point lights should be provided.*

Location

5.3.7.2 Aiming point lights shall be collocated with the aiming point marking.

Characteristics

5.3.7.3 Aiming point lights shall form a pattern of at least six omnidirectional white lights as shown in Figure 5-4. The lights shall be inset when a light extending above the surface could endanger helicopter operations.

5.3.7.4 **Recommendation.—** *The light distribution of aiming point lights should be as shown in Figure 5-9, Illustration 5.*

5.3.8 Touchdown and lift-off area lighting system

Application

5.3.8.1 A touchdown and lift-off area lighting system shall be provided at a heliport intended for use at night.

5.3.8.2 The touchdown and lift-off area lighting system for a surface level heliport shall consist of one or more of the following:

a) perimeter lights; or

b) floodlighting; or

c) luminescent panel lighting when a) and b) are not practicable and final approach and take-off area lights are available.

5.3.8.3 The touchdown and lift-off area lighting system for an elevated heliport or helideck shall consist of:

a) perimeter lights; and

b) floodlighting and/or luminescent panel lighting.

Note.— At elevated heliports and helidecks, surface texture cues within the touchdown and lift-off area are essential for helicopter positioning during the final approach and landing. Such cues are provided by using floodlighting or luminescent panel lighting or a combination of these two forms of lighting, in addition to perimeter lights.

5.3.8.4 **Recommendation.—** *Touchdown and lift-off area floodlighting or luminescent panel lighting should be provided at a surface-level heliport intended for use at night when enhanced surface texture cues are required.*

Location

5.3.8.5 Touchdown and lift-off area perimeter lights shall be placed along the edge of the area designated for use as the touchdown and lift-off area or within a distance of 1.5 m from the edge. Where the touchdown and lift-off area is a circle the lights shall be:

a) located on straight lines in a pattern which will provide information to pilots on drift displacement; and

b) where a) is not practicable, evenly spaced around the perimeter of the touchdown and lift-off area at the appropriate interval except that over a sector of 45° the lights shall be spaced at half spacing.

5.3.8.6 Touchdown and lift-off area perimeter lights shall be uniformly spaced at intervals of not more than 3 m for elevated heliports and helidecks and not more than 5 m for surface level heliports. There shall be a minimum number of four lights on each side including a light at each corner. For a circular touchdown and lift-off area, where lights are installed in accordance with 5.3.8.5 b) there shall be a minimum of fourteen lights.

Note.— Guidance on this issue is contained in the Heliport Manual.

5.3.8.7 The touchdown and lift-off area perimeter lights shall be installed at an elevated heliport or fixed helideck such that the pattern cannot be seen by the pilot from below the elevation of the touchdown and lift-off area.

5.3.8.8 The touchdown and lift-off area perimeter lights shall be installed at a floating helideck, such that the pattern cannot be seen by the pilot from below the elevation of the touchdown and lift-off area when the helideck is level.

5.3.8.9 On surface level heliports, luminescent panel lights shall be placed along the marking designating the edge of the touchdown and lift-off area. Where the touchdown and lift-off area is a circle the luminescent panels shall be located on straight lines circumscribing the area.

5.3.8.10 On surface level heliports the minimum number of panels on a touchdown and lift-off area shall be nine. The total length of luminescent panels in a pattern shall not be less than 50 per cent of the length of the pattern. There shall be an odd number with a minimum number of three panels on each side of the touchdown and lift-off area including a panel at each corner. Luminescent panels shall be uniformly spaced with a distance between adjacent panel ends of not more than 5 m on each side of the touchdown and lift-off area.

5.3.8.11 **Recommendation.**— *When luminescent panels are used on an elevated heliport or helideck to enhance surface texture cues the panels should not be placed adjacent to the perimeter lights. They should be placed around a touchdown marking where it is provided or coincident with heliport identification marking.*

5.3.8.12 Touchdown and lift-off area floodlights shall be located so as to avoid glare to pilots in flight or to personnel working on the area. The arrangement and aiming of floodlights shall be such that shadows are kept to a minimum.

Characteristics

5.3.8.13 The touchdown and lift-off area perimeter lights shall be fixed omnidirectional lights showing yellow.

5.3.8.14 At a surface level heliport the luminescent panels shall emit yellow light when used to define the boundary of the touchdown and lift-off area.

Note.— In other circumstances, luminescent panels may emit light of other colours.

5.3.8.15 **Recommendation.**— *The chromaticity and luminance of colours of luminescent panels should conform to Annex 14, Volume I, Appendix 1, 3.4.*

5.3.8.16 A luminescent panel shall have a minimum width of 6 cm. The panel housing shall be the same colour as the marking it defines.

5.3.8.17 **Recommendation.**— *The perimeter lights should not exceed a height of 25 cm and should be inset when a light extending above the surface could endanger helicopter operations.*

5.3.8.18 **Recommendation.**— *The touchdown and lift-off area floodlights should not exceed a height of 25 cm.*

5.3.8.19 The luminescent panels shall not extend above the surface by more than 2.5 cm.

5.3.8.20 **Recommendation.**— *The light distribution of the perimeter lights should be as shown in Figure 5-9, Illustration 6.*

5.3.8.21 **Recommendation.**— *The light distribution of the luminescent panels should be as shown in Figure 5-9, Illustration 7.*

5.3.8.22 The spectral distribution of touchdown and lift-off area floodlights shall be such that the surface and obstacle marking can be correctly identified.

5.3.8.23 **Recommendation.**— *The average horizontal illuminance of the floodlighting should be at least 10 lux, with a uniformity ratio (average to minimum) of not more than 8:1 measured on the surface of the touchdown and lift-off area.*

5.3.9 Winching area floodlighting

Application

5.3.9.1 Winching area floodlighting shall be provided at a winching area intended for use at night.

Location

5.3.9.2 Winching area floodlights shall be located so as to avoid glare to pilots in flight or to personnel working on the area. The arrangement and aiming of floodlights shall be such that shadows are kept to a minimum.

Characteristics

5.3.9.3 The spectral distribution of winching area floodlights shall be such that the surface and obstacle markings can be correctly identified.

5.3.9.4 **Recommendation.**— *The average horizontal illuminance should be at least 10 lux, measured on the surface of the winching area.*

5.3.10 Taxiway lights

Note.— The specifications for taxiway centre line lights and taxiway edge lights in Annex 14, Volume I, 5.3.15 and 5.3.16 are equally applicable to taxiways intended for ground taxiing of helicopters.

5.3.11 Visual aids for denoting obstacles

Note.— The specifications for marking and lighting of obstacles included in Annex 14, Volume I, Chapter 6, are equally applicable to heliports and winching areas.

5.3.12 Floodlighting of obstacles

Application

5.3.12.1 At a heliport intended for use at night, obstacles shall be floodlighted if it is not possible to display obstacle lights on them.

Location

5.3.12.2 Obstacle floodlights shall be arranged so as to illuminate the entire obstacle and as far as practicable in a manner so as not to dazzle the helicopter pilots.

Characteristics

5.3.12.3 **Recommendation.**— *Obstacle floodlighting should be such as to produce a luminance of at least 10 cd/m².*

9/11/95

CHAPTER 6. HELIPORT SERVICES

6.1 Rescue and fire fighting

General

Introductory Note.— These specifications apply to surface level heliports and elevated heliports only. The specifications complement those in Annex 14, Volume I, 9.2 concerning rescue and fire fighting requirements at aerodromes.

The principal objective of a rescue and fire fighting service is to save lives. For this reason, the provision of means of dealing with a helicopter accident or incident occurring at or in the immediate vicinity of a heliport assumes primary importance because it is within this area that there are the greatest opportunities of saving lives. This must assume at all times the possibility of, and need for, extinguishing a fire which may occur either immediately following a helicopter accident or incident or at any time during rescue operations.

The most important factors bearing on effective rescue in a survivable helicopter accident are the training received, the effectiveness of the equipment and the speed with which personnel and equipment designated for rescue and fire fighting purposes can be put into use.

For an elevated heliport, requirements to protect any building or structure on which the heliport is located are not taken into account.

Rescue and fire fighting requirements for helidecks may be found in the Heliport Manual.

Level of protection to be provided

6.1.1 **Recommendation.—** *The level of protection to be provided for rescue and fire fighting should be based on the over-all length of the longest helicopter normally using the heliport and in accordance with the heliport fire fighting category determined from Table 6-1, except at an unattended heliport with a low movement rate.*

Note.— Guidance to assist the appropriate authority in providing rescue and fire fighting equipment and services at surface-level and elevated heliports is given in the Heliport Manual.

6.1.2 **Recommendation.—** *During anticipated periods of operations by smaller helicopters, the heliport fire fighting category may be reduced to that of the highest category of helicopter planned to use the heliport during that time.*

Extinguishing agents

6.1.3 **Recommendation.—** *The principal extinguishing agent should be a foam meeting the minimum performance level B.*

Note.— Information on the required physical properties and fire extinguishing performance criteria needed for a foam to achieve an acceptable performance level B rating is given in the Airport Services Manual, *Part 1.*

6.1.4 **Recommendation.—** *The amounts of water for foam production and the complementary agents to be provided should be in accordance with the heliport fire fighting category determined under 6.1.1 and Table 6-2 or Table 6-3 as appropriate.*

Note.— The amounts of water specified for elevated heliports do not have to be stored on or adjacent to the heliport if there is a suitable adjacent pressurized water main system capable of sustaining the required discharge rate.

6.1.5 **Recommendation.—** *At a surface-level heliport it is permissible to replace all or part of the amount of water for foam production by complementary agents.*

6.1.6 **Recommendation.—** *The discharge rate of the foam solution should not be less than the rates shown in Table 6-2 or Table 6-3 as appropriate. The discharge rate of complementary agents should be selected for optimum effectiveness of the agent used.*

6.1.7 **Recommendation.—** *At an elevated heliport, at least one hose spray line capable of delivering foam in a jet*

Table 6-1. Heliport fire fighting category

Category	Helicopter over-all length[a]
H1	up to but not including 15 m
H2	from 15 m up to but not including 24 m
H3	from 24 m up to but not including 35 m

a. Helicopter length, including the tail boom and the rotors.

Table 6-2. Minimum usable amounts of extinguishing agents for surface level heliports

Category	Foam meeting performance level B		Complementary agents				
	Water (L)	Discharge rate foam solution (L/min)	Dry chemical powders (kg)	or	Halons (kg)	or	CO_2 (kg)
(1)	(2)	(3)	(4)		(5)		(6)
H1	500	250	23		23		45
H2	1 000	500	45		45		90
H3	1 600	800	90		90		180

Table 6-3. Minimum usable amounts of extinguishing agents for elevated heliports

Category	Foam meeting performance level B		Complementary agents				
	Water (L)	Discharge rate foam solution (L/min)	Dry chemical powders (kg)	or	Halons (kg)	or	CO_2 (kg)
(1)	(2)	(3)	(4)		(5)		(6)
H1	2 500	250	45		45		90
H2	5 000	500	45		45		90
H3	8 000	800	45		45		90

spray pattern at 250 L/min should be provided. Additionally at elevated heliports in categories 2 and 3, at least two monitors should be provided each having a capability of achieving the required discharge rate and positioned at different locations around the heliports so as to ensure the application of foam to any part of the heliport under any weather condition and to minimize the possibility of both monitors being impaired by a helicopter accident.

Rescue equipment

6.1.8 **Recommendation.**— *At an elevated heliport rescue equipment should be stored adjacent to the heliport.*

Note.— Guidance on the rescue equipment to be provided at a heliport is given in the Heliport Manual.

Response time

6.1.9 **Recommendation.**— *At a surface-level heliport, the operational objective of the rescue and fire fighting service should be to achieve response times not exceeding two minutes in optimum conditions of visibility and surface conditions.*

Note.— Response time is considered to be the time between the initial call to the rescue and fire fighting service and the time when the first responding vehicle(s) (the service) is (are) in position to apply foam at a rate of at least 50 per cent of the discharge rate specified in Table 6-2.

6.1.10 **Recommendation.**— *At an elevated heliport, the rescue and fire fighting service should be immediately available on or in the vicinity of the heliport while helicopter movements are taking place.*

— **END** —

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

AERONAUTICAL INFORMATION SERVICES

ANNEX 15

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

NINTH EDITION — JULY 1994

This edition incorporates all amendments adopted by the Council prior to 1 March 1994 and supersedes, on 10 November 1994, all previous editions of Annex 15.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-28	Incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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APPENDICES

FOREWORD

Historical background

Standards and Recommended Practices for Aeronautical Information Services were first adopted by the Council on 15 May 1953, pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago 1944), and were designated as Annex 15 to the Convention.

Annex 15 as now presented has undergone the following development. The first requirements were developed by the Air Navigation Committee as a result of recommendations of Regional Air Navigation Meetings, and were published by authority of the Council as Procedures for International Notices to Airmen (PANS-NOTAM, PICAO Doc 2713) in January 1947. In 1949, the Special NOTAM Meeting reviewed and proposed amendments to these procedures which were later issued as "Procedures for Air Navigation Services (PANS-AIS, Doc 7106)" and which became applicable on 1 August 1951. In 1952, the PANS-AIS were reviewed by the First Session of the Aeronautical Information Services Division which recommended the adoption of Standards and Recommended Practices. Following consideration by all Contracting States, these recommendations were reviewed by the Air Navigation Commission and the first set of Standards and Recommended Practices was adopted by the Council on 15 May 1953 as Annex 15 to the Convention. This Annex became applicable on 1 April 1954.

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

It is to be noted that some Standards in this Annex incorporate, by reference, other specifications having the status of Recommended Practices. In such cases the text of the Recommended Practice becomes part of the Standard.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

The following editorial practice has been followed in the writing of specifications: for Standards the operative verb "shall" is used, and for Recommended Practices the operative verb "should" is used.

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 15

Amendment	*Source(s)*	*Subject(s)*	*Adopted* *Effective* *Applicable*
1st Edition	First Session of the Aeronautical Information Services Division		15 May 1953 1 September 1953 1 April 1954
1	Consultation with States	Editorial amendments for consistency in terminology.	27 May 1955 1 October 1955 1 October 1955
2	Consultation with States	Editorial amendments for consistency in terminology.	15 May 1956 15 September 1956 1 December 1956
3	Consultation with States	Definition and identification of prohibited, restricted and danger areas.	16 April 1957 1 September 1957 1 December 1957
4	Consultation with States	Guidance material on the application of the definitions of danger area, prohibited area and restricted area.	14 November 1958 — 14 November 1958
5	Consultation with States	Editorial amendments for consistency in terminology; establishment of world-wide application of location indicators instead of place name abbreviations.	24 March 1959 1 September 1959 1 October 1959
6	Aeronautical Information Services and Aeronautical Charts Division	Contents of Aeronautical Information Publications (AIP); specifications for Aeronautical Information Circulars, and the NOTAM Code.	20 June 1960 1 October 1960 1 January 1961

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
7	Aeronautical Information Services and Aeronautical Charts Division	Deletion of guidance material.	2 December 1960 — 1 January 1961
8	Correspondence and Council Action to approve new *ABC — ICAO Abbreviations and Codes* (Doc 8400)	Regulated system (AIRAC); deletion of "NOTAM Code" and "Abbreviations for use by aeronautical information services"; minor amendments to Appendix 1.	25 March 1964 1 August 1964 1 November 1964
9	Rules of the Air and Air Traffic Services/Operations Divisional Meeting	Definitions for danger area, prohibited area, and restricted area.	10 December 1965 10 April 1966 25 August 1966
10	Aeronautical Information Services and Aeronautical Charts Division (1966)	Specifications for Snowplan; definition and *pro forma* for SNOWTAM; NOTAM Class I text; content of AIP; identification and delineation of restricted airspace; Aeronautical Information Circulars.	13 June 1967 8 October 1967 8 February 1968
11	Fifth Air Navigation Conference	Pre-flight information service; information on runway visual range systems.	23 January 1969 23 May 1969 18 September 1969
12	Sixth Air Navigation Conference, and transfer from Regional Supplementary Procedures	Publication of information on air traffic services systems, i.e. on reporting points and minimum flight altitudes; NOTAM information on the conduct of search and rescue operations.	15 May 1970 15 September 1970 4 February 1971
13	Aeronautical Information Services and Aeronautical Charts Division; Sixth Air Navigation Conference	Predetermined distribution system of NOTAM Class I; composition of NOTAM; information on aeronautical meteorological facilities and services available for international air navigation.	19 March 1971 6 September 1971 6 January 1972
14	Regional Air Navigation Meeting Recommendations of world-wide applicability. Recommendation 19/29 of CAR IV RAN Meeting (1966); Recommendation 19/10 of SAM/SAT/III RAN Meeting (1967); Recommendations 19/4 and 19/5 of MID/SEA RAN Meeting (1968); Recommendation 17/5 of NAT/V RAN Meeting (1970)	Availability of Aeronautical Information Service in cases where 24-hour service is not provided; decoding of NOTAM for pre-flight planning; promulgation of information that no NOTAM Class II have been issued; provision of information to the aeronautical information service by each of the State services associated with aircraft operations; publication in AIP of the coordinates of the antennae of stations providing aeronautical mobile and/or aeronautical navigation services, to an accuracy of at least one-tenth of a minute.	15 December 1971 15 April 1972 7 December 1972
15	Amendment 43 to Annex 4 — *Aeronautical Charts*; Amendment 1 to 10th edition of PANS-RAC (Doc 4444); Recommendations 16/3, 16/8, 16/10 b) and 16/15 of the 6th EUM RAN Meeting; Amendment 28 to Annex 14 — *Aerodromes*; Amendment 51 to Annex 10 — *Aeronautical Telecommunications*	Publication in AIP of the locations at aerodromes of VOR and INS check-points; publication in AIP of names, coded designators and geographical coordinates of significant points defining air traffic services routes, and of information on bird concentrations in the vicinity of aerodromes and bird migrations; listing of types of information inappropriate to NOTAM; type of information appropriate to Aeronautical Information Circulars; alignment of the terminology with the definition in Annex 14 for snow on the ground.	19 March 1973 30 July 1973 23 May 1974
16	Council's request (78-14) to consult States on publication in AIP of differences from Annexes and PANS; Amendment 6 to the PANS-RAC	Publication in AIP of differences between the national regulations and practices of a State and the related ICAO Standards, Recommended Practices and Procedures; elimination of inconsistencies between requirements in Appendix 1 and parent provisions in the Annex; transfer of requirements for information concerning ATIS from the MET to the RAC part of the AIP.	25 June 1974 25 October 1974 27 February 1975
17	Recommendation 2/6 of the Fourth Meeting of the Technical Panel on Supersonic Transport Operations; study by the Air Navigation Commission concerning interception of aircraft	Dissemination by NOTAM of forecasts of solar cosmic radiation where provided; publication in AIP of interception procedures and visual signals to be used.	4 February 1975 4 June 1975 9 October 1975

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
18	Recommendations of Regional Air Navigation Meetings (EUM 6 Rec 9/4, AFI/5 Rec 6/2 c) d) and ASIA/PAC Rec 6/3 c)) and request by IATA to amend Annex 14; general review of Annex 14	Publication in AIP of information concerning operations for the removal of disabled aircraft at aerodromes; notification of the status of rescue and fire fighting services available at an aerodrome in terms of significant changes in the level of protection; definitions for manoeuvring area and movement area; substitution of expression "altimeter check location" for "altimeter check-point".	5 February 1976 5 June 1976 30 December 1976
19	Recommendation 3/16 of the 7th Air Navigation Conference; Revision (Amendment No. 60) of Annex 3 — *Meteorological Service for International Air Navigation*	Publication in AIP, in the case of ILS installations, the extent of compliance with the provisions in Annex 10 regarding localizer and glide path beam structure and of the height of the ILS reference datum; realignment of Part 4 — Meteorology with the new specifications and terminology introduced by Amendment 60 to Annex 3.	27 June 1977 27 October 1977 23 February 1978
20	9th Air Navigation Conference	Publication in the AIP of description of ATS routes; North reference (magnetic, true or grid) for tracks or bearings.	9 December 1977 9 April 1978 10 August 1978
21	Proposals submitted by the Federal Republic of Germany (also on behalf of the United Kingdom) and the Union of Soviet Socialist Republics	NOTAM Class I format and the publication of amendments to the AIP.	31 March 1980 31 July 1980 27 November 1980
22	Proposal arising from a study by the Air Navigation Commission and proposal submitted by the Secretariat	Activities which constitute a potential hazard to flights of civil aircraft and receipt of AIRAC NOTAM 28 days in advance of the effective date.	13 March 1981 13 July 1981 26 November 1981
23	Proposals submitted by the Secretariat and the United Kingdom	Plain language pre-flight information bulletins, interception of civil aircraft and "Nil Notification" of AIRAC NOTAM.	2 April 1982 2 August 1982 25 November 1982
24	Recommendations 7/5, 7/8 and 10/2 of the Aerodromes, Air Routes and Ground Aids Divisional Meeting (1981)	Revised SNOWTAM format; publication in the AIP of wet runway surface friction and of the existence of an obstacle-free zone.	17 November 1982 17 March 1983 24 November 1983
25	Recommendation 7/7 of the Aerodromes, Air Routes and Ground Aids Divisional Meeting (1981)	Method of referencing date/time.	25 March 1985 29 July 1985 21 November 1985
26	Various sources, including Conclusions 22/24 and 24/20 of the European Air Navigation Planning Group (EANPG); Recommendation 9 of All Weather Operations Panel (AWOP); Recommendation 1/4 of the Obstacle Clearance Panel (OCP); Amendments 64, 47 and 38 to Annexes 3, 4 and 14 respectively; proposals submitted by the United Kingdom and by the Secretariat	Updating of the provisions relating to the use of A-4 sheet size paper in the AIP; origination and distribution of NOTAM and AIC; adequacy and authenticity of aeronautical information and the regulated system (AIRAC); changes to predetermined distribution system for NOTAM Class I; introduction of an abbreviated heading and changes to the SNOWTAM format and the guidance for its completion; publication in the AIP of the location of the DME zero-range indication point; updating of the list of charts forming part of the AIP; publication in the AIP of additional operational data concerning standard routes for taxiing aircraft, highest elevation of the touchdown zone of a precision approach runway, and geographical coordinates of thresholds and aircraft stands; inclusion of references to the seventh and eighth letters in the address indicators in the predetermined distribution system; and volcanic ash cloud warnings.	6 March 1987 27 July 1987 22 October 1987
27	Various sources, including Conclusion 30/15 of the European Air Navigation Planning Group (EANPG); Air Navigation Commission's review of the Annexes; Recommendation 3/3 of the Visual Flight Rules Operations Panel (VFOP); proposal submitted by some European States; and Amendment 39 to Annex 14	Introduction of Integrated Aeronautical Information Package and revised NOTAM Format; promulgation of information on areas or routes where the possibility of interception exists and information relating to safeguarding international civil aviation against acts of unlawful interference; introduction of new ATS airspace classification; bird hazard reduction; updating of terminology and list of friction devices associated with measuring of paved surfaces; introduction of heliport data.	4 March 1991 28 July 1991 14 November 1991

28	Various sources, including Conclusion 34/12 of the European Air Navigation Planning Group (EANPG); adoption by the Council of WGS-84 as the standard geodetic reference system for international aviation; proposal by RGCSP/8; and the Secretariat	Introduction in Chapter 1 of new and revised definitions relating to heliport and Integrated Aeronautical Information Package; amendments to Chapter 3 related to the exchange of aeronautical information and introduction of new provisions concerning the promulgation of WGS-84 related geographical coordinates; amendments and rearrangements of Chapter 4 concerning the restructured contents and general specifications of AIP, AIP Amendment and AIP Supplement specifications and their distribution; amendments to Chapter 5 concerning NOTAM origination and distribution and introduction of a new provision governing the promulgation of information on the release into the atmosphere of radioactive materials and toxic chemicals; upgrading in Chapter 6 to a Standard, of a provision concerning the use of AIRAC dates for the promulgation of changes requiring cartographic work and for updating of navigation databases; deletion in Chapter 8 of a Recommended Practice relating to the format of pre-flight information bulletins; substitution, in Chapter 9, of the specific term "aeronautical fixed telecommunication network (AFTN)" by the general term "aeronautical fixed service (AFS)"; introduction in Appendix 1 of completely restructured contents of AIP.	28 February 1994 28 June 1994 10 November 1994; 25 April 1996; 1 January 1998

10/11/94

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. INTRODUCTION

Note.— The object of the aeronautical information service is to ensure the flow of information necessary for the safety, regularity and efficiency of international air navigation.

These Standards and Recommended Practices are to be used in conjunction with the *ICAO Abbreviations and Codes* (Doc 8400).

It is recognized that Supplementary Procedures may be required in certain cases in order to meet particular requirements of the ICAO Regions.

Guidance material on the organization and operation of aeronautical information services is contained in the *Aeronautical Information Services Manual* (Doc 8126).

CHAPTER 2. DEFINITIONS

When the following terms are used in the Standards and Recommended Practices for aeronautical information services, they have the following meanings:

Aeronautical Information Circular (AIC). A notice containing information that does not qualify for the origination of a NOTAM or for inclusion in the AIP, but which relates to flight safety, air navigation, technical, administrative or legislative matters.

Aeronautical Information Publication (AIP). A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

AIP Amendment. Permanent changes to the information contained in the AIP.

AIP Supplement. Temporary changes to the information contained in the AIP which are published by means of special pages.

AIRAC. An acronym (aeronautical information regulation and control) signifying a system aimed at advance notification based on common effective dates, of circumstances that necessitate significant changes in operating practices.

Danger area. An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times.

Direct transit arrangements. Special arrangements approved by the public authorities concerned by which traffic which is pausing briefly in its passage through the Contracting State may remain under their direct control.

Heliport. An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Integrated Aeronautical Information Package. A package which consists of the following elements:

— AIP, including amendment service;
— supplements to the AIP;
— NOTAM and pre-flight information bulletins (PIB);
— AIC;
— checklists and summaries.

International airport. Any airport designated by the Contracting State in whose territory it is situated as an airport of entry and departure for international air traffic, where the formalities incident to customs, immigration, public health, animal and plant quarantine and similar procedures are carried out.

International NOTAM office. An office designated by a State for the exchange of NOTAM internationally.

Manoeuvring area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Movement area. That part of an aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

NOTAM. A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

Pre-flight information bulletin (PIB). A presentation of current NOTAM information of operational significance, prepared prior to flight.

Prohibited area. An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is prohibited.

Restricted area. An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions.

Route stage. A route or portion of a route flown without an intermediate landing.

SNOWTAM. A special series NOTAM notifying the presence or removal of hazardous conditions due to snow, ice, slush or standing water associated with snow, slush and ice on the movement area, by means of a specific format.

CHAPTER 3. GENERAL

3.1 Responsibilities and functions

3.1.1 Each Contracting State shall:

a) provide an aeronautical information service; or

b) agree with one or more other Contracting State(s) for the provision of a joint service; or

c) delegate the authority for the provision of the service to a non-governmental agency, provided the Standards and Recommended Practices of this Annex are adequately met.

The State concerned shall remain responsible for the information published.

3.1.1.1 An aeronautical information service shall collect, collate, edit and publish aeronautical information concerning the entire territory of the State as well as areas in which the State is responsible for air traffic services outside its territory.

3.1.1.2 Aeronautical information shall be published as an Integrated Aeronautical Information Package.

3.1.1.3 Where 24-hour service is not provided, service shall be available during the whole period an aircraft is in flight in the area of responsibility of an aeronautical information service plus a period of at least two hours before and after such period. The service shall also be available at such other time as may be requested by an appropriate ground organization.

3.1.2 An aeronautical information service shall, in addition, obtain information to enable it to provide pre-flight information service and to meet the need for in-flight information:

a) from the aeronautical information services of other States;

b) from other sources that may be available.

Note.— One such source is the subject of a provision in 8.2.

3.1.3 An aeronautical information service shall promptly make available to the aeronautical information services of other States any information necessary for the safety, regularity or efficiency of air navigation required by them, to enable them to comply with 3.1.4 below.

3.1.4 An aeronautical information service shall ensure that information necessary for the safety, regularity or efficiency of air navigation is available in a form suitable for the operational requirements of:

a) flight operations personnel including flight crews and the services responsible for pre-flight information;

b) the air traffic services unit responsible for flight information service.

3.2 Adequacy and authenticity

3.2.1 Each Contracting State shall take all reasonable measures to ensure that the information it provides relating to its own territory is adequate, accurate and timely. This shall include arrangements for the timely provision of required information to the aeronautical information service by each of the State services associated with aircraft operations.

3.2.1.1 Before introducing changes to the air navigation system, due account shall be taken by the services responsible for such changes of the time needed by the aeronautical information service for the preparation, production and issue of relevant material for promulgation. Timely and close co-ordination between the services concerned including the aeronautical information service is therefore required, to ensure timely provision of the information to the aeronautical information service.

3.2.2 Aeronautical information published for and on behalf of a State shall clearly indicate that it is published under the authority of that State.

3.2.3 Aeronautical information obtained under 3.1.2 a) shall, when disseminated, be clearly identified as having the authority of the State of origin.

3.2.4 Aeronautical information obtained under 3.1.2 b) shall, if possible, be verified before dissemination and if not verified shall, when disseminated, be clearly identified as such.

3.2.4.1 Material to be issued as part of the Integrated Aeronautical Information Package shall be thoroughly checked and co-ordinated by the responsible services before it is submitted to the aeronautical information service, in order to make certain that all necessary information has been included and that it is correct in detail prior to distribution.

Note.— Guidance material on the liaison with other related services is contained in the Aeronautical Information Services Manual *(Doc 8126).*

3.3 Exchange of aeronautical information

3.3.1 Each State shall designate the office to which all elements of the Integrated Aeronautical Information Package originated by other States shall be addressed. Such an office shall be qualified to deal with requests for information originated by other States.

3.3.2 Where a State designates more than one international NOTAM office, it shall define the extent of responsibility and the territory covered by each office.

3.3.3 An aeronautical information service shall arrange, as necessary, to satisfy operational requirements, for the issuance and receipt of NOTAM distributed by telecommunication.

3.3.4 States shall, wherever practicable, establish direct contact between aeronautical information services in order to facilitate the international exchange of aeronautical information.

3.3.5 The interchange of aeronautical information shall be on a free basis. One copy of each of the elements of the Integrated Aeronautical Information Package that have been requested by an aeronautical information service shall be made available without charge, even where authority for publication and distribution has been delegated to a commercial agency.

3.3.6 **Recommendation.—** *The exchange of more than one copy of the elements of the Integrated Aeronautical Information Package and other air navigation documents including those containing air navigation legislation and regulations should be subject to bilateral agreement.*

3.4 General specifications

3.4.1 **Recommendation.—** *Each element of the Integrated Aeronautical Information Package for international distribution should include an English text for those parts expressed in plain language.*

3.4.2 Place names shall be spelt in conformity with local usage, transliterated, when necessary, into the Latin alphabet.

3.4.3 **Recommendation.—** *Units of measurement used in the dissemination of aeronautical information should be consistent with the decision taken by the State in respect of the use of the tables contained in Annex 5 to the Convention.*

3.4.4 Geographical coordinates

3.4.4.1 Applicable as of 1 January 1998, published geographical coordinates indicating latitude and longitude shall be expressed in terms of the World Geodetic System — 1984 (WGS-84) geodetic reference datum. Geographical coordinates which have been transformed into WGS-84 coordinates but whose accuracy of original field work does not meet the requirements in Annex 11, Chapter 2 and Annex 14, Volume I and II, Chapter 2, shall be identified by an asterisk.

3.4.4.2 The order of resolution of geographical coordinates shall be that as specified in Appendices 1 and 5.

Note.— Specifications governing the determination and reporting of WGS-84 coordinates are given in Annex 11, Chapter 2, and Annex 14, Volumes I and II, Chapter 2.

3.4.5 Use of ICAO abbreviations

ICAO abbreviations shall be used in the aeronautical information services whenever they are appropriate and their use will facilitate dissemination of information.

3.4.6 Use of automation

Recommendation.— *Automation in AIS should be introduced with the objective of improving the speed, accuracy, efficiency and cost effectiveness of aeronautical information services.*

3.4.7 Identification and delineation of prohibited, restricted and danger areas

3.4.7.1 Each prohibited area, restricted area, or danger area established by a State shall, upon initial establishment, be given an identification and full details shall be promulgated (see ENR 5.1 of Appendix 1).

3.4.7.2 The identification so assigned shall be used to identify the area in all subsequent notifications pertaining to that area.

3.4.7.3 The identification shall be composed of a group of letters and figures as follows:

a) nationality letters for location indicators assigned to the State or territory, which has established the airspace;

b) a letter P for prohibited area, R for restricted area and D for danger area as appropriate;

c) a number, unduplicated within the State or territory concerned.

Note.— Nationality letters are those contained in Location Indicators *(Doc 7910).*

3.4.7.4 To avoid confusion, identification numbers shall not be re-used for a period of at least one year after cancellation of the area to which they refer.

3.4.7.5 **Recommendation.—** *When a prohibited, restricted or danger area is established, the area should be as small as practicable and be contained within simple geometrical limits, so as to permit ease of reference by all concerned.*

CHAPTER 4. AERONAUTICAL INFORMATION PUBLICATIONS (AIP)

Note 1.— AIP are intended primarily to satisfy international requirements for the exchange of aeronautical information of a lasting character essential to air navigation. When practicable, the form of presentation is designed to facilitate their use in flight.

Note 2.— AIP constitute the basic information source for permanent information and long duration temporary changes.

4.1 Contents

4.1.1 Applicable as of 25 April 1996, an Aeronautical Information Publication shall contain, in three parts, sections and sub-sections uniformly referenced to allow for standardized electronic data storage and retrieval, current information relating to, and arranged under, those subjects enumerated in Appendix 1 that appear in Roman type, except that when the AIP, or volume of the AIP, is designed basically to facilitate operational use in flight, the precise format and arrangement may be left to the discretion of the State provided that an adequate table of contents is included.

4.1.1.1 **Recommendation.**— *Aeronautical Information Publications should, in addition, contain current information relating to those subjects enumerated in Appendix 1 that appear in italic type.*

4.1.2 Aeronautical Information Publications shall include in Part 1 — General (GEN):

a) a statement of the competent authority responsible for the air navigation facilities, services or procedures covered by the AIP;

b) the general conditions under which the services or facilities are available for international use;

c) a list of significant differences between the national regulations and practices of the State and the related ICAO Standards, Recommended Practices and Procedures given in a form that would enable a user to differentiate readily between the requirements of the State and the related ICAO provisions;

d) the choice made by a State in each significant case where an alternative course of action is provided for in ICAO Standards, Recommended Practices and Procedures.

4.1.3 The aeronautical charts listed alphabetically below shall, when available for designated international aerodromes/heliports, form part of the AIP, or be distributed separately to recipients of the AIP:

a) Aerodrome/Heliport Chart — ICAO;

b) Aerodrome Ground Movement Chart — ICAO;

c) Aerodrome Obstacle Chart — ICAO Type A;

d) Aircraft Parking/Docking Chart — ICAO;

e) Area Chart — ICAO;

f) Instrument Approach Chart — ICAO;

g) Precision Approach Terrain Chart — ICAO;

h) Standard Arrival Chart — Instrument (STAR) — ICAO;

i) Standard Departure Chart — Instrument (SID) — ICAO;

j) Visual Approach Chart — ICAO.

4.1.4 Charts, maps or diagrams shall be used, when appropriate, to complement or as a substitute for the tabulations or text of Aeronautical Information Publications.

Note.— Where appropriate, charts produced in conformity with Annex 4 — Aeronautical Charts, *may be used to fulfil this requirement. Guidance material as to the specifications of index maps and diagrams included in Aeronautical Information Publications is contained in the* Aeronautical Information Services Manual *(Doc 8126).*

4.2 General specifications

4.2.1 Each Aeronautical Information Publication shall be self-contained and shall include a table of contents.

Note.— If it is necessary by reason of bulk or for convenience, to publish an AIP in two or more parts or volumes, each of them will indicate that the remainder of the information is to be found in the other part(s) or volume(s).

4.2.1.1 Each AIP shall not duplicate information within itself or from other sources.

4.2.1.2 When two or more States combine to issue a joint AIP, this shall be made clear both on the cover and in the table of contents.

4.2.2 **Recommendation.**— *AIP should be published in loose-leaf form unless the complete publication is reissued at frequent intervals.*

4.2.3 Each Aeronautical Information Publication shall be dated. In the case of Aeronautical Information Publications issued in loose-leaf form, each page shall be dated. The date, consisting of the day, month (by name) and year, shall be the publication date or the effective date of the information.

4.2.4 A checklist giving the current date of each page in the Aeronautical Information Publication series shall be reissued frequently to assist the user in maintaining a current publication. The page number/chart title and date of the checklist shall appear on the checklist itself.

4.2.5 Each Aeronautical Information Publication issued as a bound volume and each page of an Aeronautical Information Publication issued in loose-leaf form shall be so annotated as to indicate clearly:

a) the identity of the Aeronautical Information Publication;

b) territory covered and subdivisions when necessary;

c) identification of issuing State and producing organization (authority);

d) page numbers/chart titles;

e) degree of reliability if the information is doubtful.

4.2.6 **Recommendation.**— *The sheet size should be no larger than 210 × 297 mm, except that larger sheets may be used provided they are folded to the same size.*

4.2.7 All changes to the AIP, or new information on a reprinted page, shall be identified by a distinctive symbol or annotation.

4.2.8 Operationally significant changes to the AIP shall be published in accordance with AIRAC procedures and shall be clearly identified by the acronym — AIRAC.

4.2.9 AIP shall be amended or reissued at such regular intervals as may be necessary to keep them up to date. Recourse to hand amendments or annotations shall be kept to the minimum. The normal method of amendment shall be by means of replacement sheets.

4.2.9.1 The regular interval referred to in 4.2.9 shall be specified in the AIP, Part 1 — General (GEN).

Note.— Guidance material on the establishment of intervals between publication dates of AIP Amendments is contained in the Aeronautical Information Services Manual *(Doc 8126).*

4.3 Specifications for AIP Amendments

4.3.1 Permanent changes to the AIP shall be published as AIP Amendments.

4.3.2 Each AIP Amendment shall be allocated a serial number, which shall be consecutive.

4.3.3 Each AIP Amendment page, including the cover sheet, shall display a publication date.

4.3.4 Each AIRAC AIP Amendment page, including the cover sheet, shall display an effective date.

4.3.5 When an AIP Amendment is issued, it shall include references to the serial number of those elements, if any, of the Integrated Aeronautical Information Package which have been incorporated into the amendment.

4.3.6 A brief indication of the subjects affected by the amendment shall be given on the AIP Amendment cover sheet.

4.3.7 When an AIP Amendment will not be published at the established interval or publication date, a NIL notification shall be originated and distributed by the monthly printed plain-language summary of NOTAM in force required by 5.2.8.3.

4.4 Specifications for AIP Supplements

4.4.1 Temporary changes of long duration (three months or longer) and information of short duration which contains extensive text and/or graphics shall be published as AIP Supplements.

4.4.2 Each AIP Supplement shall be allocated a serial number which shall be consecutive and based on the calendar year.

4.4.3 AIP Supplement pages shall be kept in the AIP as long as all or some of their contents remain valid.

4.4.4 When an AIP Supplement is sent in replacement of a NOTAM, it shall include a reference to the serial number of the NOTAM.

4.4.5 A checklist of AIP Supplements currently in force shall be issued at intervals of not more than one month. This information shall be issued through the medium of the monthly printed plain-language summary of NOTAM in force required by 5.2.8.3.

4.4.6 **Recommendation.**— *AIP Supplement pages should be coloured in order to be conspicuous, preferably in yellow.*

4.4.7 **Recommendation.**— *AIP Supplement pages should be kept as the first item in the AIP parts.*

4.5 Distribution

AIP, AIP Amendments and AIP Supplements shall be made available by the most expeditious means.

CHAPTER 5. NOTAM

5.1 Origination

5.1.1 A NOTAM shall be originated and issued promptly whenever the information to be disseminated is of a temporary nature and of short duration or when operationally significant permanent changes, or temporary changes of long duration are made at short notice, except for extensive text and/or graphics.

Note.— Information of short duration containing extensive text and/or graphics is published as an AIP Supplement (see Chapter 4, 4.4).

5.1.1.1 A NOTAM shall be originated and issued whenever the following information is of direct operational significance:

a) establishment, closure or significant changes in operation of aerodrome(s) or runways;

b) establishment, withdrawal and significant changes in operation of aeronautical services (AGA, AIS, ATS, COM, MET, SAR, etc.);

c) the establishment or withdrawal of electronic and other aids to air navigation and aerodromes. This includes: interruption or return to operation, change of frequencies, change in notified hours of service, change of identification, change of orientation (directional aids), change of location, power increase or decrease amounting to 50 per cent or more, change in broadcast schedules or contents, or irregularity or unreliability of operation of any electronic aid to air navigation, and air-ground communication services;

d) establishment, withdrawal or significant changes made to visual aids;

e) interruption of or return to operation of major components of aerodrome lighting systems;

f) establishment, withdrawal or significant changes made to procedures for air navigation services;

g) occurrence or correction of major defects or impediments in the manoeuvring area;

h) changes to and limitations on availability of fuel, oil and oxygen;

i) major changes to search and rescue facilities and services available;

j) establishment, withdrawal or return to operation of hazard beacons marking significant obstacles to air navigation;

k) changes in regulations requiring immediate action, e.g. prohibited areas for SAR action;

l) presence of hazards which affect air navigation (including obstacles, military exercises, displays, races, major parachuting events outside promulgated sites);

m) erecting, removal of or changes to significant obstacles to air navigation in the take-off/climb, missed approach, approach areas and runway strip;

n) establishment or discontinuance (including activation or deactivation) as applicable, or changes in the status of prohibited, restricted or danger areas;

o) establishment or discontinuance of areas or routes or portions thereof where the possibility of interception exists and where the maintenance of guard on the VHF emergency frequency 121.5 MHz is required;

p) allocation, cancellation or change of location indicators;

q) significant changes in the level of protection normally available at an aerodrome for rescue and fire fighting purposes. NOTAM shall be originated only when a change of category is involved and such change of category shall be clearly stated (see Annex 14, Volume I, Chapter 9, and Attachment A, Section 17);

r) presence or removal or significant changes in hazardous conditions due to snow, slush, ice or water on the movement area;

Note.— Notification of such conditions is to be made preferably by use of the SNOWTAM format in Appendix 2, or the NOTAM Code (Doc 8400) and plain language.

s) outbreaks of epidemics necessitating changes in notified requirements for inoculations and quarantine measures;

t) forecasts of solar cosmic radiation, where provided;

u) occurrence of pre-eruption volcanic activity, the location, date and time of volcanic eruptions and the existence, density and extent of volcanic ash cloud, including direction of movement, flight levels and routes or portions of routes which could be affected.

v) release into the atmosphere of radioactive materials or toxic chemicals following a nuclear or chemical incident, the location, date and time of the incident, the flight levels and routes or portions thereof which could be affected and the direction of movement.

5.1.1.2 When an AIP Amendment or an AIP Supplement is published in accordance with AIRAC procedures, NOTAM shall be originated giving a brief description of the contents, the effective date and the reference number to the amendment or supplement. This NOTAM shall come into force on the same effective date as the amendment or supplement.

5.1.1.2.1 **Recommendation.—** *NOTAM should remain in force as a reminder in the pre-flight information bulletin until the next checklist/summary is issued.*

5.1.1.3 **Recommendation.—** *The need for origination of a NOTAM should be considered in any other operationally significant circumstance.*

5.1.1.4 The following information shall not be notified by NOTAM:

a) routine maintenance work on aprons and taxiways which does not affect the safe movement of aircraft;

b) runway marking work, when aircraft operations can safely be conducted on other available runways, or the equipment used can be removed when necessary;

c) temporary obstructions in the vicinity of aerodromes that do not affect the safe operation of aircraft;

d) partial failure of aerodrome lighting facilities where such failure does not directly affect aircraft operations;

e) partial temporary failure of air-ground communications when suitable alternative frequencies are known to be available and are operative;

f) the lack of apron marshalling services and road traffic control;

g) the unserviceability of location, destination or other instruction signs on the aerodrome movement area;

h) parachuting when in uncontrolled airspace under VFR (see 5.1.1.1 l)), when controlled, at promulgated sites or within danger or prohibited areas;

i) other information of a similar temporary nature.

5.1.1.5 At least seven days' advance notice shall be given of the activation of established danger, restricted or prohibited areas and of activities requiring temporary airspace restrictions other than for emergency operations.

5.1.1.5.1 **Recommendation.—** *Notice of any subsequent cancellation of the activities or any reduction of the hours of activity or the dimensions of the airspace should be given as soon as possible.*

Note.— Whenever possible, at least 24 hours' advance notice is desirable, to permit timely completion of the notification process and to facilitate airspace utilization planning.

5.1.1.6 **Recommendation.—** *NOTAM notifying unserviceability of aids to air navigation, facilities or communication services should give an estimate of the period of unserviceability or the time at which restoration of service is expected.*

5.2 General specifications

5.2.1 Each NOTAM in a series of NOTAM shall be allocated a serial number by the originator. That number shall be consecutive and based on the calendar year.

5.2.1.1 When NOTAM are distributed in more than one series, each series shall be separately identified by letter.

5.2.2 Each NOTAM shall be as brief as possible and so compiled that its meaning is clear without reference to another document.

5.2.3 Each NOTAM shall be transmitted as a single telecommunication message.

5.2.4 A NOTAM containing permanent or temporary information of long duration shall carry appropriate AIP or AIP Supplement references.

5.2.5 When a NOTAM is issued which cancels or supersedes a previous NOTAM, the serial number of the previous NOTAM shall be indicated.

5.2.6 When errors occur in a NOTAM, a replacement NOTAM shall be issued.

5.2.7 Location indicators included in the text of a NOTAM shall conform to the official ICAO list.

5.2.7.1 In no case shall a curtailed form of such indicator be used.

5.2.7.2 Where no ICAO location indicator is assigned to the location, the name of the place spelt in accordance with 3.4.2 shall be entered in plain language.

5.2.8 A checklist of NOTAM currently in force shall be issued over the AFTN at intervals of not more than one month.

5.2.8.1 A checklist of NOTAM shall refer to the latest AIP Amendments, AIP Supplements and at least the internationally distributed AIC.

5.2.8.2 A checklist of NOTAM shall have the same distribution as the actual message series to which they refer and shall be clearly identified as checklist.

5.2.8.3 A monthly printed plain-language summary of NOTAM in force including the indications of the latest AIP Amendments, checklist of AIP Supplements and AIC issued, shall be prepared with a minimum of delay and forwarded by the most expeditious means to recipients of the Integrated Aeronautical Information Package.

5.3 Distribution

5.3.1 A NOTAM shall be distributed to addressees to whom the information is of direct operational significance, and who would not otherwise have at least seven days' prior notification.

5.3.2 Except as otherwise provided in 5.3.3, the text of each NOTAM shall contain the information in the order shown in the NOTAM Format in Appendix 5.

5.3.3 Information concerning snow, ice and standing water on aerodrome pavements shall, when reported by means of a SNOWTAM, contain the information in the order shown in the format in Appendix 2.

5.3.4 NOTAM shall be prepared in conformity with the relevant provisions of the ICAO communication procedures.

5.3.4.1 The aeronautical fixed telecommunication network (AFTN) shall, whenever practicable, be employed for NOTAM distribution.

5.3.4.2 When a NOTAM exchanged as specified in 5.3.7 is sent by means other than the aeronautical fixed telecommunication network (AFTN), a six-digit date-time group indicating the date and time of filing the NOTAM and the identification of the originator shall be used, preceding the text.

5.3.5 NOTAM transmitted over the international telecommunication service shall be composed of the significations/uniform abbreviated phraseology assigned to the ICAO NOTAM Code complemented by ICAO abbreviations, indicators, identifiers, designators, call signs, frequencies, figures and plain language.

Note 1.— The ICAO NOTAM Code and ICAO abbreviations are those contained in ICAO Abbreviations and Codes *(Doc 8400).*

Note 2.— A SNOWTAM (see format in Appendix 2) may be used for information relating to snow, slush, ice or standing water associated with snow, slush and ice in the movement area.

5.3.6 The originating State shall select the NOTAM that are to be given international distribution.

5.3.6.1 **Recommendation.—** *Selective distribution lists should be used when practicable.*

Note.— These lists are intended to obviate superfluous dissemination of information. Guidance material relating to this is contained in the Aeronautical Information Services Manual *(Doc 8126).*

5.3.7 International exchange of a NOTAM shall take place only as mutually agreed between the international NOTAM offices concerned.

Note.— Arrangements may be made for direct exchange of SNOWTAM (see Appendix 2) between aerodromes.

5.3.7.1 These exchanges of NOTAM between international NOTAM offices shall, as far as practicable, be limited to the requirements of the receiving States concerned by means of separate series providing for at least international and domestic flights.

5.3:7.2 A predetermined distribution system for NOTAM transmitted on the AFTN in accordance with Appendix 4 shall be used whenever possible, subject to the requirements of 5.3.7.

CHAPTER 6. AERONAUTICAL INFORMATION REGULATION AND CONTROL (AIRAC)

6.1 Regulated system

6.1.1 Information concerning the circumstances listed in Appendix 3, Part 1, shall be disseminated under the regulated system (AIRAC), i.e. basing establishment, withdrawal or significant changes upon a series of common effective dates at intervals of 28 days, including 10 January 1991. The information shall be distributed by the AIS unit at least 42 days in advance of the effective date with the objective of reaching recipients at least 28 days in advance of the effective date and the information notified therein shall not be changed further for at least another 28 days after the effective date, unless the circumstance notified is of a temporary nature and would not persist for the full period.

Note.— Guidance material on the procedures applicable to the AIRAC system is contained in the Aeronautical Information Services Manual *(Doc 8126).*

6.1.1.1 **Recommendation.—** *Whenever major changes are planned and where additional notice is desirable and practicable, a publication date of at least 56 days in advance of the effective date should be used.*

6.1.1.2 **Recommendation.—** *The regulated system (AIRAC) should also be used for the promulgation of information relating to the establishment and withdrawal of, and premeditated significant changes in, the circumstances listed in Appendix 3, Part 2.*

6.1.2 When information has not been submitted for publication at the AIRAC date, a NIL notification shall be originated and distributed by NOTAM, not later than one cycle before the AIRAC effective date concerned.

6.1.3 **Recommendation.—** *The use of the date in the AIRAC cycle which occurs between 21 December and 17 January inclusive should be avoided as an effective date for the introduction of significant changes under the AIRAC system.*

6.1.4 Implementation dates other than AIRAC effective dates shall not be used for pre-planned operationally significant changes requiring cartographic work and/or for updating of navigation databases.

6.1.5 **Recommendation.—** *When the planned effective date will not coincide with the AIRAC effective date, the publication date of the information whenever possible should precede by 28 days the beginning of the AIRAC cycle within which the planned effective date falls.*

CHAPTER 7. AERONAUTICAL INFORMATION CIRCULARS (AIC)

7.1 Origination

7.1.1 An AIC shall be originated whenever it is necessary to promulgate aeronautical information which does not qualify:

a) under the specifications in 4.1 for inclusion in an AIP; or

b) under the specifications in 5.1 for the origination of a NOTAM.

7.1.1.1 An AIC shall be originated whenever it is desirable to promulgate:

a) a long-term forecast of any major change in legislation, regulations, procedures or facilities;

b) information of a purely explanatory or advisory nature liable to affect flight safety;

c) information or notification of an explanatory or advisory nature concerning technical, legislative or purely administrative matters.

This shall include:

1) forecasts of important changes in the air navigation procedures, services and facilities provided;

2) forecasts of implementation of new navigational systems;

3) significant information arising from aircraft accident/incident investigation which has a bearing on flight safety;

4) information on regulations relating to the safeguarding of international civil aviation against acts of unlawful interference;

5) advice on medical matters of special interest to pilots;

6) warnings to pilots concerning the avoidance of physical hazards;

7) effect of certain weather phenomena on aircraft operations;

8) information on new hazards affecting aircraft handling techniques;

9) regulations relating to the carriage of restricted articles by air;

10) reference to the requirements of, and publication of changes in, national legislation;

11) aircrew licensing arrangements;

12) training of aviation personnel;

13) application of, or exemption from, requirements in national legislation;

14) advice on the use and maintenance of specific types of equipment;

15) actual or planned availability of new or revised editions of aeronautical charts;

16) carriage of radio equipment;

17) explanatory information relating to noise abatement;

18) selected airworthiness directives;

19) changes in NOTAM series or distribution, new editions of AIP or major changes in their contents, coverage or format;

20) advance information on the snow plan (see 7.1.1.2);

21) other information of a similar nature.

Note.— The publication of an AIC does not remove the obligations set forth in Chapters 4 and 5.

7.1.1.2 The snow plan published under AD 1.2.2 of Appendix 1 shall be supplemented by seasonal information, to be issued well in advance of the beginning of each winter — not less than one month before the normal onset of winter conditions — and should contain information such as that listed below:

a) a list of aerodromes where snow clearance is expected to be performed during the coming winter:

*1) in accordance with the runway and taxiway systems; or

* This information, or any part of it, may be included in the AIP, if so desired.

*2) planned snow clearing, deviating from the runway system (length, width and number of runways, affected taxiways and aprons or portions thereof);

*b) information concerning any centre designated to co-ordinate information on the current state of progress of clearance and on the current state of runways, taxiways and aprons;

c) a division of the aerodromes into SNOWTAM distribution lists in order to avoid excessive NOTAM distribution;

*d) an indication, as necessary, of minor changes to the standing snow plan;

*e) a descriptive list of clearance equipment;

*f) a listing of what will be considered as the minimum critical snow bank to be reported at each aerodrome at which reporting will commence.

7.2 General specifications

7.2.1 AIC shall be issued in printed form.

Note.— Both text and diagrams may be included.

7.2.1.1 The originating State shall select the AIC that are to be given international distribution.

7.2.1.2 Each AIC shall be allocated a serial number which should be consecutive and based on the calendar year.

7.2.1.3 When AIC are distributed in more than one series, each series shall be separately identified by a letter.

7.2.1.4 **Recommendation.—** *Differentiation and identification of AIC topics according to subjects using colour coding should be practised where the numbers of AIC in force are sufficient to make identification in this form necessary.*

7.2.2 A checklist of AIC currently in force shall be issued at least once a year, with distribution as for the AIC.

7.3 Distribution

States shall give AIC selected for international distribution the same distribution as for the AIP.

* This information, or any part of it, may be included in the AIP, if so desired.

CHAPTER 8. PRE-FLIGHT AND POST-FLIGHT INFORMATION

8.1 Pre-flight information

8.1.1 At any aerodrome normally used for international air operations, aeronautical information essential for the safety, regularity and efficiency of air navigation and relative to the route stages originating at the aerodrome shall be made available to flight operations personnel, including flight crews and services responsible for pre-flight information.

8.1.2 Aeronautical information provided for pre-flight planning purposes at the aerodromes referred to in 8.1.1 shall include relevant:

a) elements of the Integrated Aeronautical Information Package;

b) maps and charts.

Note.— The documentation listed in a) and b) may be limited to national publications and when practicable, those of immediately adjacent States, provided a complete library of aeronautical information is available at a central location and means of direct communications are available between the aerodrome AIS unit and that library.

8.1.2.1 Additional current information relating to the aerodrome of departure shall be provided concerning the following:

a) construction or maintenance work on or immediately adjacent to the manoeuvring area;

b) rough portions of any part of the manoeuvring area, whether marked or not, e.g. broken parts of the surface of runways and taxiways;

c) presence and depth of snow, ice or water on runways and taxiways, including their effect on surface friction;

d) snow drifted or piled on or adjacent to runways or taxiways;

e) parked aircraft or other objects on or immediately adjacent to taxiways;

f) presence of other temporary hazards including those created by birds;

g) failure or irregular operation of part or all of the aerodrome lighting system including approach, threshold, runway, taxiway, obstruction and manoeuvring area unserviceability lights and aerodrome power supply;

h) failure, irregular operation and changes in the operational status of ILS (including markers), SRE, PAR, DME, SSR, VOR, NDB, VHF aeromobile channels, RVR observing system, and secondary power supply.

8.1.3 A recapitulation of current NOTAM and other information of urgent character shall be made available to flight crews in the form of plain language pre-flight information bulletins (PIB).

Note.— Guidance on the preparation of PIB is contained in the Aeronautical Information Services Manual *(Doc 8126).*

8.2 Post-flight information

States shall ensure that arrangements are made to receive at aerodromes/heliports information concerning the state and operation of air navigation facilities noted by aircrews, and shall ensure that such information is made available to the aeronautical information service for such distribution as the circumstances necessitate.

CHAPTER 9. TELECOMMUNICATION REQUIREMENTS

9.1 International NOTAM offices shall be connected to the aeronautical fixed service (AFS).

9.1.1 The connexions shall provide for printed communications.

9.2 Each international NOTAM office shall be connected, through the aeronautical fixed service (AFS), to the following points within the territory for which it provides service:

a) area control centres and flight information centres;

b) aerodromes/heliports at which an information service is established in accordance with Chapter 8.

APPENDIX 1. CONTENTS OF AERONAUTICAL INFORMATION PUBLICATION (AIP)

(see Chapter 4)

Note.— The contents of this Appendix become applicable as of 25 April 1996 (see Chapter 4, 4.1.1).

PART 1 — GENERAL (GEN)

If an AIP is produced and made available in more than one volume with each having a separate amendment and supplement service, a separate preface, record of AIP Amendments, record of AIP Supplements, checklist of AIP pages and list of current hand amendments must be included in each volume.

GEN 0.1 Preface

Brief description of the Aeronautical Information Publication (AIP), including:

1) name of the publishing authority;

2) applicable ICAO documents;

3) the AIP structure and established regular amendment interval; and

4) service to contact in case of detected AIP errors or omissions.

GEN 0.2 Record of AIP Amendments

A record of AIP Amendments and AIRAC AIP Amendments (published in accordance with the AIRAC system) containing:

1) amendment number;

2) publication date;

3) date inserted (for the AIRAC AIP Amendments, effective date); and

4) initials of officer who inserted the amendment.

GEN 0.3 Record of AIP Supplements

A record of issued AIP Supplements containing:

1) Supplement number;

2) Supplement subject;

3) AIP section(s) affected;

4) period of validity; and

5) cancellation record.

GEN 0.4 Checklist of AIP pages

A checklist of AIP pages containing:

1) page number/chart title; and

2) publication or effective date (day, month by name and year) of the aeronautical information.

GEN 0.5 List of hand amendments to the AIP

A list of current hand amendments to the AIP containing:

1) AIP page(s) affected;

2) amendment text; and

3) AIP Amendment number by which a hand amendment was introduced.

GEN 0.6 Table of contents to Part 1

A list of sections and subsections contained in Part 1 — General (GEN).

Note.— Subsections may be listed alphabetically.

GEN 1. NATIONAL REGULATIONS AND REQUIREMENTS

GEN 1.1 Designated authorities

The addresses of designated authorities concerned with the facilitation of international air navigation (civil aviation, meteorology, customs, immigration, health, en-route and aerodrome/heliport charges, agricultural quarantine and aircraft accidents investigation) containing, for each authority:

1) designated authority;

2) name of the authority;

3) postal address;

4) telephone number;

5) telefax number;

6) telex number; and

7) aeronautical fixed service (AFS) address.

GEN 1.2 Entry, transit and departure of aircraft

Regulations and requirements for advance notification and applications for permission concerning entry, transit and departure of aircraft on international flights.

GEN 1.3 Entry, transit and departure of passengers and crew

Regulations (including customs, immigration and quarantine, and requirements for advance notification and applications for permission) concerning entry, transit and departure of non-immigrant passengers and crew.

GEN 1.4 Entry, transit and departure of cargo

Regulations (including customs, and requirements for advance notification and applications for permission) concerning entry, transit and departure of cargo.

Note.— Provisions for facilitating entry and departure for search, rescue, salvage, investigation, repair or salvage in connexion with lost or damaged aircraft are detailed in section GEN 3.6, Search and rescue.

GEN 1.5 Aircraft instruments, equipment and flight documents

Brief description of aircraft instruments, equipment and flight documents, including:

1) instruments, equipment (including aircraft communication and navigation equipment) and flight documents to be carried on aircraft, including any special requirement in addition to the provisions specified in Annex 6, Part I, Chapters 6 and 7; and

2) emergency locator transmitter (ELT), signalling devices and life-saving equipment as presented in Annex 6, Part I, 6.6 and Part II, 6.4 where so determined by regional air navigation meetings, for flights over designated land areas.

GEN 1.6 Summary of national regulations and international agreements/conventions

A list of titles and references and, where applicable, summaries of national regulations affecting air navigation, together with a list of international agreements/conventions ratified by State.

GEN 1.7 Differences from ICAO Standards, Recommended Practices and Procedures

A list of significant differences between national regulations and practices of the State and related ICAO provisions, including:

1) provision affected (Annex and edition number, paragraph); and

2) difference in full text.

All significant differences must be listed under this subsection. All Annexes must be listed in a numerical order even if there is no difference to an Annex, in which case a NIL notification must be provided. National differences or the degree of non-application of the regional supplementary procedures (SUPPS) must be notified immediately following the Annex to which the supplementary procedure relates.

GEN 2. TABLES AND CODES

GEN 2.1 Measuring system, aircraft markings, holidays

GEN 2.1.1 Units of measurement

Description of units of measurement used including table of units of measurement.

GEN 2.1.2 Time system

Description of time system employed, together with an indication of whether or not daylight saving hours are employed and how the time system is presented throughout the AIP.

GEN 2.1.3 Geodetic reference datum

Brief description of geodetic datum used, including:

1) name/designation of datum(s);

2) area(s) of application; and

3) explanation, if applicable, of asterisk used to identify those coordinates which do not meet Annexes 4 and 15 requirements.

GEN 2.1.4 Aircraft nationality and registration marks

Indication of aircraft nationality and registration marks adopted by the State.

GEN 2.1.5 Public holidays

A list of public holidays with indication of services being affected.

GEN 2.2 Abbreviations used in AIS publications

A list of alphabetically arranged abbreviations and their respective significations used by the State in its Aeronautical Information Publication and in the dissemination of aeronautical information with appropriate annotation for those national abbreviations which are different from *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC, Doc 8400).

Note.— A list of alphabetically arranged definitions/glossary of terms may also be added.

GEN 2.3 Chart symbols

A list of chart symbols arranged according to the chart series where symbols are applied.

GEN 2.4 Location indicators

A list of alphabetically arranged location indicators assigned to the locations of aeronautical fixed stations to be used for encoding and decoding purposes. An annotation to locations not connected to the Aeronautical Fixed Service (AFS) must be provided.

GEN 2.5 List of radio navigation aids

A list of radio navigation aids arranged alphabetically, containing:

1) identifier;

2) name of the station;

3) type of facility/aid; and

4) indication whether aid serves en-route (E), aerodrome (A) or dual (AE) purposes.

GEN 2.6 Conversion tables

Tables for conversion between:

1) nautical miles and kilometres and vice versa;

2) feet and metres and vice versa;

3) decimal minutes of arc and seconds of arc and vice versa; and

4) other conversion tables, as appropriate.

GEN 2.7 Sunrise/sunset tables

Brief description of criteria used for determination of the times given in the sunrise/sunset tables, together with an alphabetical list of locations for which the times are given with a reference to the related page in the table and the sunrise/sunset tables for the selected stations/locations, including:

1) station name;

2) ICAO location indicator;

3) geographical coordinates in degrees and minutes;

4) date(s) for which times are given;

5) time for the beginning of morning civil twilight;

6) time for sunrise;

7) time for sunset; and

8) time for the end of evening civil twilight.

GEN 3. SERVICES

GEN 3.1 Aeronautical information services

GEN 3.1.1 Responsible service

Description of the Aeronautical Information Service (AIS) provided and its major components, including:

1) service/unit name;

2) postal address;

3) telephone number;

4) telefax number;

5) telex number;

6) AFS address;

7) a statement concerning the ICAO documents on which the service is based and a reference to the AIP location where differences, if any, are listed; and

8) an indication if service is not H24.

GEN 3.1.2 Area of responsibility

The area of responsibility for the aeronautical information service.

GEN 3.1.3 Aeronautical publications

Description of the elements of the Integrated Aeronautical Information Package, including:

1) AIP and related amendment service;

2) AIP Supplements;

3) AIC;

4) NOTAM and pre-flight information bulletins (PIB);

5) checklists and summaries; and

6) how they may be obtained.

When an AIC is used to promulgate publication prices, that must be indicated in this section of the AIP.

GEN 3.1.4 AIRAC system

Brief description of the AIRAC system provided including a table of present and near future AIRAC dates.

GEN 3.1.5 Pre-flight information service at aerodromes/heliports

A list of aerodromes/heliports at which pre-flight information is routinely available, including an indication of relevant:

1) elements of the Integrated Aeronautical Information Packages held;

2) maps and charts held; and

3) general area of coverage of such data.

GEN 3.2 Aeronautical charts

GEN 3.2.1 Responsible service(s)

Description of service(s) responsible for the production of aeronautical charts, including:

1) service name;

2) postal address;

3) telephone number;

4) telefax number;

5) telex number;

6) AFS address;

7) a statement concerning the ICAO documents on which the service is based and a reference to the AIP location where differences, if any, are listed; and

8) an indication if service is not H24.

GEN 3.2.2 Maintenance of charts

Brief description of how aeronautical charts are revised and amended.

GEN 3.2.3 Purchase arrangements

Details of how charts may be obtained, containing:

1) service/sales agency(ies);

2) postal address;

3) telephone number;

4) telefax number;

5) telex number; and

6) AFS address.

GEN 3.2.4 Aeronautical chart series available

A list of aeronautical chart series available followed by a general description of each series and an indication of the intended use.

GEN 3.2.5 List of aeronautical charts available

A list of aeronautical charts available, including:

1) title of series;

2) scale of series;

3) name and/or number of each chart or each sheet in a series;

4) price per sheet; and

5) date of latest revision.

GEN 3.2.6 Index to the World Aeronautical Chart (WAC) — ICAO 1:1 000 000

An index chart showing coverage and sheet layout for the WAC 1:1 000 000 produced by a State. If Aeronautical Chart — ICAO 1:500 000 is produced instead of WAC 1:1 000 000, index charts must be used to indicate coverage and sheet layout for the Aeronautical Chart — ICAO 1:500 000.

GEN 3.2.7 Topographical charts

Details of how topographical charts may be obtained, containing:

1) name of service/agency(ies);

2) postal address;

3) telephone number;

4) telefax number;

5) telex number; and

6) AFS address.

GEN 3.2.8 Corrections to charts not contained in the AIP

A list of corrections to aeronautical charts not contained in the AIP, or an indication where such information can be obtained.

GEN 3.3 Air traffic services

GEN 3.3.1 Responsible service

Description of the air traffic service and its major components, including:

1) service name;

2) postal address;

3) telephone number;

4) telefax number;

5) telex number;

6) AFS address;

7) a statement concerning the ICAO documents on which the service is based and a reference to the AIP location where differences, if any, are listed; and

8) an indication if service is not H24.

GEN 3.3.2 Area of responsibility

Brief description of area of responsibility for which air traffic services are provided.

GEN 3.3.3 Types of services

Brief description of main types of air traffic services provided.

GEN 3.3.4 Co-ordination between the operator and ATS

General conditions under which co-ordination between the operator and air traffic services is effected.

GEN 3.3.5 Minimum flight altitude

The criteria used to determine minimum flight altitudes.

GEN 3.3.6 ATS units address list

A list of ATS units and their addresses arranged alphabetically, containing:

1) unit name;

2) postal address;

3) telephone number;

4) telefax number;

5) telex number; and

6) AFS address.

GEN 3.4 Communication services

GEN 3.4.1 Responsible service

Description of the service responsible for the provision of telecommunication and navigation facilities, including:

1) service name;

2) postal address;

3) telephone number;

4) telefax number;

5) telex number;

6) AFS address;

7) a statement concerning the ICAO documents on which the service is based and a reference to the AIP location where differences, if any, are listed; and

8) an indication if service is not H24.

GEN 3.4.2 Area of responsibility

Brief description of area of responsibility for which telecommunication service is provided.

GEN 3.4.3 Types of service

Brief description of the main types of service and facilities provided, including:

1) radio navigation services;

2) mobile service;

3) broadcasting service;

4) language(s) used; and

5) an indication of where detailed information can be obtained.

GEN 3.4.4 Requirements and conditions

Brief description concerning the requirements and conditions under which the communication service is available.

GEN 3.5 Meteorological services

GEN 3.5.1 Responsible service

Brief description of the meteorological service responsible for the provision of meteorological information, including:

1) service name;

2) postal address;

3) telephone number;

4) telefax number;

5) telex number;

6) AFS address;

7) a statement concerning the ICAO documents on which the service is based and a reference to the AIP location where differences, if any, are listed; and

8) an indication if service is not H24.

GEN 3.5.2 Area of responsibility

Brief description of area and/or air routes for which meteorological service is provided.

GEN 3.5.3 Meteorological observations and reports

Detailed description of the meteorological observations and reports provided for international air navigation, including:

1) name of the station and the ICAO location indicator;

2) type and frequency of observation including an indication of automatic observing equipment;

3) types of meteorological reports (e.g. METAR) and details of any supplementary information included (e.g. trend type of landing forecast);

4) specific type of observation system and number of observation sites used to observe and report surface wind, visibility, runway visual range, cloud base, temperature and, where applicable, wind shear (e.g. anemometer at intersection of runways, transmissometer next to touchdown points and intersection, etc.);

5) hours of operation; and

6) indication of aeronautical climatological information available.

GEN 3.5.4 Types of services

Brief description of the main types of service provided, including details of briefing, consultation, display of meteorological information, flight documentation available for operators and flight crew members, and of the methods and means used for supplying the meteorological information.

GEN 3.5.5 Notification required from operators

Minimum amount of advance notice required by the meteorological authority from operators in respect of briefing, consultation and flight documentation and other meteorological information they require or change.

GEN 3.5.6 Aircraft reports

As necessary, requirements of the meteorological authority for the making and transmission of aircraft reports.

GEN 3.5.7 VOLMET service

Description of VOLMET service, including:

1) name of transmitting station;

2) call sign or identification and emission;

3) frequency or frequencies used for broadcast;

4) broadcasting period;

5) hours of service;

6) list of aerodromes/heliports for which reports and/or forecasts are included; and

7) contents and format of the reports and forecasts included and remarks.

GEN 3.5.8 SIGMET service

Description of the meteorological watch provided within flight information regions or control areas for which air traffic services are provided, including a list of the meteorological watch offices with:

1) name of the meteorological watch office, ICAO location indicator;

2) hours of service;

3) flight information region(s) or control area(s) served;

4) types of SIGMET information issued (SIGMET, SST SIGMET) and validity periods;

5) specific procedures applied to SIGMET information (e.g. for volcanic ash, tropical cyclones);

6) the air traffic services unit(s) provided with SIGMET information; and

7) additional information (e.g. concerning any limitation of service, etc.).

GEN 3.5.9 Other automated meteorological services

Description of available automated services for the provision of meteorological information (e.g. automated pre-flight information service accessible by telephone and/or computer modem) including:

1) service name;

2) information available;

3) areas, routes and aerodromes covered; and

4) telephone, telex and fax number(s).

GEN 3.6 Search and rescue

GEN 3.6.1 Responsible service(s)

Brief description of service(s) responsible for the provision of search and rescue (SAR), including:

1) service/unit name;

2) postal address;

3) telephone number;

4) telefax number;

5) telex number;

6) AFS address; and

7) a statement concerning the ICAO documents on which the service is based and a reference to the AIP location where differences, if any, are listed.

GEN 3.6.2 Area of responsibility

Brief description of area of responsibility within which search and rescue services are provided.

GEN 3.6.3 Types of service

Brief description and geographical portrayal, where appropriate, of the type of service and facilities provided including indications where SAR aerial coverage is dependent upon significant deployment of aircraft.

GEN 3.6.4 SAR agreements

Brief description of SAR agreements in force, including provisions for facilitating entry and departure of other States' aircraft for search, rescue, salvage, repair or salvage in connexion with lost or damaged aircraft, either with airborne notification only or after flight plan notification.

GEN 3.6.5 Conditions of availability

Brief description of provisions for search and rescue, including the general conditions under which the service and facilities are available for international use, including an indication of whether a facility available for search and rescue is specialized in SAR techniques and functions, or is specially used for other purposes but adapted for SAR purposes by training and equipment, or is only occasionally available and has no particular training or preparation for SAR work.

GEN 3.6.6 Procedures and signals used

Brief description of the procedures and signals employed by rescue aircraft and a table showing the signals to be used by survivors.

GEN 4. CHARGES FOR AERODROMES/HELIPORTS AND AIR NAVIGATION SERVICES

Reference may be made to where details of actual charges may be found, if not itemized in this chapter.

GEN 4.1 Aerodrome/heliport charges

Brief description of type of charges which may be applicable at aerodromes/heliports available for international use, including:

1) landing of aircraft;

2) parking, hangarage and long-term storage of aircraft;

3) passenger service;

4) security;

5) noise-related items;

6) other (customs, health, immigration, etc.);

7) exemptions/reductions; and

8) methods of payment.

GEN 4.2 Air navigation services charges

Brief description of charges which may be applicable to air navigation services provided for international use, including:

1) approach control;

2) route air navigation services;

3) cost basis for air navigation services and exemptions/ reductions; and

4) methods of payment.

PART 2 — EN-ROUTE (ENR)

If an AIP is produced and made available in more than one volume with each having a separate amendment and supplement service, a separate preface, record of AIP Amendments, record of AIP Supplements, checklist of AIP pages and list of current hand amendments must be included in each volume. In the case of an AIP being published as one volume, the annotation "not applicable" must be entered against each of the above subsections.

Reference must be made in the appropriate subsection to indicate that differences between national regulations and ICAO SARPs and procedures exist and that they are detailed in GEN 1.7.

ENR 0.6 Table of contents to Part 2

A list of sections and subsections contained in Part 2 — En-route.

Note.— Subsections may be listed alphabetically.

ENR 1. GENERAL RULES AND PROCEDURES

ENR 1.1 General rules

The requirement is for publication of the general rules as applied within the State.

ENR 1.2 Visual flight rules

The requirement is for publication of the visual flight rules as applied within the State.

ENR 1.3 Instrument flight rules

The requirement is for publication of the instrument flight rules as applied within the State.

ENR 1.4 ATS airspace classification

The description of ATS airspace classes in the form of the ATS airspace classification table in Annex 11, Appendix 4, appropriately annotated to indicate those airspace classes not used by the State.

ENR 1.5 Holding, approach and departure procedures

ENR 1.5.1 General

The requirement is for a statement concerning the criteria on which holding, approach and departure procedures are established. If different from ICAO provisions, the requirement is for presentation of criteria used in a tabular form.

ENR 1.5.2 Arriving flights

The requirement is to present procedures (conventional or area navigation or both) for arriving flights which are common to flights into or within the same type of airspace. If different procedures apply within a terminal airspace, a note to this effect must be given together with a reference to where the specific procedures can be found.

ENR 1.5.3 Departing flights

The requirement is to present procedures (conventional or area navigation or both) for departing flights which are common to flights departing from any aerodrome/heliport.

ENR 1.6 Radar services and procedures

ENR 1.6.1 Primary radar

Description of primary radar services and procedures, including:

1) supplementary services;

2) the application of radar control service;

3) radar and radio failure procedures; and

4) graphic portrayal of area of radar coverage.

ENR 1.6.2 Secondary surveillance radar (SSR)

Description of secondary surveillance radar (SSR) operating procedures, including:

1) emergency procedures;

2) radio communication failure and unlawful interference procedures;

3) the system of SSR code assignment; and

4) graphic portrayal of area of SSR coverage.

Note.— The SSR description is of particular importance in area or routes where the possibility of interception exists.

ENR 1.7 Altimeter setting procedures

The requirement is for a statement of altimeter setting procedures in use, containing:

1) brief introduction with a statement concerning the ICAO documents on which the procedures are based together with differences to ICAO provisions, if any;

2) basic altimeter setting procedures;

3) description of altimeter setting region(s);

4) procedures applicable to operators (including pilots); and

5) table of cruising levels.

ENR 1.8 Regional supplementary procedures

The requirement is for presentation of regional supplementary procedures (SUPPS) affecting the entire area of responsibility, with properly annotated national differences, if any.

ENR 1.9 Air traffic flow management

Brief description of air traffic flow management (ATFM) system, including:

1) ATFM structure, service area, service provided, location of unit(s) and hours of operation;

2) types of flow messages and descriptions of the formats; and

3) procedures applicable for departing flights, containing:

a) service responsible for provision of information on applied ATFM measures;

b) flight plan requirements; and

c) slot allocations.

ENR 1.10 Flight planning

The requirement is to indicate any restriction, limitation or advisory information related to the flight planning stage which may assist the user in the presentation of the intended flight operation, including:

1) procedures for the submission of a flight plan;

2) repetitive flight plan system; and

3) changes to the submitted flight plan.

ENR 1.11 Addressing of flight plan messages

The requirement is for an indication, in tabular form, of the addresses allocated to flight plans, showing:

1) category of flight (IFR, VFR or both);

2) route (into or via FIR and/or TMA); and

3) message address.

ENR 1.12 Interception of civil aircraft

The requirement is for a complete statement of interception procedures and visual signals to be used with a clear indication of whether ICAO provisions are applied and if not, a complete presentation of differences.

ENR 1.13 Unlawful interference

The requirement is for presentation of appropriate procedures to be applied in case of unlawful interference.

ENR 1.14 Air traffic incidents

Description of air traffic incidents reporting system, including:

1) definition of air traffic incidents;

2) use of the "Air Traffic Incident Reporting Form";

3) reporting procedures (including in-flight procedure); and

4) purpose of reporting and handling of the form.

ENR 2. AIR TRAFFIC SERVICES AIRSPACE

ENR 2.1 FIR, UIR, TMA

Detailed description of flight information regions (FIR), upper flight information regions (UIR), and terminal control areas (TMA), including:

1) name, geographical coordinates in degrees and minutes of the FIR/UIR lateral limits and in degrees, minutes and seconds of the TMA lateral limits, vertical limits and class of airspace;

2) identification of unit providing the service;

3) call sign of aeronautical station serving the unit and language(s) used, specifying the area and conditions, when and where to be used, if applicable;

4) frequencies supplemented by indications for specific purposes; and

5) remarks.

Control zones around military air bases not otherwise described in the AIP must be included in this subsection. Where the requirements of Annex 2 concerning flight plans, two-way communications and position reporting apply to all flights in order to eliminate or reduce the need for interceptions and/or where the possibility of interception exists and the maintenance of guard on the VHF emergency channel 121.5 MHZ is required, a statement to this effect must be included for the relevant area(s) or portion(s) thereof.

A description of designated areas over which the carriage of an emergency locator transmitter (ELT) is required and where aircraft shall continuously guard the VHF emergency frequency 121.5 Mhz, except for those periods when aircraft are carrying out communications on other VHF channels or when airborne equipment limitations or cockpit duties do not permit simultaneous guarding of two channels.

Note.— Other types of airspace around civil aerodromes/heliports such as control zones and aerodrome traffic zones are described in the relevant aerodrome or heliport section.

ENR 2.2 Other regulated airspace

Where established, a detailed description of other types of the regulated airspace and airspace classification.

ENR 3. ATS ROUTES

Note 1.— Bearings, tracks and radials are normally magnetic. In areas of high latitude, where it is determined by the appropriate authority that reference to Magnetic North is impractical, another suitable reference, i.e. True North or Grid North, may be used.

Note 2.— Change-over points established at the midpoint between two radio navigation aids, or at the intersection of the two radials in the case of a route which changes direction between the navigation aids, need not be shown for each route segment if a general statement regarding their existence is made.

ENR 3.1 Lower ATS routes

Detailed description of lower ATS routes, including:

1) route designator, required navigation performance (RNP) type(s) applicable to a specified segment(s), names, coded designators or name-codes and the geographical coordinates in degrees, minutes and seconds of all significant points defining the route including "compulsory" or "on-request" reporting points;

2) tracks or VOR radials, distance between each successive designated significant point and, in the case of VOR radials, change-over points;

3) upper and lower limits/minimum flight altitudes and airspace classification;

4) lateral limits;

5) direction of cruising levels; and

6) remarks, including an indication of the controlling unit and its operating frequency.

Note.— In relation to Annex 11, Appendix 1, and for flight planning purposes, the specified RNP type is not considered to be an integral part of the route designator.

ENR 3.2 Upper ATS routes

Detailed description of upper ATS routes, including:

1) route designator, required navigation performance (RNP) type(s) applicable to a specified segment(s), names, coded designators or name-codes and the geographical coordinates in degrees, minutes and seconds of all significant points defining the route including "compulsory" or "on-request" reporting points;

2) tracks or VOR radials, distance between each successive designated significant point and, in the case of VOR radials, change-over points;

3) upper and lower limits and airspace classification;

4) lateral limits;

5) direction of cruising levels; and

6) remarks, including an indication of the controlling unit and its operating frequency.

Note.— In relation to Annex 11, Appendix 1, and for flight planning purposes, the specified RNP type is not considered to be an integral part of the route designator.

ENR 3.3 Area navigation routes

Detailed description of area navigation (RNAV) routes, including:

1) route designator, required navigation performance (RNP) type(s) applicable to a specified segment(s), names, coded designators or name-codes and the geographical coordinates in degrees, minutes and seconds of all significant points defining the route including "compulsory" or "on-request" reporting points;

2) in respect of way-points defining a VOR/DME area navigation route, additionally:

   a) station identification of the reference VOR/DME;

   b) bearing to the nearest tenth of a degree and the distance to the nearest tenth of a nautical mile from the reference VOR/DME, if the way-point is not collocated with it; and

   c) elevation of the transmitting antenna of DME to the nearest 30 m (100 ft);

3) great circle distance between defined end points and distance between each successive designated significant point;

4) upper and lower limits and airspace classification;

5) direction of cruising levels; and

6) remarks, including an indication of the controlling unit and its operating frequency.

Note.— In relation to Annex 11, Appendix 1, and for flight planning purposes, the specified RNP type is not considered to be an integral part of the route designator.

ENR 3.4 Helicopter routes

Detailed description of helicopter routes, including:

1) route designator, required navigation performance (RNP) type(s) applicable to a specified segment(s), names, coded designators or name-codes and the geographical coordinates in degrees, minutes and seconds of all significant points defining the route including "compulsory" or "on-request" reporting points;

2) tracks or VOR radials, distance between each successive designated significant point and, in the case of VOR radials, change-over points;

3) upper and lower limits and airspace classification;

4) minimum flight altitudes; and

5) remarks, including an indication of the controlling unit and its operating frequency.

Note.— In relation to Annex 11, Appendix 1, and for flight planning purposes, the specified RNP type is not considered to be an integral part of the route designator.

ENR 3.5 Other routes

The requirement is to describe other specifically designated routes which are compulsory within specified area(s).

Note.— Arrival, transit and departure routes which are specified in connexion with procedures for traffic to and from aerodromes/heliports need not be described since they are described in the relevant section of Part 3 — Aerodromes.

ENR 3.6 En-route holding

The requirement is for a detailed description of en-route holding procedures, containing:

1) holding identification (if any) and holding fix (navigation aid) or way-point with geographical coordinates in degrees, minutes and seconds;

2) inbound track;

3) direction of the procedure turn;

4) maximum indicated air speed;

5) minimum and maximum holding level;

6) time/distance outbound; and

7) indication of the controlling unit and its operating frequency.

Note.— Obstacle clearance criteria related to holding procedures are contained in Procedures for Air Navigation Services, Aircraft Operations *(PANS-OPS, Doc 8168), Volumes I and II.*

ENR 4. RADIO NAVIGATION AIDS/SYSTEMS

ENR 4.1 Radio navigation aids — en-route

A list of stations providing radio navigation services established for en-route purposes and arranged alphabetically by name of the station, including:

1) name of the station and for VOR, magnetic variation used for technical line-up of the aid;

2) identification;

3) frequency/channel for each element;

4) hours of operation;

5) geographical coordinates in degrees, minutes and seconds of the site of the transmitting antenna;

6) elevation of the transmitting antenna of DME to the nearest 30 m (100 ft); and

7) remarks.

If the operating authority of the facility is other than the designated governmental agency, the name of the operating authority must be indicated in the remarks column. Facility coverage must be indicated in the remarks column.

ENR 4.2 Special navigation systems

Description of stations associated with special navigation systems (DECCA, LORAN, etc.), including:

1) name of station or chain;

2) type of service available (master signal, slave signal, colour);

3) frequency (channel number, basic pulse rate, recurrence rate, as applicable);

4) hours of operation;

5) geographical coordinates in degrees, minutes and seconds of the site of the transmitting station; and

6) remarks.

If the operating authority of the facility is other than the designated governmental agency, the name of the operating authority must be indicated in the remarks column. Facility coverage must be indicated in the remarks column.

ENR 4.3 Name-code designators for significant points

An alphabetically arranged list of name-code designators (five-letter pronounceable "name-code") established for significant points at positions not marked by the site of radio navigation aids, including:

1) name-code designator;

2) geographical coordinates in degrees, minutes and seconds of the position; and

3) reference to ATS or other routes where the point is located.

ENR 4.4 Aeronautical ground lights — en-route

A list of aeronautical ground lights and other light beacons designating geographical locations which are selected by the State as being significant, including:

1) name of the city or town or other identification of the beacon;

2) type of beacon and intensity of the light in thousands of candelas;

3) characteristics of the signal;

4) operational hours; and

5) remarks.

ENR 5. NAVIGATION WARNINGS

ENR 5.1 Prohibited, restricted and danger areas

Description, supplemented by graphic portrayal where appropriate, of prohibited, restricted and danger areas together with information regarding their establishment and activation, including:

1) identification, name and geographical coordinates of the lateral limits in degrees, minutes and seconds if inside and in degrees and minutes if outside control area/control zone boundaries;

2) upper and lower limits; and

3) remarks, including time of activity.

Type of restriction or nature of hazard and risk of interception in the event of penetration must be indicated in the remarks column.

ENR 5.2 Military exercise and training areas

Description, supplemented by graphic portrayal where appropriate, of established military training areas and military exercises taking place at regular intervals, including:

1) geographical coordinates of the lateral limits in degrees, minutes and seconds if inside and in degrees and minutes if outside control area/control zone boundaries;

2) system and means of activation announcements together with information pertinent to civil flights; and

3) remarks, including time of activity.

ENR 5.3 Other activities of a dangerous nature

Description, supplemented by charts where appropriate, of activities that could affect flights (e.g. active volcanoes, etc.), including:

1) geographical coordinates in degrees and minutes of centre of area and range of influence;

2) vertical limits;

3) advisory measures;

4) authority responsible for the provision of information; and

5) remarks, including time of activity.

ENR 5.4 Air navigation obstacles — en-route

Brief description of the criteria used for the determination of air navigation obstacles, supplemented by a list of significant en-route obstacles affecting air navigation, including:

1) designation;

2) type of obstacle;

3) geographical coordinates in degrees, minutes and seconds;

4) elevation and height; and

5) type and colour of obstacle lighting (if any).

ENR 5.5 Aerial sporting and recreational activities

Brief description, supplemented by graphic portrayal where appropriate, of intensive aerial sporting and recreational activities together with conditions under which they are carried out, including:

1) designation and geographical coordinates of the lateral limits in degrees, minutes and seconds if inside and in degrees and minutes if outside control area/control zone boundaries;

2) vertical limits;

3) operator/user telephone number; and

4) remarks, including time of activity.

Note.— This paragraph may be subdivided into different sections for each different category of activity, giving the indicated details in each case.

ENR 5.6 Bird migration and areas with sensitive fauna

Description, supplemented by charts where practicable, of movements of birds associated with migration, including migration routes and permanent resting areas and areas with sensitive fauna.

ENR 6. EN-ROUTE CHARTS

The requirement is for the En-route Chart — ICAO and index charts to be included in this section.

PART 3 — AERODROMES (AD)

If an AIP is produced and made available in more than one volume with each having a separate amendment and supplement service, a separate preface, record of AIP Amendments, record of AIP Supplements, checklist of AIP pages and list of current hand amendments must be included in each volume. In the case of an AIP being published as one volume, the annotation "not applicable" must be entered against each of the above subsections.

AD 0.6 Table of contents to Part 3

A list of sections and subsections contained in Part 3 — Aerodromes (AD).

Note.— Subsections may be listed alphabetically.

AD 1. AERODROMES/HELIPORTS — INTRODUCTION

AD 1.1 Aerodrome/heliport availability

Brief description of the State's designated authority responsible for aerodromes and heliports, including:

1) the general conditions under which aerodromes/heliports and associated facilities are available for use;

2) a statement concerning the ICAO documents on which the services are based and a reference to the AIP location where differences, if any, are listed;

3) regulations, if any, concerning civil use of military air bases;

4) the general conditions under which the low visibility procedures applicable to CAT II/III operations at aerodromes, if any, are applied;

5) friction measuring device used and the runway friction level below which the State will declare the runway to be slippery when wet; and

6) other information of a similar nature.

AD 1.2 Rescue and fire fighting services and snow plan

AD 1.2.1 Rescue and fire fighting services

Brief description of rules governing the establishment of rescue and fire fighting services at aerodromes and heliports available for public use together with an indication of rescue and fire fighting categories established by a State.

AD 1.2.2 Snow plan

Brief description of general snow plan considerations for aerodromes/heliports available for public use at which snow conditions are normally liable to occur, including:

1) organization of the winter service;

2) surveillance of movement areas;

3) measuring methods and measurements taken;

4) actions taken to maintain the usability of movement areas;

5) system and means of reporting;

6) the cases of runway closure; and

7) dissemination of information about snow conditions.

Note.— Where different snow plan considerations apply at aerodromes/heliports, this subparagraph may be subdivided accordingly.

AD 1.3 Index to aerodromes and heliports

A list, supplemented by graphic portrayal, of aerodromes and heliports within a State, including:

1) aerodrome/heliport name and ICAO location indicator;

2) type of traffic permitted to use the aerodrome/heliport (international/national, IFR/VFR, scheduled/non-scheduled, private); and

3) reference to AIP, Part 3 subsection in which aerodrome/heliport details are presented.

AD 1.4 Grouping of aerodromes/heliports

Brief description of the criteria applied by the State in grouping aerodromes/heliports for the production/distribution/provision of information purposes (e.g. international/national; primary/secondary; major/other; civil/military; etc.).

AD 2. AERODROMES

Note.— **** is to be replaced by the relevant ICAO location indicator.

**** AD 2.1 Aerodrome location indicator and name

The requirement is for the ICAO location indicator allocated to the aerodrome and the name of aerodrome. An ICAO location indicator must be an integral part of the referencing system applicable to all subsections in section AD 2.

****** AD 2.2 Aerodrome geographical and administrative data**

The requirement is for aerodrome geographical and administrative data, including:

1) aerodrome reference point (geographical coordinates in degrees, minutes and seconds) and its site;

2) direction and distance of aerodrome reference point from centre of the city or town which the aerodrome serves;

3) aerodrome elevation and reference temperature;

4) magnetic variation to the nearest degree, date of information and annual change;

5) name of aerodrome administration, address, telephone, telefax and telex numbers and AFS address;

6) types of traffic permitted to use the aerodrome (IFR/VFR); and

7) remarks.

****** AD 2.3 Operational hours**

Detailed description of the hours of operation of services at the aerodrome, including:

1) aerodrome administration;

2) customs and immigration;

3) health and sanitation;

4) AIS briefing office;

5) ATS reporting office (ARO);

6) MET briefing office;

7) air traffic service;

8) fuelling;

9) handling;

10) security;

11) de-icing; and

12) remarks.

****** AD 2.4 Handling services and facilities**

Detailed description of the handling services and facilities available at the aerodrome, including:

1) cargo-handling facilities;

2) fuel and oil types;

3) fuelling facilities and capacity;

4) de-icing facilities;

5) hangar space for visiting aircraft;

6) repair facilities for visiting aircraft; and

7) remarks.

****** AD 2.5 Passenger facilities**

Brief description of passenger facilities available at the aerodrome, including:

1) *hotel(s) at or in the vicinity of aerodrome;*

2) *restaurant(s) at or in the vicinity of aerodrome;*

3) *transportation possibilities;*

4) medical facilities;

5) *bank and post office at or in the vicinity of aerodrome;*

6) *tourist office;* and

7) remarks.

****** AD 2.6 Rescue and fire fighting services**

Detailed description of the rescue and fire fighting services and equipment available at the aerodrome, including:

1) aerodrome category for fire fighting;

2) rescue equipment;

3) *capability for removal of disabled aircraft;* and

4) remarks.

****** AD 2.7 Seasonal availability — clearing**

Detailed description of the equipment and operational priorities established for the clearance of aerodrome movement areas, including:

1) type(s) of clearing equipment;

2) clearance priorities; and

3) remarks.

****** AD 2.8 Aprons, taxiways and check locations data**

Details related to the physical characteristics of aprons, taxiways and positions of designated checkpoints, including:

1) surface and strength of aprons;

2) width, surface and strength of taxiways;

3) location and elevation of altimeter check locations;

4) location of VOR and INS checkpoints; and

5) remarks.

If check locations are presented on an aerodrome chart, a note to that effect must be provided under this subsection.

****** AD 2.9 Surface movement guidance and control system and markings**

Brief description of the surface movement guidance and control system and runway and taxiway markings, including:

1) use of aircraft stand identification signs, taxiway guide lines and visual docking/parking guidance system at aircraft stands;

2) runway and taxiway markings and lights;

3) stop bars (if any); and

4) remarks.

****** AD 2.10 Aerodrome obstacles**

Detailed description of significant obstacles, including:

1) obstacles in the approach and take-off areas, including:

a) runway designation and area affected;

b) type of obstacle, elevation, marking and lighting (if any);

c) geographical coordinates in degrees, minutes, seconds and tenths of seconds; and

d) NIL indication, if appropriate;

2) obstacles in the circling area and at the aerodrome, including:

a) type of obstacle, elevation, marking and lighting (if any);

b) geographical coordinates in degrees, minutes, seconds and tenths of seconds; and

c) NIL indication, if appropriate.

Note.— Annex 4, 3.2.2 and 5.2.1 b) specify that an indication be given where no significant obstacles exist in the take-off flight path area, circling area and at the aerodrome.

****** AD 2.11 Meteorological information provided**

Detailed description of meteorological information provided at the aerodrome and an indication of which meteorological office is responsible for the service enumerated, including:

1) name of the associated meteorological office;

2) hours of service and, where applicable, the designation of the responsible meteorological office outside these hours;

3) office responsible for preparation of TAFs and periods of validity and interval of issuance of the forecasts;

4) type of landing forecasts available for the aerodrome and interval of issuance;

5) information on how briefing and/or consultation is provided;

6) types of flight documentation supplied and language(s) used in flight documentation;

7) charts and other information displayed or available for briefing or consultation;

8) supplementary equipment (e.g. weather radar) available for providing information on meteorological conditions;

9) the air traffic services unit(s) provided with meteorological information; and

10) additional information (e.g. concerning any limitation of service, etc.).

****** AD 2.12 Runway physical characteristics**

Detailed description of runway physical characteristics, for each runway, including:

1) designations;

2) true and magnetic bearings;

3) dimensions of runways;

4) strength of pavement (PCN and associated data) and surface of each runway and associated stopways;

5) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for each threshold;

6) elevations of thresholds and the highest elevation of the touchdown zone of a precision approach runway;

7) slope of each runway and associated stopways;

8) dimensions of stopway (if any);

9) dimensions of clearway (if any);

10) dimensions of strips;

11) the existence of an obstacle-free zone; and

12) remarks.

****** AD 2.13 Declared distances**

Detailed description of declared distances for each direction of each runway, including:

1) runway designator;

2) take-off run available;

3) take-off distance available;

4) accelerate-stop distance available;

5) landing distance available; and

6) remarks.

If a runway direction cannot be used for take-off or landing, or both, because it is operationally forbidden, then this must be declared and the words "not usable" or the abbreviation "NU" entered. (Annex 14, Volume I, Attachment A, Section 3).

****** AD 2.14 Approach and runway lighting**

Detailed description of approach and runway lighting, including:

1) runway designator;

2) type, length and intensity of approach lighting system;

3) runway threshold lights, colour and wing bars;

4) type of visual approach slope indicator system;

5) length of runway touchdown zone lights;

6) length, spacing, colour and intensity of runway centre line lights;

7) length, spacing, colour and intensity of runway edge lights;

8) colour of runway end lights and wing bars;

9) length and colour of stopway lights; and

10) remarks.

****** AD 2.15 Other lighting, secondary power supply**

Description of other lighting and secondary power supply, including:

1) location, characteristics and hours of operation of aerodrome beacon/identification beacon (if any);

2) location and lighting (if any) of anemometer/landing direction indicator;

3) taxiway edge and taxiway centre line lights;

4) secondary power supply including switch-over time; and

5) remarks.

****** AD 2.16 Helicopter landing area**

Detailed description of helicopter landing area provided at the aerodrome, including:

1) geographical coordinates in degrees, minutes, seconds and hundredths of seconds of the geometric centre of touch-down and lift-off (TLOF) or of each threshold of final approach and take-off (FATO) area (where appropriate):

2) TLOF and/or FATO area elevation;

3) TLOF and FATO area dimensions, surface type, bearing strength and marking;

4) true and magnetic bearings of FATO;

5) declared distances available;

6) approach and FATO lighting; and

7) remarks.

****** AD 2.17 Air traffic services airspace**

Detailed description of air traffic services (ATS) airspace organized at the aerodrome, including:

1) airspace designation and geographical coordinates in degrees, minutes and seconds of the lateral limits;

2) vertical limits;

3) airspace classification;

4) call sign and language(s) of the ATS unit providing service;

5) transition altitude; and

6) remarks.

****** AD 2.18 Air traffic services communication facilities**

Detailed description of air traffic services communication facilities established at the aerodrome, including:

1) service designation;

2) call sign;

3) frequency(ies);

4) hours of operation; and

5) remarks.

****** AD 2.19 Radio navigation and landing aids**

Detailed description of radio navigation and landing aids associated with the instrument approach and the terminal area procedures at the aerodrome, including:

1) type of aids and category of ILS/MLS and for VOR/ILS/MLS also magnetic variation used for technical line-up of the aid;

2) identification;

3) frequency(ies);

4) hours of operation;

5) geographical coordinates in degrees, minutes, seconds and hundredths of seconds of the site of the transmitting antenna;

6) elevation of the transmitting antenna of DME to the nearest 30 m (100 ft) and of DME/P to the nearest 3 m (10 ft); and

7) remarks.

When the same aid is used for both en-route and aerodrome purposes, description must also be given in section ENR 4. If the operating authority of the facility is other than the designated governmental agency, the name of the operating authority must be indicated in the remarks column. Facility coverage must be indicated in the remarks column.

****** AD 2.20 Local traffic regulations**

Detailed description of regulations applicable to the traffic at the aerodrome including standard routes for taxiing aircraft, parking regulations, school and training flights and similar but excluding flight procedures.

****** AD 2.21 Noise abatement procedures**

Detailed description of noise abatement procedures established at the aerodrome.

****** AD 2.22 Flight procedures**

Detailed description of the conditions and flight procedures, including radar procedures, established on the basis of airspace organization at the aerodrome.

****** AD 2.23 Additional information**

Additional information at the aerodrome, such as an indication of bird concentrations at the aerodrome, together with an indication of significant daily movement between resting and feeding areas, to the extent practicable.

**** AD 2.24 Charts related to an aerodrome

The requirement is for charts related to an aerodrome to be included in the following order:

1) Aerodrome/Heliport Chart — ICAO;

2) Aircraft Parking/Docking Chart — ICAO;

3) Aerodrome Ground Movement Chart — ICAO;

4) Aerodrome Obstacle Chart — ICAO Type A (for each runway);

5) Precision Approach Terrain Chart — ICAO (precision approach Cat II and III runways);

6) Area Chart — ICAO (departure and transit routes);

7) Standard Departure Chart — Instrument — ICAO;

8) Area Chart — ICAO (arrival and transit routes);

9) Standard Arrival Chart — Instrument — ICAO;

10) Instrument Approach Chart — ICAO (for each runway and procedure type);

11) Visual Approach Chart — ICAO; and

12) bird concentrations in the vicinity of aerodrome.

If some of the charts are not produced, a statement to this effect must be given in section GEN 3.2, Aeronautical charts.

AD 3. HELIPORTS

When a helicopter landing area is provided at the aerodrome, associated data must be listed only under **** AD 2.16.

Note.— **** is to be replaced by the relevant ICAO location indicator.

**** AD 3.1 Heliport location indicator and name

The requirement is for the ICAO location indicator assigned to the heliport and the name of heliport. An ICAO location indicator must be an integral part of the referencing system applicable to all subsections in section AD 3.

**** AD 3.2 Heliport geographical and administration data

The requirement is for heliport geographical and administration data, including:

1) heliport reference point (geographical coordinates in degrees, minutes and seconds) and its site;

2) direction and distance of heliport reference point from centre of the city or town which the heliport serves;

3) heliport elevation and reference temperature;

4) magnetic variation to the nearest degree, date of information and annual change;

5) name of heliport administration, address, telephone, telefax and telex numbers and AFS address;

6) types of traffic permitted to use the heliport (IFR/VFR); and

7) remarks.

**** AD 3.3 Operational hours

Detailed description of the hours of operation of services at the heliport, including:

1) heliport administration;

2) customs and immigration;

3) health and sanitation;

4) AIS briefing office;

5) ATS reporting office (ARO);

6) MET briefing office;

7) air traffic service;

8) fuelling;

9) handling;

10) security;

11) de-icing; and

12) remarks.

****** AD 3.4 Handling services and facilities**

Detailed description of the handling services and facilities available at the heliport, including:

1) cargo-handling facilities;

2) fuel and oil types;

3) fuelling facilities and capacity;

4) de-icing facilities;

5) hangar space for visiting helicopter;

6) repair facilities for visiting helicopter; and

7) remarks.

****** AD 3.5 Passenger facilities**

Brief description of passenger facilities available at the heliport, including:

1) *hotel(s) at or in the vicinity of the heliport;*

2) *restaurant(s) at or in the vicinity of the heliport;*

3) *transportation possibilities;*

4) medical facilities;

5) *bank and post office at or in the vicinity of the heliport;*

6) *tourist office;* and

7) remarks.

****** AD 3.6 Rescue and fire fighting services**

Detailed description of the rescue and fire fighting services and equipment available at the heliport, including:

1) heliport category for fire fighting;

2) rescue equipment;

3) *capability for removal of disabled helicopter;* and

4) remarks.

25/4/96

****** AD 3.7 Seasonal availability — clearing**

Detailed description of the equipment and operational priorities established for the clearance of heliport movement areas, including:

1) type(s) of clearing equipment;

2) clearance priorities; and

3) remarks.

****** AD 3.8 Aprons, taxiways and check locations data**

Details related to the physical characteristics of aprons, taxiways and positions of designated checkpoints, including:

1) surface and strength of aprons, helicopter stands;

2) width, surface type and designation of helicopter ground taxiways;

3) width and designation of helicopter air taxiway and air transit route;

4) position and elevation of altimeter check locations;

5) location of VOR and INS checkpoints; and

6) remarks.

If check locations are presented on a heliport chart, a note to that effect must be provided under this subsection.

****** AD 3.9 Markings and markers**

Brief description of final approach and take-off area and taxiway markings and markers, including:

1) final approach and take-off markings;

2) taxiway markings, air taxiway markers and air transit route markers; and

3) remarks.

****** AD 3.10 Heliport obstacles**

Detailed description of significant obstacles on and in the vicinity of the heliport, including:

1) obstacles in the final approach and take-off areas and at the heliport;

2) type of obstacle, elevation, marking and lighting (if any);

3) geographical coordinates in degrees, minutes, seconds and tenths of seconds; and

4) NIL indication, if appropriate.

****** AD 3.11 Meteorological information provided**

Detailed description of meteorological information provided at the heliport and an indication of which meteorological office is responsible for the service enumerated, including:

1) name of the associated meteorological office;

2) hours of service and, where applicable, the designation of the responsible meteorological office outside these hours;

3) office responsible for preparation of TAFs and periods of validity of the forecasts;

4) types of landing forecasts available for the heliport and interval of issuance;

5) information on how briefing and/or consultation is provided;

6) type of flight documentation supplied and language(s) used in flight documentation;

7) charts and other information displayed or available for briefing or consultation;

8) supplementary equipment (e.g. weather radar) available for providing information on meteorological conditions;

9) the air traffic services unit(s) provided with meteorological information; and

10) additional information (e.g. concerning any limitation of service; etc.).

****** AD 3.12 Heliport data**

Detailed description of heliport dimensions and related information, including:

1) heliport type — surface-level, elevated or helideck;

2) touchdown and lift-off area dimensions (TLOF);

3) true and magnetic bearings of final approach and take-off area (FATO);

4) dimensions of FATO and surface type;

5) surface and bearing strength in tonnes (1 000 kg) of TLOF;

6) geographical coordinates in degrees, minutes, seconds and hundredths of seconds of the geometric centre of TLOF or of each threshold of FATO (where appropriate);

7) TLOF and/or FATO elevation and slope;

8) dimensions of safety area;

9) dimensions of helicopter clearway;

10) the existence of an obstacle-free sector; and

11) remarks.

****** AD 3.13 Declared distances**

Detailed description of declared distances, where relevant for a heliport, including:

1) take-off distance available;

2) rejected take-off distance available;

3) landing distance available; and

4) remarks.

****** AD 3.14 Approach and FATO lighting**

Detailed description of approach and FATO lighting, including:

1) type, length and intensity of approach lighting system;

2) type of visual approach slope indicator system;

3) characteristics and location of FATO area lights;

4) characteristics and location of aiming point lights;

5) characteristics and location of TLOF lighting system; and

6) remarks.

****** AD 3.15 Other lighting, secondary power supply**

Description of other lighting and secondary power supply, including:

1) location, characteristics and hours of operation of heliport beacon;

2) location and lighting of wind direction indicator (WDI);

3) taxiway edge and taxiway centre line lights;

4) secondary power supply including switch-over time; and

5) remarks.

****** AD 3.16 Air traffic services airspace**

Detailed description of air traffic services (ATS) airspace organized at the heliport, including:

1) airspace designation and geographical coordinates in degrees, minutes and seconds of the lateral limits;

2) vertical limits;

3) airspace classification;

4) call sign and language(s) of ATS unit providing service;

5) transition altitude; and

6) remarks.

****** AD 3.17 Air traffic services communication facilities**

Detailed description of air traffic services communication facilities established at the heliport, including:

1) service designation;

2) call sign;

3) frequency(ies);

4) hours of operation; and

5) remarks.

****** AD 3.18 Radio navigation and landing aids**

Detailed description of radio navigation and landing aids associated with the instrument approach and the terminal area procedures at the heliport, including:

1) type of aid and for VOR also magnetic variation used for technical line-up of the aid;

2) identification;

3) frequency(ies);

4) hours of operation;

5) geographical coordinates in degrees, minutes, seconds and hundredths of seconds of the site of transmitting antenna;

6) elevation of the transmitting antenna of DME to the nearest 30 m (100 ft) and of DME/P to the nearest 3 m (10 ft); and

7) remarks.

When the same aid is used for both en-route and heliport purposes, a description must also be given in section ENR 4. If the operating authority of the facility is other than the designated governmental agency, the name of the operating authority must be indicated in the remarks column. Facility coverage must be indicated in the remarks column.

****** AD 3.19 Local traffic regulations**

Detailed description of regulations applicable to traffic at the heliport, including standards routes for taxiing helicopters, parking regulations, school and training flights and similar but excluding flight procedures.

****** AD 3.20 Noise abatement procedures**

Detailed description of noise abatement procedures established at the heliport.

****** AD 3.21 Flight procedures**

Detailed description of the conditions and flight procedures, including radar procedures, established on the basis of airspace organization established at the heliport.

****** AD 3.22 Additional information**

Additional information about the heliport, such as an indication of bird concentrations at the heliport together with an indication of significant daily movement between resting and feeding areas, to the extent practicable.

****** AD 3.23 Charts related to a heliport**

The requirement is for charts related to a heliport to be included in the following order:

1) Aerodrome/Heliport Chart — ICAO;

2) Area Chart — ICAO (departure and transit routes);

3) Standard Departure Chart — Instrument — ICAO;

4) Area Chart — ICAO (arrival and transit routes);

5) Standard Arrival Chart — Instrument — ICAO;

6) Instrument Approach Chart — ICAO (for each procedure type);

7) Visual Approach Chart — ICAO; and

8) bird concentrations in the vicinity of heliport.

If some of the charts are not produced, a statement to this effect must be given in section GEN 3.2, Aeronautical charts.

APPENDIX 2. SNOWTAM FORMAT

(see Chapter 5, 5.3.3)

(COM heading)	(PRIORITY INDICATOR)	(ADDRESSES)		≪≡
	(DATE AND TIME OF FILING)	(ORIGINATOR'S INDICATOR)		≪≡
(Abbreviated heading)	(SWAA* SERIAL NUMBER) S W * *	(LOCATION INDICATOR)	DATE/TIME OF OBSERVATION	(OPTIONAL GROUP) ≪≡(

SNOWTAM	(Serial number) →

(AERODROME LOCATION INDICATOR)	A)	→
(DATE/TIME OF OBSERVATION *(Time of completion of measurement in UTC)*)	B)	→
(RUNWAY DESIGNATORS)	C)	→
(CLEARED RUNWAY LENGTH, IF LESS THAN PUBLISHED LENGTH *(m)*)	D)	→
(CLEARED RUNWAY WIDTH, IF LESS THAN PUBLISHED WIDTH *(m; if offset left or right of centre line add "L" or "R")*)	E)	→
(DEPOSITS OVER TOTAL RUNWAY LENGTH *(Observed on each third of the runway, starting from threshold having the lower runway designation number)* NIL — CLEAR AND DRY 1 — DAMP 2 — WET or water patches 3 — RIME OR FROST COVERED *(depth normally less than 1 mm)* 4 — DRY SNOW 5 — WET SNOW 6 — SLUSH 7 — ICE 8 — COMPACTED OR ROLLED SNOW 9 — FROZEN RUTS OR RIDGES)	F)	→
(MEAN DEPTH *(mm)* FOR EACH THIRD OF TOTAL RUNWAY LENGTH)	G)	→
(FRICTION MEASUREMENTS ON EACH THIRD OF RUNWAY AND FRICTION MEASURING DEVICE MEASURED OR CALCULATED COEFFICIENT *or* ESTIMATED SURFACE FRICTION 0.40 and above — GOOD — 5 0.39 to 0.36 — MEDIUM/GOOD — 4 0.35 to 0.30 — MEDIUM — 3 0.29 to 0.26 — MEDIUM/POOR — 2 0.25 and below — POOR — 1 9 - unreliable — UNRELIABLE — 9 *(When quoting a measured coefficient use the observed two figures, followed by the abbreviation of the friction measuring device used. When quoting an estimate use single digit)*)	H)	→
(CRITICAL SNOWBANKS *(If present, insert height (cm)/distance from the edge of runway (m) followed by "L", "R" or "LR" if applicable)*)	J)	→
(RUNWAY LIGHTS *(If obscured, insert "YES" followed by "L", "R" or both "LR" if applicable)*)	K)	→
(FURTHER CLEARANCE *(If planned, insert length (m)/width (m) to be cleared or if to full dimensions, insert "TOTAL")*)	L)	→
(FURTHER CLEARANCE EXPECTED TO BE COMPLETED BY . . . *(UTC)*)	M)	→
(TAXIWAY *(If no appropriate taxiway is available, insert "NO")*)	N)	→
(TAXIWAY SNOWBANKS *(If more than 60 cm, insert "YES" followed by distance apart, m)*)	P)	→
(APRON *(If unusable insert "NO")*)	R)	→
(NEXT PLANNED OBSERVATION/MEASUREMENT IS FOR) *(month/day/hour in UTC)*	S)	→
(PLAIN LANGUAGE REMARKS *(Including contaminant coverage and other operationally significant information, e.g. sanding, deicing)*)	T)	)≪≡

NOTES:
1. *Enter ICAO nationality letters as given in ICAO Doc 7910, Part 2
2. Information on other runways, repeat from C to P
3. Words in brackets ( ) not to be transmitted

SIGNATURE OF ORIGINATOR *(not for transmission)*

GUIDANCE FOR THE COMPLETION OF THE SNOWTAM FORMAT

1. *General*

a) When reporting on two or three runways, repeat Items C to P inclusive.

b) Items together with their indicator must be dropped completely, where no information is to be included.

c) Metric units must be used and the unit of measurement not reported.

d) The maximum validity of SNOWTAM is 24 hours. New SNOWTAM must be issued whenever there is a significant change in conditions. The following changes relating to runway conditions are considered as significant:

1) a change in the coefficient of friction of about 0.05;

2) changes in depth of deposit greater than the following: 20 mm for dry snow, 10 mm for wet snow, 3 mm for slush;

3) a change in the available length or width of a runway of 10 per cent or more;

4) any change in the type of deposit or extent of coverage which requires reclassification in Items F or T of the SNOWTAM;

5) when critical snow banks exist on one or both sides of the runway, any change in the height or distance from centre line;

6) any change in the conspicuity of runway lighting caused by obscuring of the lights;

7) any other conditions known to be significant according to experience or local circumstances.

e) The abbreviated heading "TTAAiiii CCCC MMYYGGgg (BBB)" is included to facilitate the automatic processing of SNOWTAM messages in computer data banks. The explanation of these symbols is:

TT = data designator for SNOWTAM = SW;
AA = geographical designator for States, e.g. LF = FRANCE, EG = United Kingdom (see *Location Indicators* (Doc 7910), Part 2, Index to Nationality Letters for Location Indicators);
iiii = SNOWTAM serial number in a four-figure group;
CCCC = four-letter location indicator of the aerodrome to which the SNOWTAM refers (see *Location Indicators* (Doc 7910));
MMYYGGgg = date/time of observation/measurement, whereby:
MM = month, e.g. January = 01, December = 12
YY = day of the month
GGgg = time in hours (GG) and minutes (gg) UTC;
(BBB) = optional group for:
Correction to SNOWTAM message previously disseminated with the same serial number = COR.

Note.— Brackets in (BBB) are used to indicate that this group is optional.

Example: Abbreviated heading of SNOWTAM No. 149 from Zurich, measurement/observation of 7 November at 0620 UTC:

SWLS0149 LSZH 11070620

2. *Item A* — Aerodrome location indicator (four-letter location indicator).

3. *Item B* — Eight-figure date/time group — giving time of observation as month, day, hour and minute in UTC; this item must always be completed.

4. *Item C* — Lower runway designator number.

5. *Item D* — Cleared runway length in metres, if less than published length (see Item T on reporting on part of runway not cleared).

6. *Item E* — Cleared runway width in metres, if less than published width; if offset left or right of centre line add "L" or "R", as viewed from the threshold having the lower runway designation number.

7. *Item F* — Deposit over total runway length as explained in SNOWTAM Format. Suitable combinations of these numbers may be used to indicate varying conditions over runway segments. If more than one deposit is present on the same portion of the runway, they should be reported in sequence from the top to the bottom. Drifts, depths of deposit appreciably greater than the average values or other significant characteristics of the deposits may be reported under Item T in plain language.

Note.— Definitions for the various types of snow are given at the end of this Appendix.

8. *Item G* — Mean depth in millimetres deposit for each third of total runway length, or "XX" if not measurable or operationally not significant; the assessment to be made to an accuracy of 20 mm for dry snow, 10 mm for wet snow and 3 mm for slush.

9. *Item H* — Friction measurements on each third of the runway and friction measuring device. Measured or calculated coefficient (two digits) or, if not available, estimated surface friction (single digit) in the order from the threshold having the lower runway designation number. Insert a code 9 when surface conditions or available friction measuring device do not permit a reliable surface friction measurement to be made. Use the following abbreviations to indicate the type of friction measuring device used:

BRD	Brakemeter-Dynometer
GRT	Grip Tester
MUM	Mu-meter
RFT	Runway friction tester
SFH	Surface friction tester (high pressure tire)
SFL	Surface friction tester (low pressure tire)
SKH	Skiddometer (high pressure tire)
SKL	Skiddometer (low pressure tire)
TAP	Tapley meter

If other equipment used specify in plain language.

10. *Item J* — Critical snowbanks. If present insert height in centimetres and distance from edge of runway in metres, followed by left ("L") or right ("R") side or both sides ("LR"), as viewed from the threshold having the lower runway designation number.

11. *Item K* — If runway lights are obscured insert "YES" followed by "L", "R" or both "LR" as viewed from the threshold having the lower runway designation number.

12. *Item L* — When further clearance will be undertaken, enter length and width of runway or "TOTAL" if runway will be cleared to full dimensions.

13. *Item M* — Enter the anticipated time of completion in UTC.

14. *Item N* — The code for Item F may be used to describe taxiway conditions; enter "NO" if no taxiways serving the associated runway are available.

15. *Item P* — If applicable, enter "YES" followed by the lateral distance in metres.

16. *Item R* — The code for Item F may be used to describe apron conditions; enter "NO" if apron unusable.

17. *Item S* — Enter the anticipated time of next observation/measurement in UTC.

18. *Item T* — Describe in plain language any operationally significant information but always report on length of uncleared runway (Item D) and extent of runway contamination (Item F) for each third of the runway (if appropriate) in accordance with the following scale:

Runway contamination — 10% — if less than 10% of runway contaminated
Runway contamination — 25% — if 11-25% of runway contaminated
Runway contamination — 50% — if 26-50% of runway contaminated
Runway contamination — 100% — if 51-100% of runway contaminated.

EXAMPLE OF COMPLETED SNOWTAM FORMAT

GG EHAMZQZX EDDFZQZX EKCHZQZX
070645 LSZHYNYX
SWLS0149 LSZH 11070620
SNOWTAM 0149

A) LSZH	B) 11070620	C) 02	D) ... P)
		C) 09	D) ... P)
		C) 12	D) ... P)
R) NO	S) 11070920	T) DEICING.	

Definitions of the various types of snow

Slush. Water-saturated snow which with a heel-and-toe slap-down motion against the ground will be displaced with a splatter; specific gravity: 0.5 up to 0.8.

Note.— Combinations of ice, snow and/or standing water may, especially when rain, rain and snow, or snow is falling, produce substances with specific gravities in excess of 0.8. These substances, due to their high water/ice content, will have a transparent rather than a cloudy appearance and, at the higher specific gravities, will be readily distinguishable from slush.

Snow (on the ground).

a) *Dry snow.* Snow which can be blown if loose or, if compacted by hand, will fall apart again upon release; specific gravity: up to but not including 0.35.

b) *Wet snow.* Snow which, if compacted by hand, will stick together and tend to or form a snowball; specific gravity: 0.35 up to but not including 0.5.

c) *Compacted snow.* Snow which has been compressed into a solid mass that resists further compression and will hold together or break up into lumps if picked up; specific gravity: 0.5 and over.

APPENDIX 3. INFORMATION TO BE NOTIFIED BY AIRAC

(see Chapter 6, 6.1.1 and 6.1.1.2)

PART 1

1. The establishment, withdrawal of, and premeditated significant changes (including operational trials) to:

1.1 Limits (horizontal and vertical), regulations and procedures applicable to:

a) flight information regions;

b) control areas;

c) control zones;

d) advisory areas;

e) ATS routes;

f) permanent danger, prohibited and restricted areas (including type and periods of activity when known) and ADIZ;

g) permanent areas or routes or portions thereof where the possibility of interception exists.

1.2 Positions, frequencies, call signs, known irregularities and maintenance periods, of radio navigation aids and communication facilities.

1.3 Holding and approach procedures, arrival and departure procedures, noise abatement procedures and any other pertinent ATS procedures.

1.4 Meteorological facilities (including broadcasts) and procedures.

1.5 Runways and stopways.

PART 2

2. The establishment and withdrawal of, and premeditated significant changes to:

2.1 Position, height and lighting of navigational obstacles.

2.2 Taxiways and aprons.

2.3 Hours of service: aerodromes, facilities and services.

2.4 Customs, immigration and health services.

2.5 Temporary danger, prohibited and restricted areas and navigational hazards, military exercises and mass movements of aircraft.

2.6 Temporary areas or routes or portions thereof where the possibility of interception exists.

APPENDIX 4. PREDETERMINED DISTRIBUTION SYSTEM FOR NOTAM

(see Chapter 5, 5.3.7.2 and Annex 10, Volume II, Chapter 4, 4.4.17)

1. The predetermined distribution system provides for incoming NOTAM (including SNOWTAM) to be channelled through the AFTN direct to designated addressees predetermined by the receiving country concerned while concurrently being routed to the international NOTAM office for checking and control purposes.

2. The addressee indicators for those designated addressees are constituted as follows:

1) *First and second letters:*

The first two letters of the location indicator for the AFTN communication centre associated with the relevant international NOTAM office of the receiving country.

2) *Third and fourth letters:*

The letters "ZZ" indicating a requirement for special distribution.

3) *Fifth letter:*

The fifth letter differentiating between NOTAM (letter "N") and SNOWTAM (letter "S").

4) *Sixth and seventh letters:*

The sixth and seventh letters, each taken from the series A to Z and denoting the national and/or international distribution list(s) to be used by the receiving AFTN centre.

Note.— The fifth, sixth and seventh letters replace the three-letter designator YNY which, in the normal distribution system, denotes an international NOTAM office.

5) *Eighth letter:*

The eighth position letter shall be the filler letter "X" to complete the eight-letter addressee indicator.

3. States are to inform the States from which they receive NOTAM of the sixth and seventh letters to be used under different circumstances to ensure proper routing.

APPENDIX 5. NOTAM FORMAT

(see Chapter 5, 5.3.2)

Priority Indicator	→
Address	
	≪≡
Date and time of filing	→
Originator's Indicator	≪≡(

Message Series, Number and Identifier

NOTAM containing new information	.... (series and number/year)	NOTAMN
NOTAM replacing a previous NOTAM	.... (series and number/year)	NOTAMR................................ (series and number/year of NOTAM to be replaced)
NOTAM cancelling a previous NOTAM	.... (series and number/year)	NOTAMC................................ (series and number/year of NOTAM to be cancelled) ≪≡

Qualifiers

	FIR	NOTAM Code	Traffic	Purpose	Scope	Lower Limit	Upper Limit	Coordinates, Radius	
Q)	/	Q /	/	/	/	/	/		≪≡

Identification of ICAO location indicator in which the facility, airspace or condition reported on is located	A) →

Period of Validity

From *(date-time group)*	B)		→
To *(PERM or date-time group)*	C)	EST* PERM*	≪≡
Time Schedule *(if applicable)*	D)		→
			≪≡

Text of NOTAM; Plain Language Entry (using ICAO Abbreviations)

E)

≪≡

Lower Limit	F) →
Upper Limit	G))≪≡
Signature	

***Delete as appropriate**

GUIDANCE FOR THE COMPLETION OF THE NOTAM FORMAT

1. General

1.1 The qualifier line (Q) and all identifiers (A to G inclusive) each followed by a closing parenthesis, as shown in the format, must be transmitted unless there is no entry to be made against a particular identifier.

1.2 Each NOTAM must deal with only one subject and one condition concerning the subject.

2. NOTAM numbering

Series must be indicated by a letter and the number must consist of four digits followed by a stroke and two digits for the year (A0023/91).

3. Qualifiers (Item Q)

This Item is divided in eight fields, each separated by a stroke. If no entry is to be made in a field, it is not necessary to transmit blanks between the strokes. The definition of each field is as follows:

1) FIR

ICAO location indicator, FIR or country indicator plus "XX" if applicable to more than one FIR within a State which will then be listed in Item A).

2) NOTAM CODE

ICAO five-letter code or one of the following combinations as necessary:

a) If the subject of the NOTAM (second and third letters of NOTAM Code) is not in the NOTAM Code list, the following letters should be used in reference to the category:

QAGXX = AGA QRCXX = RAC
QCOXX = COM QXXXX = Other

b) If the conditions of the subject are not in the NOTAM Code list, insert "XX" condition as the fourth and fifth letters.

Example: QFAXX

c) The following fourth and fifth letters of NOTAM Code should be used in NOTAM cancellations:

AK : RESUMED NORMAL OPS
AL : OPERATIVE SUBJECT TO PREVIOUSLY PUBLISHED LIMITATIONS/CONDITIONS (OPR SUBJ PREVIOUS COND)
AO : OPERATIONAL
CC : COMPLETED
XX : PLAIN LANGUAGE.

3) TRAFFIC

I = IFR
V = VFR
IV = IFR/VFR is of interest to both types of flights.

4) PURPOSE

N = NOTAM selected for the immediate attention of aircraft operators
B = NOTAM selected for PIB entry
O = Operationally significant for IFR flights
M = Miscellaneous NOTAM; not subject for a briefing, but it is available on request.

5) SCOPE

Aerodrome A
En-route E
Nav Warning W

Note.— Some radio navigation aids will be both "A" and "E" serving a dual purpose as en-route and terminal aids, for example; therefore the NOTAM text will be used to determine if the scope should refer to A, E or AE. If a subject is qualified AE, the aerodrome location indicator must be reported in Item A).

6) and 7) LOWER/UPPER

Used when applicable
"FL000=SEA/GROUND level".
Default values are 000/999.

Note.— If the subject refers to "airspace organization" (e.g. CTR, TMA, UIR, ...) an appropriate lower/upper limit must be stated in the Q-line.

8) COORDINATES, RADIUS

The latitude and longitude accurate to one minute, as well as a three-digit distance figure giving the radius of influence in NM (e.g. 4700N01140E043). Coordinates present approximate centre of circle whose radius encompasses the whole area of influence.

4. Item A)

Insert ICAO location indicator of aerodrome or FIR in which the facility, airspace, or condition being reported on is located. More than one FIR/UIR may be indicated when appropriate. If there is no available ICAO location indicator, use the ICAO nationality letter as given in ICAO Doc 7910, Part 2 plus XX and followed up in Item E) by the name, in plain language.

5. Item B)

For date-time group use a ten-figure group, giving year, month, day, hours and minutes in UTC. This entry is the date-time at which the NOTAM N, R or C comes into force. In the case of NOTAM R which replaces the previous NOTAM and promulgates new information, field B) must give the date-time group at which this new information supersedes that to which it refers.

6. Item C)

A date-time group must be used unless the information is PERM. If the information on timing is uncertain, the approximate duration must be indicated using a date-time group followed by an EST. Any NOTAM which includes an EST must be cancelled or replaced.

7. Item D)

If the hazard, status of operation or condition of facilities being reported on will be active during specified periods, insert such information under Item D).

8. Item E)

Use decoded NOTAM Code, completed where necessary by indicators, identifiers, designators, call signs, frequencies, figures and plain language. ICAO abbreviations should be used where appropriate. This entry must be clear and concise in order to provide a suitable PIB entry. In the case of NOTAM C, a subject reference and status message should be included to enable accurate plausibility checks.

9. Items F) and G)

These items are normally applicable to navigation warnings or airspace restrictions and are usually part of the PIB entry. Insert lower and upper height limits of activities or restrictions, clearly indicating reference datum and units of measurement.

Example:

If a danger area EG-DXX located at 5510N00520W with a radius of 50 NM (and affecting two FIR) is to be activated up to 12 200 m (40 000 ft) MSL on April 03, 07, 12, 21, 24 and 28 1991, daily from 0730 to 1500 UTC and up to 9 150 m (30 000 ft) MSL on April 19 and 20 1991 daily from 0730 to 1500 UTC, two NOTAM would be required, as follows:

(A0623/91 NOTAMN
Q) EGXX/QRDCA/IV/NBO/W/000/400/5510N00520W050
A) EGTT/EGPX B) 9104030730 C) 9104281500
D) APR 03 07 12 21 24 AND 28 0730 TO 1500
E) DANGER AREA DXX IS ACTIVE
F) GND G) 12 200 m (40 000 ft) MSL.)

(A0624/91 NOTAMN
Q) EGXX/QRDCA/IV/NBO/W/000/300/5510N00520W050
A) EGTT/EGPX B) 9104190730 C) 9104201500
D) APR 19 AND 20 0730 TO 1500
E) DANGER AREA DXX IS ACTIVE
F) GND G) 9 150 m (30 000 ft) MSL.)

— END —

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

ENVIRONMENTAL PROTECTION

ANNEX 16

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME I

AIRCRAFT NOISE

THIRD EDITION — 1993

This edition incorporates all amendments to Annex 16 adopted by the Council prior to 25 March 1993 and supersedes on 11 November 1993 all previous editions of the Annex.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword and the relevant clauses in each Chapter.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments in announced in the *ICAO Journal* and in the monthly supplements to the *Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-4	Incorporated in this Edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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ATTACHMENTS

FOREWORD

Historical background

Standards and Recommended Practices for Aircraft Noise were first adopted by the Council on 2 April 1971 pursuant to the provisions of Article 37 of the Convention on International Civil Aviation (Chicago, 1944) and designated as Annex 16 to the Convention. The Annex was developed in the following manner:

The Sixteenth Session of the Assembly, Buenos Aires, September 1968, adopted the following Resolution:

> A16-3: *Aircraft Noise in the Vicinity of Airports*
>
> *Whereas* the problem of aircraft noise is so serious in the vicinity of many of the world's airports that public reaction is mounting to a degree that gives cause for great concern and requires urgent solution;
>
> *Whereas* the noise that concerns the public and civil aviation today is being caused by increase in traffic of existing aircraft;
>
> *Whereas* the introduction of future aircraft types could increase and aggravate this noise unless action is taken to alleviate the situation;
>
> *Whereas* the Fifth Air Navigation Conference of ICAO held in Montreal in November 1967 made certain recommendations, based on the principal conclusions of the International Conference on the Reduction of Noise and Disturbance Caused by Civil Aircraft ("The London Noise Conference") held in London in November 1966, with the object of reaching international solutions to the problem through the machinery of ICAO; and
>
> *Whereas* the Assembly has noted the action being taken by the Council, in consultation with States and the appropriate international organizations, to give effect to the recommendations of the Fifth Air Navigation Conference, as reported to the Assembly by the Secretary General;
>
> THE ASSEMBLY RESOLVES to instruct the Council:
>
> 1) to call an international conference within the machinery of ICAO as soon as practicable, bearing in mind the need for adequate preparation, to consider the problem of aircraft noise in the vicinity of airports;
>
> 2) to establish international specifications and associated guidance material relating to aircraft noise;
>
> 3) to include, in appropriate existing Annexes and other relevant ICAO documents and possibly in a separate Annex on noise, such material as the description and methods of measurement of aircraft noise and suitable limitations on the noise caused by aircraft that is of concern to communities in the vicinity of airports; and
>
> 4) to publish such material on a progressive basis, commencing at the earliest possible time.

In response to Assembly Resolution A16-3, a Special Meeting on Aircraft Noise in the Vicinity of Aerodromes was convened in Montreal (November-December 1969) to examine the following aspects related to the problems of aircraft noise:

a) procedures for describing and measuring aircraft noise;

b) human tolerance to aircraft noise;

c) aircraft noise certification;

d) criteria for establishment of aircraft noise abatement operating procedures;

e) land use control; and

f) ground run-up noise abatement procedures.

Based on the recommendations of the Special Meeting on Aircraft Noise in the Vicinity of Aerodromes, draft International Standards and Recommended Practices for Aircraft Noise were developed and, after amendment following the usual consultation with the Contracting States of the Organization, were adopted by the Council to form the text of this Annex.

With the development of Standards and Recommended Practices dealing with the control of aircraft engine emissions, it was felt that all provisions relating to environmental aspects of aviation should be included into a single document. Accordingly, as part of the Resolution adopting Amendment 5, it was agreed that Annex 16 should be retitled as "Environmental Protection" and Volume I of the Annex should contain the existing provisions (Third Edition) of Annex 16 — *Aircraft Noise* as amended by Amendment 5 and Volume II should contain the provisions related to aircraft engine emissions.

Table A shows the origin of amendments together with a list of the principal subjets involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Applicability

Part I of Volume I of Annex 16 contains definitions and Part II contains Standards, Recommended Practices and guidelines for noise certification applicable to the classification of aircraft specified in individual Chapters of that Part, where such aircraft are engaged in international air navigation.

Note.— Chapters 2 and 3 exclude jet aeroplanes having short take-off and landing (STOL) capabilities which, pending the development by ICAO of a suitable definition, are described for the purpose of this Annex as those requiring a runway (with no stopway or clearway) of 610 m or less at the maximum certificated mass for airworthiness.

Parts III, IV and V of Volume I of Annex 16 contain Recommended Practices and guidance material for use by States with a view to promoting uniformity in measurement of noise for monitoring purposes, use of an international noise exposure reference unit for land use planning, and establishment of noise abatement operating procedures.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Use of the Annex text in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as is practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of international air navigation. Wherever possible, the provisions of this Annex have been written in such a way as to facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38..

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Provisions* governing the applicability of the Standards and Recommended Practices.

d) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light italics, the status being indicated by the prefix *Note*.

It is to be noted that in the English text the following practice has been adhered to when writing the specifications: Standards employ the operative verb "shall" while Recommended Practices employ the operative verb "should".

The units of measurement used in this document are in accordance with the International System of Units (SI) as specified in Annex 5 to the Convention on International Civil Aviation. Where Annex 5 permits the use of non-SI alternative units these are shown in parentheses following the basic units. Where two sets of units are quoted it must not be assumed that the pairs of values are equal and interchangeable. It may, however, be inferred that an equivalent level of safety is achieved when either set of units is used exclusively.

Any reference to a portion of this document which is identified by a number includes all subdivisions of that portion.

Co-ordination with ISO activity

In the provisions related to certification procedures, extensive use is made of the related specifications developed by the International Organization for Standardization (ISO) and the Commission électrotechnique Internationale (IEC). In most cases these specifications have been incorporated by direct reference. However, in some cases it has been found necessary to modify the specifications to suit ICAO requirements and in such cases the modified material is included in full in this document. The assistance provided by ISO in the development of detailed specifications is recognized.

Table A. Amendments to Annex 16

Amendment	*Source(s)*	*Subject(s)*	*Adopted* *Effective* *Applicable*
1st Edition	Special Meeting on Aircraft Noise in the Vicinity of Aerodromes (1969)		2 April 1971 2 August 1971 6 January 1972
1	First Meeting of the Committee on Aircraft Noise	Noise certification of future production and derived versions of subsonic jet aeroplanes and updating of terminology used to describe aircraft weight.	6 December 1972 6 April 1973 16 August 1973

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
2	Third Meeting of the Committee on Aircraft Noise	Noise certification of light propeller-driven aeroplanes and subsonic jet aeroplanes of 5 700 kg and less maximum certificated take-off weight and guidance on discharge of functions by States in the cases of lease, charter and interchange of aircraft.	3 April 1974 3 August 1974 27 February 1975
3 (2nd Edition)	Fourth Meeting of the Committee on Aircraft Noise	Noise certification standards for future subsonic jet aeroplanes and propeller-driven aeroplanes, other than STOL aeroplanes, and guidelines for noise certification of future supersonic aeroplanes, propeller-driven STOL aeroplanes and installed APUs and associated aircraft systems when operating on the ground.	21 June 1976 21 October 1976 6 October 1977
4 (3rd Edition)	Fifth Meeting of the Committee on Aircraft Noise	Introduction of a new parameter viz. number of engines in the noise certification standards for subsonic jet aeroplanes, improvements in detailed test procedures to ensure that the same level of technology is applied to all types of aircraft, and editorial changes to simplify the language and eliminate inconsistencies.	6 March 1978 6 July 1978 10 August 1978
5 (Annex 16, Volume I — 1st Edition)	Sixth Meeting of the Committee on Aircraft Noise	1. Annex retitled *Environmental Protection* and to be issued in two volumes as follows: Volume I — *Aircraft Noise* (incorporating provisions in the third edition of Annex 16 as amended by Amendment 5) and Volume II — *Aircraft Engine Emissions*. 2. Introduction in Volume I of noise certification Standards for helicopters and for future production of existing SST aeroplanes, updating of guidelines for noise certification of installed APU and associated aircraft systems and editorial amendments including changes to units of measurement to bring the Annex in line with Annex 5 provisions.	11 May 1981 11 September 1981 26 November 1981
1	Third Meeting of Operations Panel	Introduction of SARPs for noise abatement operating procedures and transfer of detailed procedures to PANS-OPS, Volume I.	30 March 1983 29 July 1983 24 November 1983
2	Seventh Meeting of the Committee on Aircraft Noise	a) Improvements in the noise certification procedures; and b) relaxation of maximum noise limits for helicopters.	6 March 1985 29 July 1985 21 November 1985
3 (Annex 16, Volume I — 2nd Edition)	First meeting of the Committee on Aviation Environmental Protection; study by the Air Navigation Commission following a recommendation of the Obstacle Clearance Panel	a) further improvements in the noise certification procedures; b) introduction of a new Chapter 10 for propeller-driven aeroplanes not exceeding 9 000 kg maximum certificated take-off mass; and c) editorial changes in Part V cross-referencing the relevant provisions in the PANS-OPS (Doc 8168).	4 March 1988 31 July 1988 17 November 1988
4 (3rd Edition)	Second Meeting of the Committee on Aviation Environmental Protection; Seventh Meeting of the Committee on Aircraft Noise; and Fifth Meeting of the Operations Panel	a) improvements in the noise certification procedures; b) introduction of a new Chapter 11 for light helicopters; c) expansion of Appendix 2 to include helicopters and replacement of Appendix 4; and d) introduction of guidance on applicability.	24 March 1993 26 July 1993 11 November 1993

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

PART I. DEFINITIONS

Aeroplane. A power-driven heavier-than-air aircraft, deriving its lift in flight chiefly from aerodynamic reactions on surfaces which remain fixed under given conditions of flight.

Aircraft. Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Associated aircraft systems. Those aircraft systems drawing electrical/pneumatic power from an auxiliary power unit during ground operations.

Auxiliary power-unit (APU). A self-contained power-unit on an aircraft providing electrical/pneumatic power to aircraft systems during ground operations.

By-pass ratio. The ratio of the air mass flow through the by-pass ducts of a gas turbine engine to the air mass flow through the combustion chambers calculated at maximum thrust when the engine is stationary in an international standard atmosphere at sea level.

Derived version of an aircraft. An aircraft which, from the point of view of airworthiness, is similar to the noise certificated prototype but incorporates changes in type design which may affect its noise characteristics adversely.

Note 1.— Where the certificating authority finds that the proposed change in design, configuration, power or mass is so extensive that a substantially new investigation of compliance with the applicable airworthiness regulations is required, the aircraft should be considered to be a new type design rather than a derived version.

Note 2.— Where more than one measurement point is involved, "adversely" refers to the net change in noise levels.

Helicopter. A heavier-than-air aircraft supported in flight chiefly by the reactions of the air on one or more power-driven rotors on substantially vertical axes.

Self-sustaining powered sailplane. A powered aeroplane with available engine power which allows it to maintain level flight but not to take off under its own power.

Subsonic aeroplane. An aeroplane incapable of sustaining level flight at speeds exceeding flight Mach number of 1.

PART II. AIRCRAFT NOISE CERTIFICATION

CHAPTER 1. ADMINISTRATION

1.1 The provisions of 1.2 to 1.5 shall apply to all aircraft included in the classifications defined for noise certification purposes in Chapters 2, 3, 4, 5, 6, 8, 10 and 11 of this Part where such aircraft are engaged in international air navigation.

1.2 Noise certification shall be granted or validated by the State of Registry of an aircraft on the basis of satisfactory evidence that the aircraft complies with requirements which are at least equal to the applicable Standards specified in this Annex.

Note.— The documents attesting noise certification may take the form of a separate Noise Certificate or a suitable statement contained in another document approved by the State of Registry and required by that State to be carried in the aircraft.

1.3 The documents attesting noise certification for an aircraft shall provide at least the following information:

a) State of Registry; nationality and registration marks;

b) manufacturer's serial number;

c) manufacturer's type and model designation; engine type/model; propeller type/model (if applicable);

d) statement of any additional modifications incorporated for the purpose of compliance with the applicable noise certification Standards;

e) the maximum mass at which compliance with the applicable noise certification Standards has been demonstrated;

f) for aeroplanes for which application for certification of the prototype is submitted on or after 6 October 1977, and for helicopters for which application for certification of the prototype is submitted on or after 1 January 1985:

the average noise level(s) at the reference point(s) for which compliance with the applicable Standard has been demonstrated to the satisfaction of the certificating authority;

g) the chapter of Annex 16, Volume I, according to which the aircraft was certificated.

1.4 The information required under 1.3 b) through g) shall be included in the flight manual.

1.5 Contracting States shall recognize as valid a noise certification granted by another Contracting State provided that the requirements under which such certification was granted are at least equal to the applicable Standards specified in this Annex.

1.6 A Contracting State shall suspend or revoke the noise certification of an aircraft on its Register if the aircraft ceases to comply with the applicable noise Standards. The State of Registry shall not remove the suspension of a noise certification or grant a new noise certification unless the aircraft is found, on reassessment, to comply with the applicable noise Standards.

1.7 Unless otherwise specified in this Volume of the Annex and subject to the provisions in 1.8, the date to be used by Contracting States in determining the applicability of the Standards in this Annex shall be the date on which either the application for the certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority.

1.8 When the time interval between the acceptance of the application for and the issue of the certificate of airworthiness for the prototype or, where this procedure is not used, the issue of the certificate of airworthiness for the first individual aircraft of the type, exceeds 5 years, the date to be used by the certificating authority in determining the applicability of the appropriate Standards in this Annex shall be 5 years before the date of issue of the certificate of airworthiness for the prototype or, where this procedure is not used, the issue of the certificate of airworthiness for the first individual aircraft of the type, except in special cases when the certificating authority accepts an extension of this period beyond 5 years.

CHAPTER 2. SUBSONIC JET AEROPLANES — APPLICATION FOR CERTIFICATE OF AIRWORTHINESS FOR THE PROTOTYPE ACCEPTED BEFORE 6 OCTOBER 1977

2.1 Applicability

Note.— See also Chapter 1, 1.6.

2.1.1 The Standards of this chapter shall be applicable to all subsonic jet aeroplanes for which either the application for certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority before 6 October 1977, except those aeroplanes:

a) requiring a runway length* of 610 m or less at maximum certificated mass for airworthiness; or

b) powered by engines with a by-pass ratio of 2 or more and for which a certificate of airworthiness for the individual aeroplane was first issued before 1 March 1972; or

c) powered by engines with a by-pass ratio of less than 2, and for which either the application for certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority, before 1 January 1969, and for which a certificate of airworthiness for the individual aeroplane was first issued before 1 January 1976.

2.1.2 The Standards of this chapter shall also be applicable to derived versions of all aeroplanes covered by 2.1.1 above for which the application for certification of a change in type design was accepted, or another equivalent procedure was carried out by the certificating authority on or after 26 November 1981.

2.2 Noise evaluation measure

2.2.1 The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 1.

2.3 Noise measurement points

2.3.1 An aeroplane, when tested in accordance with the flight test procedures of 2.6, shall not exceed the noise levels specified in 2.4 at the following points:

a) *lateral noise measurement point:* the point on a line parallel to and 650 m from the runway centre line, or extended runway centre line, where the noise level is a maximum during take-off;

b) *flyover noise measurement point:* the point on the extended centre line of the runway and at a distance of 6.5 km from the start of roll;

c) *approach noise measurement point:* the point on the ground, on the extended centre line of the runway, 120 m (395 ft) vertically below the 3° descent path originating from a point 300 m beyond the threshold. On level ground this corresponds to a position 2 000 m from the threshold.

2.4 Maximum noise levels

2.4.1 The maximum noise levels of those aeroplanes covered by 2.1.1 above, when determined in accordance with the noise evaluation method of Appendix 1, shall not exceed the following:

a) *at lateral and approach noise measurement points:* 108 EPNdB for aeroplanes with maximum certificated take-off mass of 272 000 kg or over, decreasing linearly with the logarithm of the mass at the rate of 2 EPNdB per halving of the mass down to 102 EPNdB at 34 000 kg, after which the limit remains constant;

b) *at flyover noise measurement point:* 108 EPNdB for aeroplanes with maximum certificated take-off mass of 272 000 kg or over, decreasing linearly with the logarithm of the mass at the rate of 5 EPNdB per halving of the mass down to 93 EPNdB at 34 000 kg, after which the limit remains constant.

Note.— See Attachment A for equations for the calculation of noise levels as a function of take-off mass.

2.4.2 The maximum noise levels of those aeroplanes covered by 2.1.2 above, when determined in accordance with the noise evaluation method of Appendix 1, shall not exceed the following:

* With no stopway or clearway.

2.4.2.1 *At lateral noise measurement point*

106 EPNdB for aeroplanes with maximum certificated take-off mass of 400 000 kg or over, decreasing linearly with the logarithm of the mass down to 97 EPNdB at 35 000 kg, after which the limit remains constant.

2.4.2.2 *At flyover noise measurement point*

a) *Aeroplanes with two engines or less*

104 EPNdB for aeroplanes with maximum certificated take-off mass of 325 000 kg or over, decreasing linearly with the logarithm of the mass at the rate of 4 EPNdB per halving of mass down to 93 EPNdB, after which the limit remains constant.

b) *Aeroplanes with three engines*

As a) but with 107 EPNdB for aeroplanes with maximum certificated take-off mass of 325 000 kg or over

or

as defined by 2.4.1 b), whichever is the lower.

c) *Aeroplanes with four engines or more*

As a) but with 108 EPNdB for aeroplanes with maximum certificated take-off mass of 325 000 kg or over

or

as defined by 2.4.1 b), whichever is the lower.

2.4.2.3 *At approach noise measurement point*

108 EPNdB for aeroplanes with maximum certificated take-off mass of 280 000 kg or over, decreasing linearly with the logarithm of the mass down to 101 EPNdB at 35 000 kg, after which the limit remains constant.

Note.— See Attachment A for equations for the calculation of noise levels as a function of take-off mass.

2.5 Trade-offs

2.5.1 If the maximum noise levels are exceeded at one or two measurement points:

a) the sum of excesses shall not be greater than 4 EPNdB, except that in respect of four-engined aeroplanes powered by engines with by-pass ratio of 2 or more and for which the application for certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority before 1 December 1969, the sum of any excesses shall not be greater than 5 EPNdB;

b) any excess at any single point shall not be greater than 3 EPNdB; and

c) any excesses shall be offset by corresponding reductions at the other point or points.

2.6 Test procedures

2.6.1 Take-off test procedure

2.6.1.1 Average take-off thrust* shall be used from the start of take-off to the point at which a height of at least 210 m (690 ft) above the runway is reached and the thrust thereafter shall not be reduced below that thrust which will maintain a climb gradient of at least 4 per cent.

2.6.1.2 A speed of at least V_2 + 19 km/h (V_2 + 10 kt) shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test.

2.6.1.3 A constant take-off configuration selected by the applicant shall be maintained throughout the take-off noise certification demonstration test except that the landing gear may be retracted.

2.6.2 Approach test procedure

2.6.2.1 The aeroplane shall be stabilized and following a 3° ±0.5° glide path.

2.6.2.2 The approach shall be made at a stabilized airspeed of not less than 1.3 V_S + 19 km/h (1.3 V_S + 10 kt) with thrust stabilized during approach and over the measuring point and continued to a normal touchdown.

2.6.2.3 The configuration of the aeroplane shall be with maximum allowable landing flap setting.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

* Take-off thrust representative of the mean characteristics of the production engine.

CHAPTER 3.

1.— SUBSONIC JET AEROPLANES — Application for Certificate of Airworthiness for the Prototype accepted on or after 6 October 1977

2.— PROPELLER-DRIVEN AEROPLANES OVER 5 700 kg — Application for Certificate of Airworthiness for the Prototype accepted on or after 1 January 1985 and before 17 November 1988

3.— PROPELLER-DRIVEN AEROPLANES OVER 9 000 kg — Application for Certificate of Airworthiness for the Prototype accepted on or after 17 November 1988

3.1 Applicability

Note 1.— See also Chapter 1, 1.6.

Note 2.— See Attachment E for guidance on interpretation of these applicability provisions.

3.1.1 The Standards of this chapter shall be applicable to:

a) all subsonic jet aeroplanes, including their derived versions, other than aeroplanes which require a runway* length of 610 m or less at maximum certificated mass for airworthiness, in respect of which either the application for certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority, on or after 6 October 1977;

b) all propeller-driven aeroplanes, including their derived versions, of over 5 700 kg maximum certificated take-off mass (except those described in 6.1.1), for which either the application for certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority, on or after 1 January 1985 and before 17 November 1988, except where the Standards of Chapter 10 apply;

c) all propeller-driven aeroplanes, including their derived versions, of over 9 000 kg maximum certificated take-off mass, for which either the application for certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority, on or after 17 November 1988.

3.2 Noise measurements

3.2.1 Noise evaluation measure

3.2.1.1 The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2.

3.3 Reference noise measurement points

3.3.1 An aeroplane, when tested in accordance with these Standards, shall not exceed the noise levels specified in 3.4 at the following points:

a) *lateral reference noise measurement point:* the point on a line parallel to and 450 m from the runway centre line, where the noise level is a maximum during take-off;

b) *flyover reference noise measurement point:* the point on the extended centre line of the runway and at a distance of 6.5 km from the start of roll;

c) *approach reference noise measurement point:* the point on the ground, on the extended centre line of the runway 2 000 m from the threshold. On level ground this corresponds to a position 120 m (395 ft) vertically below the 3° descent path originating from a point 300 m beyond the threshold.

* With no stopway or clearway.

3.3.2 Test noise measurement points

3.3.2.1 If the test noise measurement points are not located at the reference noise measurement points, any corrections for the difference in position shall be made in the same manner as the corrections for the differences between test and reference flight paths.

3.3.2.2 Sufficient lateral test noise measurement points shall be used to demonstrate to the certificating authority that the maximum noise level on the appropriate lateral line has been clearly determined. For jet-powered aeroplanes simultaneous measurements shall be made at one test noise measurement point at a symmetrical position on the other side of the runway. In the case of propeller-driven aeroplanes, because of their inherent asymmetry in lateral noise, simultaneous measurements shall be made at each and every test noise measurement point at a symmetrical position (within ±10 m parallel with the axis of the runway) on the opposite side of the runway.

3.3.2.3 A single reference flight path, which may include a thrust cutback in accordance with 3.6.2.1, shall be used to determine the lateral and flyover noise levels.

3.4 Maximum noise levels

3.4.1 The maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2, shall not exceed the following:

3.4.1.1 *At lateral reference noise measurement point*

103 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 400 000 kg and over and decreasing linearly with the logarithm of the mass down to 94 EPNdB at 35 000 kg, after which the limit remains constant.

3.4.1.2 *At flyover reference noise measurement point*

a) *Aeroplanes with two engines or less*

101 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 385 000 kg and over and decreasing linearly with the logarithm of the aeroplane mass at the rate of 4 EPNdB per halving of mass down to 89 EPNdB, after which the limit is constant.

b) *Aeroplanes with three engines*

As a) but with 104 EPNdB for aeroplanes with maximum certificated take-off mass of 385 000 kg and over.

c) *Aeroplanes with four engines or more*

As a) but with 106 EPNdB for aeroplanes with maximum certificated take-off mass of 385 000 kg and over.

3.4.1.3 *At approach reference noise measurement point*

105 EPNdB for aeroplanes with maximum certificated take-off mass, at which the noise certification is requested, of 280 000 kg or over, and decreasing linearly with the logarithm of the mass down to 98 EPNdB at 35 000 kg, after which the limit remains constant.

Note.— See Attachment A for equations for the calculation of noise levels as a function of take-off mass.

3.4.2 If a reference ambient air temperature of 15°C is used (see 3.6.1.5. b)), 1 EPNdB shall be added to the measured (and adjusted) noise level obtained at the flyover measurement point before it is compared with the maximum noise level of 3.4.1.2.

3.5 Trade-offs

3.5.1 If the maximum noise levels are exceeded at one or two measurement points:

a) the sum of excesses shall not be greater than 3 EPNdB;

b) any excess at any single point shall not be greater than 2 EPNdB; and

c) any excesses shall be offset by corresponding reductions at the other point or points.

3.6 Noise certification reference procedures

3.6.1 General conditions

3.6.1.1 The reference procedures shall comply with the appropriate airworthiness requirements.

3.6.1.2 The calculations of reference procedures and flight paths shall be approved by the certificating authority.

3.6.1.3 Except in conditions specified in 3.6.1.4, the take-off and approach reference procedures shall be those defined in 3.6.2 and 3.6.3 respectively.

3.6.1.4 When it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with 3.6.2 and 3.6.3, the reference procedures shall:

a) depart from the reference procedures defined in 3.6.2 and 3.6.3 only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and

b) be approved by the certificating authority.

3.6.1.5 The reference procedures shall be calculated under the following reference atmospheric conditions:

a) sea level atmospheric pressure of 1 013.25 hPa;

b) ambient air temperature of 25°C, i.e. ISA + 10°C except that, at the discretion of the certificating authority, an alternative reference ambient air temperature of 15°C, i.e. ISA may be used;

c) relative humidity of 70 per cent; and

d) zero wind.

Note.— The reference atmosphere in terms of temperature and relative humidity is homogeneous when used for the calculation of atmospheric absorption coefficients.

3.6.2 Take-off reference procedure

3.6.2.1 Take-off reference flight path shall be calculated as follows:

a) average engine take-off thrust or power shall be used from the start of take-off to the point where at least the following height above runway level is reached:

— aeroplanes with two engines or less — 300 m (985 ft)

— aeroplanes with three engines — 260 m (855 ft)

— aeroplanes with four engines or more — 210 m (690 ft);

b) upon reaching the height specified in a) above, the thrust or power shall not be reduced below that required to maintain:

1) a climb gradient of 4 per cent; and

2) in the case of multi-engined aeroplanes, level flight with one engine inoperative;

whichever thrust or power is greater;

c) the speed shall be the all-engines operating take-off climb speed selected by the applicant for use in normal operation, which shall be at least V_2 + 19 km/h (V_2 + 10 kt) but not greater than V_2 + 37 km/h (V_2 + 20 kt) and which shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test;

d) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted. Configuration shall be interpreted as meaning the conditions of the systems and centre of gravity position and shall include the position of lift augmentation devices used, whether the APU is operating, and whether air bleeds and power off-takes are operating;

e) the mass of the aeroplane at the brake release shall be the maximum take-off mass at which the noise certification is requested; and

f) the average engine shall be defined by the average of all the certification compliant engines used during the aeroplane flight tests up to and during certification when operated to the limitations and procedures given in the flight manual. This will establish a technical standard including the relationship of thrust/power to control parameters (e.g. N_1 or EPR). Noise measurements made during certification tests shall be corrected to this standard.

Note.— Take-off thrust/power used shall be the maximum available for normal operations as scheduled in the performance section of the aeroplane flight manual for the reference atmospheric conditions given in 3.6.1.5.

3.6.3 Approach reference procedure

3.6.3.1 The approach reference flight path shall be calculated as follows:

a) the aeroplane shall be stabilized and following a 3° glide path;

b) the approach shall be made at a stabilized airspeed of not less than the minimum value of V_{REF} + 19 km/h (minimum V_{REF} + 10 kt) with thrust or power stabilized during approach and over the measuring point, and continued to a normal touchdown;

Note.— The minimum value of V_{REF} *is defined as 1.3* V_S *or the approximate equivalent of 1.23* V_{S1G} .

c) the constant approach configuration and used in the airworthiness certification tests, but with the landing gear down, shall be maintained throughout the approach reference procedure;

d) the mass of the aeroplane at the touchdown shall be the maximum landing mass permitted in the approach configuration defined in 3.6.3.1 c) at which noise certification is requested; and

e) the most critical (that which produces the highest noise level) configuration with normal deployment of aerodynamic control surfaces including lift and drag producing devices, at the mass at which certification is requested shall be used. This configuration includes all those items listed in 5.2.5 of Appendix 2 that will contribute to the noisiest continuous state at the maximum landing mass in normal operation.

3.7 Test procedures

3.7.1 The test procedures shall be acceptable to the airworthiness and noise certificating authority of the State issuing the certificate.

3.7.2 The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Appendix 2.

3.7.3 Acoustic data shall be adjusted by the methods outlined in Appendix 2 to the reference conditions specified in this Chapter. Adjustments for speed and thrust shall be made as described in Section 9 of Appendix 2.

3.7.4 If the mass during the test is different from the mass at which the noise certification is requested, the necessary EPNL adjustment shall not exceed 2 EPNdB for take-offs and 1 EPNdB for approaches. Data approved by the certificating authority shall be used to determine the variation of EPNL with mass for both take-off and approach test conditions. Similarly the necessary EPNL adjustment for variations in approach flight path from the reference flight path shall not exceed 2 EPNdB.

3.7.5 For the approach conditions the test procedures shall be accepted if the aeroplane follows a steady glide path angle of 3° ±0.5°.

3.7.6 If equivalent test procedures different from the reference procedures are used, the test procedures and all methods for adjusting the results to the reference procedures shall be approved by the certificating authority. The amounts of the adjustments shall not exceed 16 EPNdB on take-off and 8 EPNdB on approach, and if the adjustments are more than 8 EPNdB and 4 EPNdB respectively, the resulting numbers shall not be within 2 EPNdB of the limit noise levels specified in 3.4.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

11/11/93

CHAPTER 4. SUPERSONIC AEROPLANES

4.1 Supersonic aeroplanes — application for certificate of airworthiness for the prototype accepted before 1 January 1975

4.1.1 The Standards of Chapter 2 of this Part, with the exception of maximum noise levels specified in 2.4, shall be applicable to all supersonic aeroplanes, including their derived versions, in respect of which either the application for the certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority before 1 January 1975 and for which a certificate of airworthiness for the individual aeroplane was first issued after 26 November 1981.

4.1.2 The maximum noise levels of those aeroplanes covered by 4.1.1, when determined in accordance with the noise evaluation method of Appendix 1, shall not exceed the measured noise levels of the first certificated aeroplane of the type.

4.2 Supersonic aeroplanes — application for certificate of airworthiness for the prototype accepted on or after 1 January 1975

Note.— Standards and Recommended Practices for these aeroplanes are not yet developed but the noise levels of Chapter 3 of this Part applicable to subsonic jet aeroplanes may be used as guidelines for aeroplanes for which the application for a certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority on or after 1 January 1975.

CHAPTER 5. PROPELLER-DRIVEN AEROPLANES OVER 5 700 kg — APPLICATION FOR CERTIFICATE OF AIRWORTHINESS FOR THE PROTOTYPE ACCEPTED BEFORE 1 JANUARY 1985

5.1 Applicability

Note 1.— See also Chapter 1, 1.6.

Note 2.— See Attachment E for guidance on interpretation of these applicability provisions.

5.1.1 The Standards defined hereunder are not applicable to:

a) aeroplanes requiring a runway* length of 610 m or less at maximum certificated mass for airworthiness;

b) aeroplanes specifically designed for fire fighting;

c) aeroplanes specifically designed for agricultural purposes;

d) aeroplanes to which the Standards of Chapter 6 apply; and

e) aeroplanes to which the Standards of Chapter 10 apply.

5.1.2 The Standards of this chapter shall be applicable to all propeller-driven aeroplanes, including their derived versions, of over 5 700 kg maximum certificated take-off mass for which either the application for a certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority on or after 6 October 1977 and before 1 January 1985.

5.1.3 The Standards of Chapter 2, with the exception of Sections 2.1 and 2.4.2, shall be applicable to derived versions and individual aeroplanes of over 5 700 kg maximum certificated take-off mass and to which Standards of Chapter 6 do not apply and are of the type for which application for a certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority before 6 October 1977 and for which a certificate of airworthiness for the individual aeroplane was issued on or after 26 November 1981.

5.1.4 The Standards of Chapter 3, with the exception of Section 3.1 shall be applicable to all propeller-driven aeroplanes, including their derived versions, of over 5 700 kg maximum take-off mass, for which either the application for a certificate of airworthiness for the prototype was accepted, or another equivalent prescribed procedure was carried out by the certificating authority on or after 1 January 1985.

Note.— The Standards in Chapters 2 and 3 although developed previously for subsonic jet aeroplanes are considered suitable for application to other aeroplane types regardless of the type of power installed.

5.2 Noise measurements

5.2.1 Noise evaluation measure

5.2.1.1 The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2.

5.3 Reference noise measurement points

5.3.1 An aeroplane, when tested in accordance with these Standards, shall not exceed the noise levels specified in 5.4 at the following points:

a) *lateral reference noise measurement point:* the point on a line parallel to and 450 m from the runway centre line or extended runway centre line, where the noise level is a maximum during take-off;

b) *flyover reference noise measurement point:* the point on the extended centre line of the runway and at a distance of 6.5 km from the start of roll;

c) *approach reference noise measurement point:* the point on the ground, on the extended centre line of the runway 2 000 m from the threshold. On level ground this corresponds to a position 120 m (395 ft) vertically below the 3° descent path originating from a point 300 m beyond the threshold.

5.3.2 Test noise measurement points

5.3.2.1 If the test noise measurement points are not located at the reference noise measurement points, any corrections for the difference in position shall be made in the same manner as the corrections for the differences between test and reference flight paths.

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* With no stopway or clearway.

5.3.2.2 Sufficient lateral test noise measurement points shall be used to demonstrate to the certificating authority that the maximum noise level on the appropriate lateral line has been clearly determined. Simultaneous measurements shall be made at one test noise measurement point at a symmetrical position on the other side of the runway.

5.3.2.3 The applicant shall demonstrate to the certificating authority that during flight test, lateral and flyover noise levels were not separately optimized at the expense of each other.

5.4 Maximum noise levels

5.4.1 The maximum noise levels, when determined in accordance with the noise evaluation method of Appendix 2, shall not exceed the following:

a) *at lateral reference noise measurement point:* 96 EPNdB constant limit for aeroplanes with maximum take-off mass, at which the noise certification is requested, up to 34 000 kg and increasing linearly with the logarithm of aeroplane mass at the rate of 2 EPNdB per doubling of mass from that point until the limit of 103 EPNdB is reached, after which the limit is constant;

b) *at flyover reference noise measurement point:* 89 EPNdB constant limit for aeroplanes with maximum take-off mass, at which the noise certification is requested, up to 34 000 kg and increasing linearly with the logarithm of aeroplane mass at the rate of 5 EPNdB per doubling of mass from that point until the limit of 106 EPNdB is reached, after which the limit is constant; and

c) *at approach reference noise measurement point:* 98 EPNdB constant limit for aeroplanes with maximum take-off mass, at which the noise certification is requested, up to 34 000 kg and increasing linearly with the logarithm of aeroplane mass at the rate of 2 EPNdB per doubling of mass from that point until the limit of 105 EPNdB is reached, after which the limit is constant.

Note.— See Attachment A for equations for the calculation of noise levels as a function of take-off mass.

5.5 Trade-offs

5.5.1 If the maximum noise levels are exceeded at one or two measurement points:

a) the sum of excesses shall not be greater than 3 EPNdB;

b) any excess at any single point shall not be greater than 2 EPNdB; and

c) any excesses shall be offset by corresponding reductions at the other point or points.

5.6 Noise certification reference procedures

5.6.1 General conditions

5.6.1.1 The reference procedures shall comply with the appropriate airworthiness requirements.

5.6.1.2 The calculations of reference procedures and flight paths shall be approved by the certificating authority.

5.6.1.3 Except in conditions specified in 5.6.1.4, the take-off and approach reference procedures shall be those defined in 5.6.2 and 5.6.3 respectively.

5.6.1.4 When it is shown by the applicant that the design characteristics of the aeroplane would prevent flight being conducted in accordance with 5.6.2 and 5.6.3, the reference procedures shall:

a) depart from the reference procedures defined in 5.6.2 and 5.6.3 only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and

b) be approved by the certificating authority.

5.6.1.5 The reference procedures shall be calculated under the following reference atmospheric conditions:

a) sea level atmospheric pressure of 1 013.25 hPa;

b) ambient air temperature of 25°C, i.e. ISA + 10°C except that at the discretion of the certificating authority, an alternative reference ambient air temperature of 15°C, i.e. ISA may be used;

c) relative humidity of 70 per cent; and

d) zero wind.

5.6.2 Take-off reference procedure

5.6.2.1 The take-off flight path shall be calculated as follows:

a) average take-off power shall be used from the start of take-off to the point where at least the height above runway level shown below is reached. The take-off power used shall be the maximum available for normal operations as scheduled in the performance section of the aeroplane flight manual for the reference atmospheric conditions given in 5.6.1.5.

— aeroplanes with two engines or less — 300 m (985 ft)

— aeroplanes with three engines — 260 m (855 ft)

— aeroplanes with four engines or more — 210 m (690 ft);

b) upon reaching the height specified in a) above, the power shall not be reduced below that required to maintain:

1) climb gradient of 4 per cent; or

2) in the case of multi-engined aeroplanes, level flight with one engine inoperative;

whichever power is the greater;

c) the speed shall be the all-engines operating take-off climb speed selected by the applicant for use in normal operation, which shall be at least V_2 + 19 km/h (V_2 + 10 kt) and which shall be attained as soon as practicable after lift-off and be maintained throughout the take-off noise certification test;

d) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted; and

e) the mass of the aeroplane at the brake-release shall be the maximum take-off mass at which the noise certification is requested.

5.6.3 Approach reference procedure

5.6.3.1 The approach reference flight path shall be calculated as follows:

a) the aeroplane shall be stabilized and following a 3° glide path;

b) the approach shall be made at a stabilized airspeed of not less than 1.3 V_S + 19 km/h (1.3 V_S + 10 kt) with power stabilized during approach and over the measuring point, and continued to a normal touchdown;

c) the constant approach configuration used in the airworthiness certification test, but with the landing gear down, shall be maintained throughout the approach reference procedure;

d) the mass of the aeroplane at the touchdown shall be the maximum landing mass permitted in the approach configuration defined in 5.6.3.1 c) at which noise certification is requested; and

e) the most critical (that which produces the highest noise levels) configuration at the mass at which certification is requested, shall be used.

5.7 Test procedures

5.7.1 The test procedures shall be acceptable to the airworthiness and noise certificating authority of the State issuing the certificate.

5.7.2 The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Appendix 2.

5.7.3 Acoustic data shall be adjusted by the methods outlined in Appendix 2 to the reference conditions specified in this chapter. Adjustments for speed and thrust shall be made as described in Section 9 of Appendix 2.

5.7.4 If the mass during the test is different from the mass at which the noise certification is requested, the necessary EPNL adjustment shall not exceed 2 EPNdB for take-offs and 1 EPNdB for approaches. Data approved by the certificating authority shall be used to determine the variation of EPNL with mass for both take-off and approach test conditions. Similarly, the necessary EPNL adjustment for variations in approach flight path from the reference flight path shall not exceed 2 EPNdB.

5.7.5 For the approach conditions the test procedures shall be accepted if the aeroplane follows a steady glide path angle of 3° ±0.5°.

5.7.6 If equivalent test procedures different from the reference procedures are used, the test procedures and all methods for adjusting the results to the reference procedures shall be approved by the certificating authority. The amounts of the adjustments shall not exceed 16 EPNdB on take-off and 8 EPNdB on approach, and if the adjustments are more than 8 EPNdB and 4 EPNdB respectively, the resulting numbers shall not be within 2 EPNdB of the limit noise levels specified in 5.4.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

CHAPTER 6. PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 9 000 kg — APPLICATION FOR CERTIFICATE OF AIRWORTHINESS FOR THE PROTOTYPE ACCEPTED BEFORE 17 NOVEMBER 1988

6.1 Applicability

Note 1.— See also Chapter 1, 1.6.

Note 2.— See Attachment E for guidance on interpretation of these applicability provisions.

6.1.1 The Standards of this chapter shall be applicable to all propeller-driven aeroplanes, except those aeroplanes specifically designed for aerobatic purposes or agricultural or fire fighting uses, of a maximum certificated take-off mass not exceeding 9 000 kg for which:

a) application for the certificate of airworthiness for the prototype was accepted, or another equivalent prescribed procedure was carried out by the certificating authority, on or after 1 January 1975 and before 17 November 1988, except for derived versions for which an application for a certificate of airworthiness was accepted or another equivalent procedure was carried out by the certificating authority on or after 17 November 1988 in which case the Standards of Chapter 10 apply; or

b) a certificate of airworthiness for the individual aeroplane was first issued on or after 1 January 1980.

6.2 Noise evaluation measure

6.2.1 The noise evaluation measure shall be a weighted over-all sound pressure level as defined in International Electrotechnical Commission (IEC) Publication 179*. The weighting applied to each sinusoidal component of the sound pressure shall be given as a function of frequency by the standard reference curve called "A".

6.3 Maximum noise levels

6.3.1 For aeroplanes specified in 6.1.1 a) and 6.1.1 b), the maximum noise levels when determined in accordance with the noise evaluation method of Appendix 3 shall not exceed the following:

— a 68 dB(A) constant limit up to an aeroplane mass of 600 kg, varying linearly with mass from that point to 1 500 kg, after which the limit is constant at 80 dB(A) up to 9 000 kg.

Note.— Where an aeroplane comes within the provisions of Chapter 10, 10.1.2, the limit of 80 dB(A) applies up to 9 000 kg.

6.4 Noise certification reference procedures

6.4.1 The reference procedure shall be calculated under the following reference atmospheric conditions:

a) sea level atomospheric pressure of 1 013.25 hPa;

b) ambient air temperature of 25°C, i.e. ISA + 10°C.

6.5 Test procedures

6.5.1 Either the test procedures described in 6.5.2 and 6.5.3 or equivalent test procedures approved by the certificating authority shall be used.

6.5.2 Tests to demonstrate compliance with the maximum noise levels of 6.3.1 shall consist of a series of level flights overhead the measuring station at a height of

$$300 \begin{smallmatrix}+10\\-30\end{smallmatrix} \text{ m } (985 \begin{smallmatrix}+30\\-100\end{smallmatrix} \text{ ft})$$

The aeroplane shall pass over the measuring point within ±10° from the vertical.

6.5.3 Overflight shall be performed at the highest power in the normal operating range**, stabilized airspeed and with the aeroplane in the cruise configuration.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

* As amended. Available from the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

** This is normally indicated in the Aeroplane Flight Manual and on the flight instruments.

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CHAPTER 7. PROPELLER-DRIVEN STOL AEROPLANES

Note.— Standards and Recommended Practices for this chapter are not yet developed. In the meantime, guidelines provided in Attachment B may be used for noise certification of propeller-driven STOL aeroplanes for which a certificate of airworthiness for the individual aeroplane was first issued on or after 1 January 1976.

CHAPTER 8. HELICOPTERS

8.1 Applicability

Note.— See also Chapter 1, 1.6.

8.1.1 The Standards of this chapter shall be applicable to all helicopters, except those designed exclusively for agricultural, fire fighting or external load carrying purposes, for which:

a) application for the certificate of airworthiness for the prototype was accepted, or another equivalent prescribed procedure was carried out by the certificating authority, on or after 1 January 1985; or

b) application for a change of type design, where such change may increase the helicopter's net noise level, was accepted, or other equivalent prescribed procedure was carried out by the certificating authority, on or after 17 November 1988.

Note 1.— Certification of helicopters which are capable of carrying external loads or equipment for specific purposes such as crop spraying should be made without such loads or equipment fitted.

Note 2.— Helicopters which comply with the standards with internal loads may be excepted when carrying external loads, if external load operations are conducted at a gross mass or with other operating parameters which are in excess of those certificated for airworthiness with internal loads.

8.1.2 An applicant under 8.1.1 may alternatively elect to show compliance with Chapter 11 instead of Chapter 8 if the helicopter has a maximum certificated take-off mass of 2 730 kg or less.

8.2 Noise evaluation measure

8.2.1 The noise evaluation measure shall be the effective perceived noise level in EPNdB as described in Appendix 2.

8.3 Reference noise measurement points

8.3.1 A helicopter, when tested in accordance with these Standards, shall not exceed the noise levels specified in 8.4 at the following points:

a) *Take-off reference noise measurement points*

1) a flight path reference point located on the ground vertically below the flight path defined in the take-off reference procedure (see 8.6.2.1) and 500 m horizontally in the direction of flight from the point at which transition to climbing flight is initiated in the reference procedure (see 8.6.2.1 b));

2) two other points on the ground symmetrically disposed at 150 m on both sides of the flight path defined in the take-off reference procedure and lying on a line through the flight path reference point.

b) *Overflight reference noise measurement points*

1) A flight path reference point located on the ground 150 m (490 ft) vertically below the flight path defined in the overflight reference procedure (see 8.6.3.1);

2) two other points on the ground symmetrically disposed at 150 m on both sides of the flight path defined in the overflight reference procedure and lying on a line through the flight path reference point.

c) *Approach reference noise measurement points*

1) a flight path reference point located on the ground 120 m (395 ft) vertically below the flight path defined in the approach reference procedure (see 8.6.4.1). On level ground, this corresponds to a position 1 140 m from the intersection of the 6.0° approach path with the ground plane;

2) two other points on the ground symmetrically disposed at 150 m on both sides of the flight path defined in the approach reference procedure and lying on a line through the flight path reference point.

8.4 Maximum noise levels

8.4.1 For helicopters specified in 8.1.1, the maximum noise levels when determined in accordance with the noise evaluation method of Appendix 2 shall not exceed the following:

8.4.1.1 *At the take-off flight path reference point:* 109 EPNdB for helicopters with maximum certificated take-off mass at which the noise certification is requested, of 80 000 kg and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 89 EPNdB after which the limit is constant.

8.4.1.2 *At the overflight path reference point:* 108 EPNdB for helicopters with maximum certificated take-off mass at which the noise certification is requested, of 80 000 kg and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 88 EPNdB after which the limit is constant.

8.4.1.3 *At the approach flight path reference point:* 110 EPNdB for helicopters with maximum certificated take-off mass at which the noise certification is requested, of 80 000 kg and over and decreasing linearly with the logarithm of the helicopter mass at a rate of 3 EPNdB per halving of mass down to 90 EPNdB after which the limit is constant.

Note.— See Attachment A for equations for the calculation of noise levels as a function of take-off mass.

8.5 Trade-offs

8.5.1 If the noise level limits are exceeded at one or two measurement points:

a) the sum of excesses shall not be greater than 4 EPNdB;

b) any excess at any single point shall not be greater than 3 EPNdB; and

c) any excess shall be offset by corresponding reductions at the other point or points.

8.6 Noise certification reference procedures

8.6.1 General conditions

8.6.1.1 The reference procedures shall comply with the appropriate airworthiness requirements.

8.6.1.2 The reference procedures and flight paths shall be approved by the certificating authority.

8.6.1.3 Except in conditions specified in 8.6.1.4, the take-off, overflight and approach reference procedures shall be those defined in 8.6.2, 8.6.3 and 8.6.4 respectively.

8.6.1.4 When it is shown by the applicant that the design characteristics of the helicopter would prevent flight being conducted in accordance with 8.6.2, 8.6.3 or 8.6.4, the reference procedures shall:

a) depart from the reference procedures defined in 8.6.2, 8.6.3 or 8.6.4 only to the extent demanded by those design characteristics which make compliance with the reference procedures impossible; and

b) be approved by the certificating authority.

8.6.1.5 The reference procedures shall be established for the following reference atmospheric conditions:

a) sea level atmospheric pressure of 1 013.25 hPa;

b) ambient air temperature of 25°C, i.e. ISA + 10°C except that, at the discretion of the certificating authority, an alternative reference ambient air temperature of 15°C, i.e. ISA may be used;

c) relative humidity of 70 per cent; and

d) zero wind.

8.6.1.6 In 8.6.2.1 d), 8.6.3.1 c) and 8.6.4.1 c), the maximum normal operating rpm shall be taken as the "maximum value in the normal rpm operating range" which is consistent with the airworthiness limitations for maximum rotor rpm for continuous (i.e. power on) operations.

8.6.2 Take-off reference procedure

8.6.2.1 The take-off reference flight procedure shall be established as follows:

a) the helicopter shall be stabilized at the maximum take-off power corresponding to minimum installed engine(s) specification power available for the reference ambient conditions or gearbox torque limit, whichever is lower, and along a path starting from a point located 500 m prior to the flight path reference point, at 20 m (65 ft) above the ground;

b) the best rate of climb speed V_y, or the lowest approved speed for the climb after take-off, whichever is the greater, shall be maintained throughout the take-off reference procedure;

c) the steady climb shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for take-off;

d) a constant take-off configuration selected by the applicant shall be maintained throughout the take-off reference procedure except that the landing gear may be retracted;

e) the mass of the helicopter shall be the maximum take-off mass at which noise certification is requested; and

f) the reference take-off path is defined as a straight line segment inclined from the starting point (500 m prior to the centre microphone location and 20 m (65 ft) above ground level) at an angle defined by Best Rate of Climb (BRC) and V_y for minimum specification engine performance.

8.6.3 Overflight reference procedure

8.6.3.1 The overflight reference procedure shall be established as follows:

a) the helicopter shall be stabilized in level flight overhead the flight path reference point at a height of 150 m (490 ft);

b) a speed of 0.9 V_H or 0.9 V_{NE}, or 0.45 V_H + 120 km/h (0.45 V_H + 65 kt) or 0.45 V_{NE} + 120 km/h (0.45 V_{NE} + 65 kt), whichever is the least, shall be maintained throughout the overflight reference procedure;

Note.— For noise certification purposes, V_H *is defined as the airspeed in level flight obtained using the torque corresponding to minimum engine installed, maximum continuous power available for sea level pressure (1 013.25 hPa), 25°C ambient conditions unless a lower airworthiness limit is imposed by the manufacturer and approved by the certificating authority.*

c) the overflight shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for level flight;

d) the helicopter shall be in the cruise configuration; and

e) the mass of the helicopter shall be the maximum take-off mass at which noise certification is requested.

8.6.4 Approach reference procedure

8.6.4.1 The approach reference procedure shall be established as follows:

a) the helicopter shall be stabilized and following a 6.0° approach path;

b) the approach shall be made at a stabilized airspeed equal to the best rate of climb speed V_y, or the lowest approved speed for the approach, whichever is the greater, with power stabilized during the approach and over the flight path reference point, and continued to a normal touchdown;

c) the approach shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for approach;

d) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure; and

e) the mass of the helicopter at touchdown shall be the maximum landing mass at which noise certification is requested.

8.7 Test procedures

8.7.1 The test procedures shall be acceptable to the airworthiness and noise certificating authority of the State issuing the certificate.

8.7.2 The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Appendix 2.

8.7.3 Test conditions and procedures shall be closely similar to reference conditions and procedures or the acoustic data shall be adjusted, by the methods outlined in Appendix 2, to the reference conditions and procedures specified in this chapter.

8.7.4 Adjustments for differences between test and reference flight procedures shall not exceed:

a) for take-off 4.0 EPNdB, of which the arithmetic sum of Δ_1 and the term $-7.5 \log (QK/Q_rK_r)$ from Δ_2 shall not in total exceed 2.0 EPNdB;

b) for overflight or approach 2.0 EPNdB.

8.7.5 During the test the average rotor rpm shall not vary from the normal maximum operating rpm by more than ±1.0 per cent during the 10 dB-down time period.

8.7.6 The helicopter airspeed shall not vary from the reference airspeed appropriate to the flight demonstration by more than ±9 km/h (5 kt) throughout the 10 dB-down time period.

8.7.7 The helicopter shall fly within ±10° or ±20 m, whichever is greater, from the vertical above the reference track throughout the 10 dB-down time period (see Figure 8-1).

8.7.8 During the approach noise demonstration the helicopter shall be established on a stabilized constant speed approach within the airspace contained between approach angles of 5.5° and 6.5°.

8.7.9 Tests shall be conducted at a helicopter mass not less than 90 per cent of the relevant maximum certificated mass and may be conducted at a mass not exceeding 105 per cent of the relevant maximum certificated mass.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

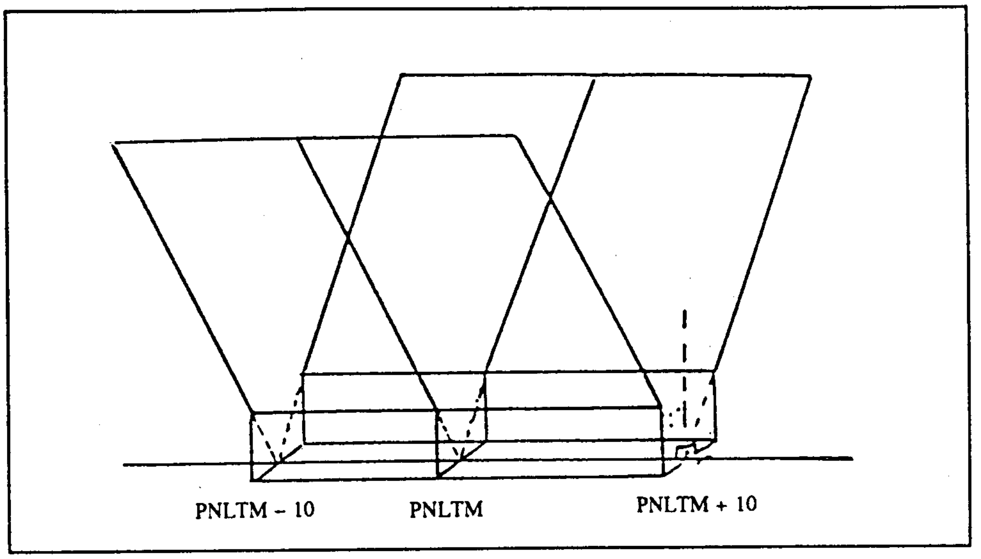

Figure 8-1. Helicopter lateral deviation tolerances

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CHAPTER 9. INSTALLED AUXILIARY POWER UNITS (APU) AND ASSOCIATED AIRCRAFT SYSTEMS DURING GROUND OPERATIONS

Note.— Standards and Recommended Practices for this Chapter are not yet developed. In the meantime, guidelines provided in Attachment C may be used for noise certification of installed auxiliary power units (APU) and associated aircraft systems in:

a) all aircraft for which application for a certificate of airworthiness for the prototype was accepted or another equivalent prescribed procedure was carried out by the certificating authority, on or after 6 October 1977; and

b) aircraft of existing type design for which application for a change of type design involving the basic APU installation was accepted or another equivalent prescribed procedure was carried out by the certificating authority, on or after 6 October 1977.

CHAPTER 10. PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 9 000 kg — APPLICATION FOR CERTIFICATE OF AIRWORTHINESS FOR THE PROTOTYPE OR DERIVED VERSION ACCEPTED ON OR AFTER 17 NOVEMBER 1988

10.1 Applicability

Note 1.— See also Chapter 1, 1.6.

Note 2.— See Attachment E for guidance on interpretation of these applicability provisions.

10.1.1 The Standards of this chapter shall be applicable to all propeller-driven aeroplanes and their derived versions, with a certificated take-off mass not exceeding 9 000 kg, except those aeroplanes specifically designed for aerobatic purposes and agricultural or fire fighting uses and self-sustaining powered sailplanes for which application for the certificate of airworthiness for the prototype or for all derived versions was accepted or another equivalent prescribed procedure was carried out by the certificating authority, on or after 17 November 1988.

10.1.2 For aeroplanes specified in 10.1.1 which fail to comply with the Standards of this chapter and where the application for the certificate of airworthiness for the prototype or all derived versions was accepted or another equivalent prescribed procedure was carried out by the certificating authority before 17 November 1993, the Standards of Chapter 6 shall apply.

10.2 Noise evaluation measure

The noise evaluation measure shall be the maximum A-weighted noise level (L_{Amax}) as defined in Appendix 6.

10.3 Reference noise measurement points

10.3.1 An aeroplane, when tested in accordance with these Standards, shall not exceed the noise level specified in 10.4 at the take-off reference noise measurement point.

10.3.2 The take-off reference noise measurement point is the point on the extended centre line of the runway at a distance of 2 500 m from the start of take-off roll.

10.4 Maximum noise levels

For aeroplanes specified in 10.1.1 the maximum noise levels determined in accordance with the noise evaluation method of Appendix 6 shall not exceed the following:

— A 76 dB(A) constant limit up to an aeroplane mass of 600 kg varying linearly from that point with the logarithm of aeroplane mass at the rate of 9.83 dB(A) per doubling of mass until the limit of 88 dB(A) is reached after which the limit is constant up to 9 000 kg.

10.5 Noise certification reference procedures

10.5.1 General conditions

10.5.1.1 The calculations of reference procedures and flight paths shall be approved by the certificating authority.

10.5.1.2 Except in conditions specified in 10.5.1.3, the take-off reference procedure shall be that defined in 10.5.2.

10.5.1.3 When it is shown by the applicant that the design characteristics of the aeroplane would prevent flights being conducted in accordance with 10.5.2, the reference procedures shall:

a) depart from the reference procedures defined only to the extent demanded by those design characteristics which make compliance with the procedures impossible; and

b) be approved by the certificating authority.

10.5.1.4 The reference procedures shall be calculated under the following atmospheric conditions:

a) sea level atmospheric pressure of 1 013.25 hPa;

b) ambient air temperature of 15°C, i.e. ISA;

c) relative humidity of 70 per cent; and

d) zero wind.

10.5.1.5 The acoustic reference atmospheric conditions shall be the same as the reference atmospheric conditions for flight.

10.5.2 Take-off reference procedure

The take-off flight path shall be calculated taking into account the following two phases.

First phase

a) Take-off power shall be used from the brake release point to the point at which the height of 15 m (50 ft) above the runway is reached.

b) A constant take-off configuration selected by the applicant shall be maintained throughout this first phase.

c) The mass of the aeroplane at the brake-release shall be the maximum take-off mass at which the noise certification is requested.

Note.— The length of this first phase shall correspond to the length given in the airworthiness data for a take-off on a level paved runway.

Second phase

a) The beginning of the second phase corresponds to the end of the first phase.

b) The aeroplane shall be in the climb configuration with landing gear up, if retractable, and flap setting corresponding to normal climb throughout this second phase.

c) The speed shall be the best rate of climb speed V_y.

d) The maximum power and rpm that can be continuously delivered by the engine or engines in this flight condition shall be maintained throughout the second phase (unless a lower limiting power is established by the certificating authority).

Note.— At sea level, standard atmospheric conditions, this power is normally obtained with full throttle for aeroplanes equipped with fixed-pitch propellers, with full throttle and maximum continuous engine rpm for aeroplanes equipped with normally aspirated engines and controllable-pitch or constant-speed propellers, and at maximum continuous manifold pressure and maximum continuous engine rpm for aeroplanes equipped with supercharged engines and controllable-pitch and constant-speed propellers. For engines with maximum continuous power installed that is less than the installed take-off power, the airworthiness limitations for maximum continuous power apply during the second phase climb.

10.6 Test procedures

10.6.1 The test procedures shall be acceptable to the airworthiness and noise certificating authorities of the State issuing the certificate.

10.6.2 The test procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure in units of L_{Amax} as described in Appendix 6.

10.6.3 Acoustic data shall be adjusted by the methods outlined in Appendix 6 to the reference conditions specified in this chapter.

10.6.4 If equivalent test procedures are used, the test procedures and all methods for correcting the results to the reference procedures shall be approved by the certificating authority.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

CHAPTER 11. HELICOPTERS NOT EXCEEDING 2 730 kg MAXIMUM CERTIFICATED TAKE-OFF MASS

11.1 Applicability

Note.— See also Chapter 1, 1.6.

11.1.1 The Standards of this chapter shall be applicable to all helicopters having a maximum certificated take-off mass not exceeding 2 730 kg, except those designed exclusively for agricultural, fire fighting or external load carrying purposes, for which:

a) the certificate of airworthiness for the prototype was issued, or another equivalent prescribed procedure was carried out by the certificating authority, on or after 11 November 1993; or

b) the certificate of airworthiness for a change of type design was issued, where such a change may increase the helicopter's overflight noise level, or another equivalent prescribed procedure was carried out by the certificating authority, on or after 11 November 1993.

Note 1.— Certification of helicopters which are capable of carrying external loads or equipment for specific purposes such as crop spraying should be made without such loads or equipment fitted.

Note 2.— Helicopters which comply with the standards with internal loads may be excepted when carrying external loads, if external load operations are conducted at a gross mass or with other operating parameters which are in excess of those certificated for airworthiness with internal loads.

11.1.2 An applicant under 11.1.1 may alternatively elect to show compliance with Chapter 8 instead of complying with this chapter.

11.2 Noise evaluation measure

The noise evaluation measure shall be the sound exposure level (SEL) as described in Appendix 4.

11.3 Reference noise measurement point

A helicopter, when tested in accordance with these Standards, shall not exceed the noise levels specified in 11.4 at a flight path reference point located on the ground 150 m (490 ft) vertically below the flight path defined in the overflight reference procedure (see 11.5.1.3).

11.4 Maximum noise level

For helicopters specified in 11.1.1, the maximum noise levels when determined in accordance with the noise evaluation method of Appendix 4 shall not exceed 82 decibels SEL for helicopters with maximum certificated take-off mass at which the noise certification is requested, of up to 788 kg and increasing at a rate of 3 decibels per doubling of mass thereafter.

11.5 Noise certification reference procedure

11.5.1 General conditions

11.5.1.1 The reference procedure shall comply with the appropriate airworthiness requirements and shall be approved by the certificating authority.

11.5.1.2 Except as otherwise approved, the overflight reference procedure shall be as defined in 11.5.2.

11.5.1.3 When it is shown by the applicant that the design characteristics of the helicopter would prevent flight being conducted in accordance with 11.5.2 the reference procedure shall be permitted to depart from the standard reference procedure, with the approval of the certificating authority, but only to the extent demanded by those design characteristics which make compliance with the reference procedures impossible.

11.5.1.4 The reference procedure shall be established for the following reference atmospheric conditions:

a) sea level atmospheric pressure of 1 013.25 hPa;

b) ambient air temperature of 25°C;

c) relative humidity of 70 per cent; and

d) zero wind.

11.5.1.5 The maximum normal operating rpm shall be taken as the maximum value in the normal rpm operating range which is consistent with the airworthiness limitations for maximum rotor rpm for continuous (i.e. power on) operations.

11.5.2 Reference procedure

The reference procedure shall be established as follows:

a) the helicopter shall be stabilized in level flight overhead the flight path reference point at a height of 150 m (490 ft);

b) a speed of 0.9 V_H or 0.9 V_{NE} or 0.45 V_H + 120 km/h (65 kt) or 0.45 V_{NE} + 120 km/h (65 kt), whichever is the least, shall be maintained throughout the overflight reference procedure. For noise certification purposes, V_H is defined as the airspeed in level flight obtained using the torque corresponding to minimum engine installed, maximum continuous power available for sea level pressure (1 013.25 hPa), 25°C ambient conditions unless a lower airworthiness limit is imposed by the manufacturer and approved by the certificating authority;

c) the overflight shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for level flight;

d) the helicopter shall be in the cruise configuration; and

e) the mass of the helicopter shall be the maximum take-off mass at which noise certification is requested.

11.6 Test procedures

11.6.1 The test procedure shall be acceptable to the airworthiness and noise certificating authority of the State issuing the certificate.

11.6.2 The test procedure and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as sound exposure level (SEL) in A-weighted decibels, as described in Appendix 4.

11.6.3 Test conditions and procedures shall be closely similar to reference conditions and procedures or the acoustic data shall be adjusted, by the methods outlined in Appendix 4, to the reference conditions and procedures specified in this chapter.

11.6.4 During the test, flights shall be made in equal numbers with tail and head wind components.

11.6.5 Adjustments for differences between test and reference flight procedures shall not exceed 2.0 dB(A).

11.6.6 During the test, the average rotor rpm shall not vary from the normal maximum operating rpm by more than ±1.0 per cent during the 10 dB-down time period.

11.6.7 The helicopter airspeed shall not vary from the reference airspeed appropriate to the flight demonstration by more than ±5 km/h (±3 kt) throughout the 10 dB-down time period.

11.6.8 The helicopter shall fly within ±10° from the vertical above the reference track through the reference noise measurement position throughout the 10 dB-down time period.

11.6.9 Tests shall be conducted at a helicopter mass not less than 90 per cent of the relevant maximum certificated mass and may be conducted at a mass not exceeding 105 per cent of the relevant maximum certificated mass.

Note.— Guidance material on the use of equivalent procedures is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

PART III. NOISE MEASUREMENT FOR MONITORING PURPOSES

Note.— The following Recommendation has been developed to assist States which measure noise for monitoring purposes, until such time as agreement on a single method can be reached.

Recommendation.— *Where the measurement of aircraft noise is made for monitoring purposes, the method of Appendix 5 should be used.*

Note.— These purposes are described as including: monitoring compliance with and checking the effectiveness of such noise abatement requirements as may have been established for aircraft in flight or on the ground. An indication of the degree of correlation between values obtained by the method used for measuring noise for aircraft design purposes and the method(s) used for monitoring purposes would be necessary.

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PART IV. ASSESSMENT OF AIRPORT NOISE

Note.— The following Recommendations have been developed for the purpose of promoting international communication between States that have adopted a variety of methods of assessing noise for land-use planning purposes.

1. **Recommendation.—** *Where international comparison of noise assessment around airports is undertaken, the methodology described in* Recommended Method for Computing Noise Contours around Airports *(Circ. 205) should be used.*

2. **Recommendation.—** *Contracting States that have not yet adopted, or are considering changing a national noise assessment methodology, should use the methodology described in* Recommended Method for Computing Noise Contours around Airports *(Circ. 205).*

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PART V. CRITERIA FOR THE APPLICATION OF NOISE ABATEMENT OPERATING PROCEDURES

Note.— Provisions in Part II of this Annex are aimed at noise certification which characterizes the maximum noise emitted by the aircraft. However, noise abatement procedures approved by national authorities and included in operations manuals allow a reduction of noise during aircraft operations.

1. Aircraft operating procedures for noise abatement shall not be introduced unless the regulatory authority, based on appropriate studies and consultation, determines that a noise problem exists.

2. **Recommendation.—** *Aircraft operating procedures for noise abatement should be developed in consultation with the operators which use the aerodrome concerned.*

3. **Recommendation.—** *The factors to be taken into consideration in the development of appropriate aircraft operating procedures for noise abatement should include the following:*

a) the nature and extent of the noise problem including:

1) the location of noise sensitive areas; and

2) critical hours.

b) the types of aircraft affected, including aircraft mass, aerodrome elevation, temperature considerations;

c) the types of procedures likely to be most effective; and

d) obstacle clearances (PANS-OPS (Doc 8168), Volumes I and II).

Note.— See Annex 6, Part I, Chapter 4 for aeroplane noise abatement operating procedures.

APPENDIX 1. EVALUATION METHOD FOR NOISE CERTIFICATION OF SUBSONIC JET AEROPLANES — APPLICATION FOR CERTIFICATE OF AIRWORTHINESS FOR THE PROTOTYPE ACCEPTED BEFORE 6 OCTOBER 1977

Note 1.— See Part II, Chapter 2.

Note 2.— The procedures in this appendix also apply to certain aircraft types covered in Chapters 4 and 5.

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

a) noise certification test and measurement conditions;

b) measurement of aeroplane noise received on the ground;

c) calculation of effective perceived noise level from measured noise data; and

d) reporting of data to the certificating authority and correcting measured data.

Note 2.— The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests, and to permit comparison between tests of various types of aeroplanes, conducted in various geographical locations. It applies only to aeroplanes within the applicability clauses of Part II, Chapter 2.

Note 3.— A complete list of symbols and units, the mathematical formulation of perceived noisiness, a procedure for determining atmospheric attenuation of sound, and detailed procedures for correcting noise levels from non-reference to reference conditions are included in Sections 6 to 9 of this appendix.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

2.1.1 This section prescribes the conditions under which noise certification tests shall be conducted and the measurement procedures that shall be used.

Note.— Many applications for a noise certificate involve only minor changes to the aeroplane type design. The resultant changes in noise can often be established reliably without the necessity of resorting to a complete test as outlined in this appendix. For this reason certificating authorities are encouraged to permit the use of appropriate "equivalent procedures". Also, there are equivalent procedures that may be used in full certification tests, in the interest of reducing costs and providing reliable results. Guidance material on the use of equivalent procedures in the noise certification of subsonic jet aeroplanes is provided in the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

2.2 General test conditions

2.2.1 Tests to show compliance with established noise certification levels shall consist of a series of take-offs and landings during which measurements shall be taken at the measuring points specified by the certificating authority. These points are typically:

a) the flyover noise measurement point*;

b) the approach noise measurement point; and

c) the lateral noise measurement point(s)**,

which for noise certification purposes are specified in Part II, Chapter 2, 2.3. To ensure that the maximum subjective noise level along the lateral is obtained, a sufficient number of lateral stations shall be used. To establish whether any asymmetry exists in the noise field at least one measuring station shall be located along the alternative lateral. On each test take-off simultaneous measurements shall be made at the lateral measuring points on both sides of the runway and also at the take-off flyover measuring point.

* Sometimes referred to as the take-off noise measurement point.

** Sometimes referred to as the sideline measurement point(s).

2.2.2 Locations for measuring noise from an aeroplane in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted, or tall grass, shrubs, or wooded areas. No obstructions which significantly influence the sound field from the aeroplane shall exist within a conical space above the measurement position, the cone being defined by an axis normal to the ground and by a half-angle 75° from this axis. If the height of the ground at any measuring point differs from that of the nearest point on the runway by more than 6 m (20 ft), corrections shall be made.

Note.— Those people carrying out the measurements could themselves constitute such obstructions.

2.2.3 The tests shall be carried out under the following atmospheric conditions:

a) no precipitation;

b) relative humidity not higher than 90 per cent or lower than 30 per cent;

c) ambient temperature not above 30°C and not below 2°C at 10 m (33 ft) above ground;

d) average wind, not above 19 km/h (10 kt) and average cross-wind component not above 9 km/h (5 kt) at 10 m (33 ft) above ground. A 30-second averaging period spanning the 10 dB-down time interval is recommended; and

e) no temperature inversion or anomalous wind conditions that would significantly affect the noise level of the aeroplane when the noise is recorded at the measuring points specified by the certificating authority.

2.3 Aeroplane testing procedures

2.3.1 The test procedures shall be acceptable to the airworthiness and noise certificating authorities of the State issuing the certificate.

2.3.2 The aeroplane testing procedures and noise measurements shall be conducted and processed in an approved manner to yield the noise evaluation measure designated as effective perceived noise level, EPNL, in units of EPNdB, as described in Section 4 of this appendix.

2.3.3 The aeroplane height and lateral position relative to the extended centre line of the runway shall be determined by a method independent of normal flight instrumentation such as radar tracking, theodolite triangulation, or photographic scaling techniques to be approved by the certificating authority.

2.3.4 The aeroplane position along the flight path shall be related to the noise recorded at the noise measurement locations by means of synchronizing signals. The position of the aeroplane shall be recorded relative to the runway from a point at least 7.4 km (4 NM) from threshold during the approach and at least 11 km (6 NM) from the start of roll during take-off.

2.3.5 If the take-off test is conducted at a mass different from the maximum take-off mass at which noise certification is requested the necessary EPNL correction shall not exceed 2 EPNdB. If the approach test is conducted at a mass different from the maximum landing mass at which noise certification is requested the EPNL correction shall not exceed 1 EPNdB. Data approved by the certificating authority shall be used to determine the variation of EPNL with mass for both take-off and approach test conditions.

2.4 Measurements

2.4.1 Position and performance data required to make the corrections referred to in Section 5 of this appendix shall be automatically recorded at an approved sampling rate. The position of the aeroplane shall be recorded relative to the runway from a point at least 7.4 km (4 NM) from threshold to touchdown during the approach and at least 11 km (6 NM) from the start of roll during the take-off. Measuring equipment shall be approved by the certificating authority.

2.4.2 Position and performance data shall be corrected by the methods outlined in Section 5 of this appendix to the meteorological reference conditions specified in 5.3.1 a).

2.4.3 Acoustic data shall be corrected by the methods outlined in Section 5 of this appendix to the meteorological reference conditions specified in 5.3.1 a) 1), 2) and 3). Acoustic data corrections shall also be made for variations of the test minimum distance from the reference minimum distance between the aeroplane's approach path and the approach measuring point, a take-off path vertically above the flyover measuring point and for differences of more than 6 m (20 ft) in elevation of measuring locations relative to the elevation of the nearest point of the runway.

2.4.4 The aerodrome tower or another facility shall be approved for use as the central location at which measurements of atmospheric parameters are representative of those conditions existing over the geographical area in which aeroplane noise measurements are made. However, the surface wind velocity and ambient air temperature shall be measured near the microphone position at the approach, sideline, and take-off measurement locations, and the tests shall not be acceptable unless the conditions conform to Section 2 of this appendix.

3. MEASUREMENT OF AEROPLANE NOISE RECEIVED ON THE GROUND

3.1 General

3.1.1 The measurements shall provide the data for determining one-third octave band noise produced by aeroplanes during flight, at any required observation stations, as a function of time.

3.1.2 Methods for determination of the distance from the observation stations to the aeroplane shall include theodolite triangulation techniques, scaling aeroplane dimensions on photographs made as the aeroplane flies directly over the measurement points, radar altimeters, and radar tracking systems. The method used shall be approved by the certificating authority.

3.1.3 Sound pressure level data for noise evaluation purposes shall be obtained with approved acoustical equipment and measurement practices that conform to the specifications given hereunder (in 3.2 to 3.4).

3.2 Measurement system

3.2.1 The acoustical measurement system shall consist of approved equipment equivalent to the following:

a) a microphone system with frequency response compatible with measurement and analysis system accuracy as stated in 3.3;

b) tripods or similar microphone mountings that minimize interference with the sound being measured;

c) recording and reproducing equipment characteristics, frequency response, and dynamic range compatible with the response and accuracy requirements of 3.3;

d) acoustic calibrators using sine wave or broadband noise of known sound pressure level. If broadband noise is used, the signal shall be described in terms of its average and maximum root-mean-square (rms) value for non-overload signal level;

e) analysis equipment with the response and accuracy requirements of 3.4.

3.3 Sensing, recording and reproducing equipment

3.3.1 The sound produced by the aeroplane shall be recorded in such a way that the complete information, time history included, is retained. A magnetic tape recorder is acceptable.

3.3.2 The characteristics of the system shall comply with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 179* with regard to the sections concerning microphone and amplifier characteristics.

Note.— The text and specifications of IEC Publication No. 179 entitled "Precision Sound Level Meters" are incorporated by reference into this Appendix and are made a part hereof.***

3.3.3 The response of the complete system to a sensibly plane progressive sinusoidal wave of constant amplitude shall lie within the tolerance limits specified in IEC Publication No. 179*, over the frequency range 45 to 11 200 Hz.

3.3.4 If limitations of the dynamic range of the equipment make it necessary, high frequency pre-emphasis shall be added to the recording channel with the converse de-emphasis on playback. The pre-emphasis shall be so applied that the instantaneous recorded sound pressure level between 800 and 11 200 Hz of the maximum measured noise signal does not vary more than 20 dB between the levels of the maximum and minimum one-third octave bands.

3.3.5 The equipment shall be acoustically calibrated using facilities for acoustic free-field calibration and electronically calibrated as stated in 3.4.

3.3.6 A wind screen shall be employed with the microphone during all measurements of aeroplane noise when the wind speed is in excess of 11 km/h (6 kt). Corrections for any insertion loss produced by the wind screen, as a function of frequency, shall be applied to the measured data and the corrections applied shall be reported.

3.4 Analysis equipment

3.4.1 A frequency analysis of the acoustical signal shall be performed in a manner equivalent to using one-third octave filters complying with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 225*.

Note.— The text and specifications of IEC Publication No. 225 entitled "Octave, Half-Octave and Third-Octave Band Filters Intended for the Analysis of Sounds and Vibrations" are incorporated by reference into this appendix and are made a part hereof.****

* As amended.

** This publication was first issued in 1965 by the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

*** This publication was first issued in 1966 by the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

3.4.2 A set of 24 consecutive one-third octave filters or its equivalent shall be used. The first filter of the set shall be centred at a geometric mean frequency of 50 Hz and the last shall be centred at a geometric mean frequency of 10 kHz.

3.4.3 The analyser indicating device shall be analog, digital, or a combination of both. The preferred sequence of signal processing shall be:

a) squaring the one-third octave filter outputs;

b) averaging or integrating; and

c) linear to logarithmic conversion.

The indicating device shall have a minimum crest factor capacity of 3 and shall measure, within a tolerance of ±1.0 dB, the true root-mean-square (rms) level of the signal in each of the 24 one-third octave bands. If other than a true rms device is utilized, it shall be calibrated for nonsinusoidal signals and time varying levels. The calibration shall provide means for converting the output levels to true rms values.

3.4.4 The dynamic response of the analyser to input signals of both full-scale and 20 dB less than full-scale amplitude, shall conform to the following two requirements:

a) the maximum output value shall read 4 dB ±1 dB less than the value obtained for a steady state signal of the same frequency and amplitude when a sinusoidal pulse of 0.5 s duration at the centre frequency of each one-third octave band is applied to the input;

b) the maximum output value shall exceed the final steady state value by 0.5 ±0.5 dB when a steady state sinusoidal signal at the geometrical mean frequency of each one-third octave band is suddenly applied to the analyser input and held constant.

3.4.5 A single value of the rms level shall be provided every 0.5 ±0.01 s for each of the 24 one-third octave bands. The levels from all of the 24 one-third octave bands shall be obtained within a 50 ms period. No more than 5 ms of data from any 0.5 s period shall be excluded from the measurement.

3.4.6 The amplitude resolution of the analyser shall be 0.50 dB or less.

3.4.7 Each output level from the analyser shall be accurate within ±1.0 dB with respect to the input signal, after all systematic errors have been eliminated. The total systematic errors for each of the output levels shall not exceed ±3 dB. For contiguous filter systems, the systematic correction between adjacent one-third octave channels shall not exceed 4 dB.

3.4.8 The dynamic range capability of the analyser for display of a single aeroplane noise event shall be at least 45 dB in terms of the difference between full-scale output level and the maximum noise level of the analyser equipment.

3.4.9 The complete electronic system shall be subjected to a frequency and amplitude electrical calibration by the use of sinusoidal or broadband signals at frequencies covering the range of 45 to 11 200 Hz, and of known amplitudes covering the range of signal levels furnished by the microphone. If broadband signals are used, they shall be described in terms of their average and maximum rms values for a non-overload signal level.

3.5 Noise measurement procedures

3.5.1 The microphones shall be oriented in a known direction so that the maximum sound received arrives as nearly as reasonable in the direction for which the microphones are calibrated. The microphones shall be placed so that their sensing elements are approximately 1.2 m (4 ft) above ground.

3.5.2 Immediately prior to and after each test, a recorded acoustic calibration of the system shall be made in the field with an acoustic calibrator for the two purposes of checking system sensitivity and providing an acoustic reference level for the analysis of the sound level data.

3.5.3 For the purpose of minimizing equipment or operator error, field calibrations shall be supplemented whenever practicable with the use of an insert voltage device to place a known signal at the input of the microphone, just prior to and after recording aeroplane noise data.

3.5.4 The ambient noise, including both acoustical background and electrical noise of the measurement systems, shall be recorded and determined in the test area with the system gain set at levels which will be used for aeroplane noise measurements. If aeroplane sound pressure levels do not exceed the background sound pressure levels by at least 10 dB in any significant one-third octave band, approved corrections for the contribution of background sound pressure level to the observed sound pressure level shall be applied.

4. CALCULATION OF EFFECTIVE PERCEIVED NOISE LEVEL FROM MEASURED NOISE DATA

4.1 General

4.1.1 The basic element in the noise certification criteria shall be the noise evaluation measure designated effective perceived noise level, EPNL, in units of EPNdB, which is a single number evaluator of the subjective effects of aeroplane noise on human beings. Simply stated, EPNL

Table 1-1. Noys as a function of sound pressure level (29<SPL<89)

SPL (dB)	One-third octave band centre frequencies (Hz) 50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
29																			1.00	1.00				
30																		1.00	1.07	1.07	1.00			
31																		1.07	1.15	1.15	1.07	1.00		
32																	1.00	1.15	1.23	1.23	1.15	1.07		
33																	1.07	1.23	1.32	1.32	1.23	1.15		
34																1.00	1.15	1.32	1.41	1.41	1.32	1.23		
35																1.07	1.23	1.41	1.51	1.51	1.41	1.32		
36																1.15	1.32	1.51	1.62	1.62	1.51	1.41		
37																1.23	1.41	1.62	1.74	1.74	1.62	1.51	1.00	
38															1.00	1.32	1.51	1.74	1.86	1.86	1.74	1.62	1.10	
39															1.07	1.41	1.62	1.86	1.99	1.99	1.86	1.74	1.21	
40										1.00	1.00	1.00	1.00	1.00	1.15	1.51	1.74	1.99	2.14	2.14	1.99	1.86	1.34	
41										1.07	1.07	1.07	1.07	1.07	1.23	1.62	1.86	2.14	2.29	2.29	2.14	1.99	1.48	1.00
42									1.00	1.15	1.15	1.15	1.15	1.15	1.32	1.74	1.99	2.29	2.45	2.45	2.29	2.14	1.63	1.10
43									1.07	1.23	1.23	1.23	1.23	1.23	1.41	1.86	2.14	2.45	2.63	2.63	2.45	2.29	1.79	1.21
44								1.00	1.15	1.32	1.32	1.32	1.32	1.32	1.52	1.99	2.29	2.63	2.81	2.81	2.63	2.45	1.99	1.34
45								1.08	1.24	1.41	1.41	1.41	1.41	1.41	1.62	2.14	2.45	2.81	3.02	3.02	2.81	2.63	2.14	1.48
46							1.00	1.16	1.33	1.52	1.52	1.52	1.52	1.52	1.74	2.29	2.63	3.02	3.23	3.23	3.02	2.81	2.29	1.63
47							1.08	1.25	1.42	1.62	1.62	1.62	1.62	1.62	1.87	2.45	2.81	3.23	3.46	3.46	3.23	3.02	2.45	1.79
48						1.00	1.17	1.34	1.53	1.74	1.74	1.74	1.74	1.74	2.00	2.63	3.02	3.46	3.71	3.71	3.46	3.23	2.63	1.98
49						1.08	1.26	1.45	1.64	1.87	1.87	1.87	1.87	1.87	2.14	2.81	3.23	3.71	3.97	3.97	3.71	3.46	2.81	2.15
50						1.17	1.36	1.56	1.76	2.00	2.00	2.00	2.00	2.00	2.30	3.02	3.46	3.97	4.26	4.26	3.97	3.71	3.02	2.40
51					1.00	1.26	1.47	1.68	1.89	2.14	2.14	2.14	2.14	2.14	2.46	3.23	3.71	4.26	4.56	4.56	4.26	3.97	3.23	2.63
52					1.08	1.36	1.58	1.80	2.03	2.30	2.30	2.30	2.30	2.30	2.64	3.46	3.97	4.56	4.89	4.89	4.56	4.26	3.46	2.81
53				1.00	1.18	1.47	1.71	1.94	2.17	2.46	2.46	2.46	2.46	2.46	2.83	3.71	4.26	4.89	5.24	5.24	4.89	4.56	3.71	3.02
54				1.09	1.28	1.58	1.85	2.09	2.33	2.64	2.64	2.64	2.64	2.64	3.03	3.97	4.56	5.24	5.61	5.61	5.24	4.89	3.97	3.23
55				1.18	1.38	1.71	2.00	2.25	2.50	2.83	2.83	2.83	2.83	2.83	3.25	4.26	4.89	5.61	6.01	6.01	5.61	5.24	4.26	3.46
56			1.00	1.29	1.50	1.85	2.15	2.42	2.69	3.03	3.03	3.03	3.03	3.03	3.48	4.56	5.24	6.01	6.44	6.44	6.01	5.61	4.56	3.71
57			1.09	1.40	1.63	2.00	2.33	2.61	2.88	3.25	3.25	3.25	3.25	3.25	3.73	4.89	5.61	6.44	6.90	6.90	6.44	6.01	4.89	3.97
58			1.18	1.53	1.77	2.15	2.51	2.81	3.10	3.48	3.48	3.48	3.48	3.48	4.00	5.24	6.01	6.90	7.39	7.39	6.90	6.44	5.24	4.26
59			1.29	1.66	1.92	2.33	2.71	3.03	3.32	3.73	3.73	3.73	3.73	3.73	4.29	5.61	6.44	7.39	7.92	7.92	7.39	6.90	5.61	4.56
60		1.00	1.40	1.81	2.08	2.51	2.93	3.26	3.57	4.00	4.00	4.00	4.00	4.00	4.59	6.01	6.90	7.92	8.49	8.49	7.92	7.39	6.01	4.89
61		1.10	1.53	1.97	2.26	2.71	3.16	3.51	3.83	4.29	4.29	4.29	4.29	4.29	4.92	6.44	7.39	8.49	9.09	9.09	8.49	7.92	6.44	5.24
62		1.21	1.66	2.15	2.45	2.93	3.41	3.78	4.11	4.59	4.59	4.59	4.59	4.59	5.28	6.90	7.92	9.09	9.74	9.74	9.09	8.49	6.90	5.61
63		1.32	1.81	2.34	2.65	3.16	3.69	4.06	4.41	4.92	4.92	4.92	4.92	4.92	5.66	7.39	8.49	9.74	10.4	10.4	9.74	9.09	7.39	6.01
64	1.00	1.45	1.97	2.54	2.88	3.41	3.98	4.38	4.73	5.28	5.28	5.28	5.28	5.28	6.06	7.92	9.09	10.4	11.2	11.2	10.4	9.74	7.92	6.44
65	1.11	1.60	2.15	2.77	3.12	3.69	4.30	4.71	5.08	5.66	5.66	5.66	5.66	5.66	6.50	8.49	9.74	11.2	12.0	12.0	11.2	10.4	8.49	6.90
66	1.22	1.75	2.34	3.01	3.39	3.98	4.64	5.07	5.45	6.06	6.06	6.06	6.06	6.06	6.96	9.09	10.4	12.0	12.8	12.8	12.0	11.2	9.09	7.39
67	1.35	1.92	2.54	3.28	3.68	4.30	5.01	5.46	5.85	6.50	6.50	6.50	6.50	6.50	7.46	9.74	11.2	12.8	13.8	13.8	12.8	12.0	9.74	7.92
68	1.49	2.11	2.77	3.57	3.99	4.64	5.41	5.88	6.27	6.96	6.96	6.96	6.96	6.96	8.00	10.4	12.0	13.8	14.7	14.7	13.8	12.8	10.4	8.49
69	1.65	2.32	3.01	3.88	4.33	5.01	5.84	6.33	6.73	7.46	7.46	7.46	7.46	7.46	8.57	11.2	12.8	14.7	15.8	15.8	14.7	13.8	11.2	9.09
70	1.82	2.55	3.28	4.23	4.69	5.41	6.31	6.81	7.23	8.00	8.00	8.00	8.00	8.00	9.19	12.0	13.8	15.8	16.9	16.9	15.8	14.7	12.0	9.74
71	2.02	2.79	3.57	4.60	5.09	5.84	6.81	7.33	7.75	8.57	8.57	8.57	8.57	8.57	9.85	12.8	14.7	16.9	18.1	18.1	16.9	15.8	12.8	10.4
72	2.23	3.07	3.88	5.01	5.52	6.31	7.36	7.90	8.32	9.19	9.19	9.19	9.19	9.19	10.6	13.8	15.8	18.1	19.4	19.4	18.1	16.9	13.8	11.2
73	2.46	3.37	4.23	5.45	5.99	6.81	7.94	8.50	8.93	9.85	9.85	9.85	9.85	9.85	11.3	14.7	16.9	19.4	20.8	20.8	19.4	18.1	14.7	12.0
74	2.72	3.70	4.60	5.94	6.50	7.36	8.57	9.15	9.59	10.6	10.6	10.6	10.6	10.6	12.1	15.8	18.1	20.8	22.3	22.3	20.8	19.4	15.8	12.8
75	3.01	4.06	5.01	6.46	7.05	7.94	9.19	9.85	10.3	11.3	11.3	11.3	11.3	11.3	13.0	16.9	19.4	22.3	23.9	23.9	22.3	20.8	16.9	13.8
76	3.32	4.46	5.45	7.03	7.65	8.57	9.85	10.6	11.0	12.1	12.1	12.1	12.1	12.1	13.9	18.1	20.8	23.9	25.6	25.6	23.9	22.3	18.1	14.7
77	3.67	4.89	5.94	7.66	8.29	9.19	10.6	11.3	11.8	13.0	13.0	13.0	13.0	13.0	14.9	19.4	22.3	25.6	27.4	27.4	25.6	23.9	19.4	15.8
78	4.06	5.37	6.46	8.33	9.00	9.85	11.3	12.1	12.7	13.9	13.9	13.9	13.9	13.9	16.0	20.8	23.9	27.4	29.4	29.4	27.4	25.6	20.8	16.9
79	4.49	5.90	7.03	9.07	9.76	10.6	12.1	13.0	13.6	14.9	14.9	14.9	14.9	14.9	17.1	22.3	25.6	29.4	31.5	31.5	29.4	27.4	22.3	18.1
80	4.96	6.48	7.66	9.85	10.6	11.3	13.0	13.9	14.6	16.0	16.0	16.0	16.0	16.0	18.4	23.9	27.4	31.5	33.7	33.7	31.5	29.4	23.9	19.4
81	5.48	7.11	8.33	10.6	11.3	12.1	13.9	14.9	15.7	17.1	17.1	17.1	17.1	17.1	19.7	25.6	29.4	33.7	36.1	36.1	33.7	31.5	25.6	20.8
82	6.06	7.81	9.07	11.3	12.1	13.0	14.9	16.0	16.9	18.4	18.4	18.4	18.4	18.4	21.1	27.4	31.5	36.1	38.7	38.7	36.1	33.7	27.4	22.3
83	6.70	8.57	9.87	12.1	13.0	13.9	16.0	17.1	18.1	19.7	19.7	19.7	19.7	19.7	22.6	29.4	33.7	38.7	41.5	41.5	38.7	36.1	29.4	23.9
84	7.41	9.41	10.7	13.0	13.9	14.9	17.1	18.4	19.4	21.1	21.1	21.1	21.1	21.1	24.3	31.5	36.1	41.5	44.4	44.4	41.5	38.7	31.5	25.6
85	8.19	10.3	11.7	13.9	14.9	16.0	18.4	19.7	20.8	22.6	22.6	22.6	22.6	22.6	26.0	33.7	38.7	44.4	47.6	47.6	44.4	41.5	33.7	27.4
86	9.05	11.3	12.7	14.9	16.0	17.1	19.7	21.1	22.4	24.3	24.3	24.3	24.3	24.3	27.9	36.1	41.5	47.6	51.0	51.0	47.6	44.4	36.1	29.4
87	10.0	12.1	13.9	16.0	17.1	18.4	21.1	22.6	24.0	26.0	26.0	26.0	26.0	26.0	29.9	38.7	44.4	51.0	54.7	54.7	51.0	47.6	38.7	31.5
88	11.1	13.0	14.9	17.1	18.4	19.7	22.6	24.3	25.8	27.9	27.9	27.9	27.9	27.9	32.0	41.5	47.6	54.7	58.6	58.6	54.7	51.0	41.5	33.7
89	12.2	13.9	16.0	18.4	19.7	21.1	24.3	26.0	27.7	29.9	29.9	29.9	29.9	29.9	34.3	44.4	51.0	58.6	62.7	62.7	58.6	54.7	44.4	36.1

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Table 1-1 (cont.). Noys as a function of sound pressure level (90<SPL<150)

SPL (dB)	One-third octave band centre frequencies (Hz) 50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
90	13.5	14.9	17.1	19.7	21.1	22.6	26.0	27.9	29.7	32.0	32.0	32.0	32.0	32.0	36.8	47.6	54.7	62.7	67.2	67.2	62.7	58.6	47.6	38.7
91	14.9	16.0	18.4	21.1	22.6	24.3	27.9	29.9	31.8	34.3	34.3	34.3	34.3	34.3	39.4	51.0	58.6	67.2	72.0	72.0	67.2	62.7	51.0	41.5
92	16.0	17.1	19.7	22.6	24.3	26.0	29.9	32.0	34.2	36.8	36.8	36.8	36.8	36.8	42.2	54.7	62.7	72.0	77.2	77.2	72.0	67.2	54.7	44.4
93	17.1	18.4	21.1	24.3	26.0	27.9	32.0	34.3	36.7	39.4	39.4	39.4	39.4	39.4	45.3	58.6	67.2	77.2	82.7	82.7	77.2	72.0	58.6	47.6
94	18.4	19.7	22.6	26.0	27.9	29.9	34.3	36.8	39.4	42.2	42.2	42.2	42.2	42.2	48.5	62.7	72.0	82.7	88.6	88.6	82.7	77.2	62.7	51.0
95	19.7	21.1	24.3	27.9	29.9	32.0	36.8	39.4	42.2	45.3	45.3	45.3	45.3	45.3	52.0	67.2	77.2	88.6	94.9	94.9	88.6	82.7	67.2	54.7
96	21.1	22.6	26.0	29.9	32.0	34.3	39.4	42.2	45.3	48.5	48.5	48.5	48.5	48.5	55.7	72.0	82.7	94.9	102	102	94.9	88.6	72.0	58.6
97	22.6	24.3	27.9	32.0	34.3	36.8	42.2	45.3	48.5	52.0	52.0	52.0	52.0	52.0	59.7	77.2	88.6	102	109	109	102	94.9	77.2	62.7
98	24.3	26.0	29.9	34.3	36.8	39.4	45.3	48.5	52.0	55.7	55.7	55.7	55.7	55.7	64.0	82.7	94.9	109	117	117	109	102	82.7	67.2
99	26.0	27.9	32.0	36.8	39.4	42.2	48.5	52.0	55.7	59.7	59.7	59.7	59.7	59.7	68.6	88.6	102	117	125	125	117	109	88.6	72.0
100	27.9	29.9	34.3	39.4	42.2	45.3	52.0	55.7	59.7	64.0	64.0	64.0	64.0	64.0	73.5	94.9	109	125	134	134	125	117	94.9	77.2
101	29.9	32.0	36.8	42.2	45.3	48.5	55.7	59.7	64.0	68.6	68.6	68.6	68.6	68.6	78.8	102	117	134	144	144	134	125	102	82.7
102	32.0	34.3	39.4	45.3	48.5	52.0	59.7	64.0	68.6	73.5	73.5	73.5	73.5	73.5	84.4	109	125	144	154	154	144	134	109	88.6
103	34.3	36.8	42.2	48.5	52.0	55.7	64.0	68.6	73.5	78.8	78.8	78.8	78.8	78.8	90.5	117	134	154	165	165	154	144	117	94.9
104	36.8	39.4	45.3	52.0	55.7	59.7	68.6	73.5	78.8	84.4	84.4	84.4	84.4	84.4	97.0	125	144	165	177	177	165	154	125	102
105	39.4	42.2	48.5	55.7	59.7	64.0	73.5	78.8	84.4	90.5	90.5	90.5	90.5	90.5	104	134	154	177	189	189	177	165	134	109
106	42.2	45.3	52.0	59.7	64.0	68.6	78.8	84.4	90.5	97.0	97.0	97.0	97.0	97.0	111	144	165	189	203	203	189	177	144	117
107	45.3	48.5	55.7	64.0	68.6	73.5	84.4	90.5	97.0	104	104	104	104	104	119	154	177	203	217	217	203	189	154	125
108	48.5	52.0	59.7	68.6	73.5	78.8	90.5	97.0	104	111	111	111	111	111	128	165	189	217	233	233	217	203	165	134
109	52.0	55.7	64.0	73.5	78.8	84.4	97.0	104	111	119	119	119	119	119	137	177	203	233	249	249	233	217	177	144
110	55.7	59.7	68.6	78.8	84.4	90.5	104	111	119	128	128	128	128	128	147	189	217	249	267	267	249	233	189	154
111	59.7	64.0	73.5	84.4	90.5	97.0	111	119	128	137	137	137	137	137	158	203	233	267	286	286	267	249	203	165
112	64.0	68.6	78.8	90.5	97.0	104	119	128	137	147	147	147	147	147	169	217	249	286	307	307	286	267	217	177
113	68.6	73.5	84.4	97.0	104	111	128	137	147	158	158	158	158	158	181	233	267	307	329	329	307	286	233	189
114	73.5	78.8	90.5	104	111	119	137	147	158	169	169	169	169	169	194	249	286	329	352	352	329	307	249	203
115	78.8	84.4	97.0	111	119	128	147	158	169	181	181	181	181	181	208	267	307	352	377	377	352	329	267	217
116	84.4	90.5	104	119	128	137	158	169	181	194	194	194	194	194	223	286	329	377	404	404	377	352	286	233
117	90.5	97.0	111	128	137	147	169	181	194	208	208	208	208	208	239	307	352	404	433	433	404	377	307	249
118	97.0	104	119	137	147	158	181	194	208	223	223	223	223	223	256	329	377	433	464	464	433	404	329	267
119	104	111	128	147	158	169	194	208	223	239	239	239	239	239	274	352	404	464	497	497	464	433	352	286
120	111	119	137	158	169	181	208	223	239	256	256	256	256	256	294	377	433	497	533	533	497	464	377	307
121	119	128	147	169	181	194	223	239	256	274	274	274	274	274	315	404	464	533	571	571	533	497	404	329
122	128	137	158	181	194	208	239	256	274	294	294	294	294	294	338	433	497	571	611	611	571	533	433	352
123	137	147	169	194	208	223	256	274	294	315	315	315	315	315	362	464	533	611	655	655	611	571	464	377
124	147	158	181	208	223	239	274	294	315	338	338	338	338	338	388	497	571	655	702	702	655	611	497	404
125	158	169	194	223	239	256	294	315	338	362	362	362	362	362	416	533	611	702	752	752	702	655	533	433
126	169	181	208	239	256	274	315	338	362	388	388	388	388	388	446	571	655	752	806	806	752	702	571	464
127	181	194	223	256	274	294	338	362	388	416	416	416	416	416	478	611	702	806	863	863	806	752	611	497
128	194	208	239	274	294	315	362	388	416	446	446	446	446	446	512	655	752	863	925	925	863	806	655	533
129	208	223	256	294	315	338	388	416	446	478	478	478	478	478	549	702	806	925	991	991	925	863	702	571
130	223	239	274	315	338	362	416	446	478	512	512	512	512	512	588	752	863	991	1062	1062	991	925	752	611
131	239	256	294	338	362	388	446	478	512	549	549	549	549	549	630	806	925	1062	1137	1137	1062	991	806	655
132	256	274	315	362	388	416	478	512	549	588	588	588	588	588	676	863	991	1137	1219	1219	1137	1062	863	702
133	274	294	338	388	416	446	512	549	588	630	630	630	630	630	724	925	1062	1219	1306	1306	1219	1137	925	752
134	294	315	362	416	446	478	549	588	630	676	676	676	676	676	776	991	1137	1306	1399	1399	1306	1219	991	806
135	315	338	388	446	478	512	588	630	676	724	724	724	724	724	832	1062	1219	1399	1499	1499	1399	1306	1062	863
136	338	362	416	478	512	549	630	676	724	776	776	776	776	776	891	1137	1306	1499	1606	1606	1499	1399	1137	925
137	362	388	446	512	549	588	676	724	776	832	832	832	832	832	955	1219	1399	1606	1721	1721	1606	1499	1219	991
138	388	416	478	549	588	630	724	776	832	891	891	891	891	891	1024	1306	1499	1721	1844	1844	1721	1606	1306	1062
139	416	446	512	588	630	676	776	832	891	955	955	955	955	955	1098	1399	1606	1844	1975	1975	1844	1721	1399	1137
140	446	478	549	630	676	724	832	891	955	1024	1024	1024	1024	1024	1176	1499	1721	1975			1975	1844	1499	1219
141	478	512	588	676	724	776	891	955	1024	1098	1098	1098	1098	1098	1261	1606	1844					1975	1606	1306
142	512	549	630	724	776	832	995	1024	1098	1176	1176	1176	1176	1176	1351	1721	1975						1721	1399
143	549	588	676	776	832	891	1024	1098	1176	1261	1261	1261	1261	1261	1448	1844							1844	1499
144	588	630	724	832	891	955	1098	1176	1261	1351	1351	1351	1351	1351	1552	1975							1975	1606
145	630	676	776	891	955	1024	1176	1261	1351	1448	1448	1448	1448	1448	1664									1721
146	676	724	832	955	1024	1098	1261	1351	1448	1552	1552	1552	1552	1552	1783									1844
147	724	776	891	1024	1098	1176	1351	1448	1552	1664	1664	1664	1664	1664	1911									1975
148	776	832	955	1098	1176	1261	1448	1552	1664	1783	1783	1783	1783	1783	2048									
149	832	891	1024	1176	1261	1351	1552	1664	1783	1911	1911	1911	1911	1911										
150	891	955	1098	1261	1351	1448	1664	1783	1911	2048	2048	2048	2048	2048										

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shall consist of instantaneous perceived noise level, PNL, corrected for spectral irregularities (the correction, called "tone correction factor", is made for the maximum tone only at each increment of time) and for duration.

4.1.2 Three basic physical properties of sound pressure shall be measured: level, frequency distribution, and time variation. More specifically, the instantaneous sound pressure level in each of 24 one-third octave bands of the noise shall be required for each one-half second increment of time during the aeroplane flyover.

4.1.3 The calculation procedure which utilizes physical measurements of noise to derive the EPNL evaluation measure of subjective response shall consist of the following five steps:

a) the 24 one-third octave bands of sound pressure level are converted to perceived noisiness by means of a noy table*. The noy values are combined and then converted to instantaneous perceived noise levels, PNL(k);

b) a tone correction factor, $C(k)$, is calculated for each spectrum to account for the subjective response to the presence of spectral irregularities;

c) the tone correction factor is added to the perceived noise level to obtain tone corrected perceived noise levels, PNLT(k), at each one-half second increment of time,

$$\text{PNLT}(k) = \text{PNL}(k) + C(k)$$

The instantaneous values of tone corrected perceived noise level are derived and the maximum value, PNLTM, is determined;

d) a duration correction factor, D, is computed by integration under the curve of tone corrected perceived noise level versus time;

e) effective perceived noise level, EPNL, is determined by the algebraic sum of the maximum tone corrected perceived noise level and the duration correction factor,

$$\text{EPNL} = \text{PNLTM} + D.$$

* See Table 1-1.

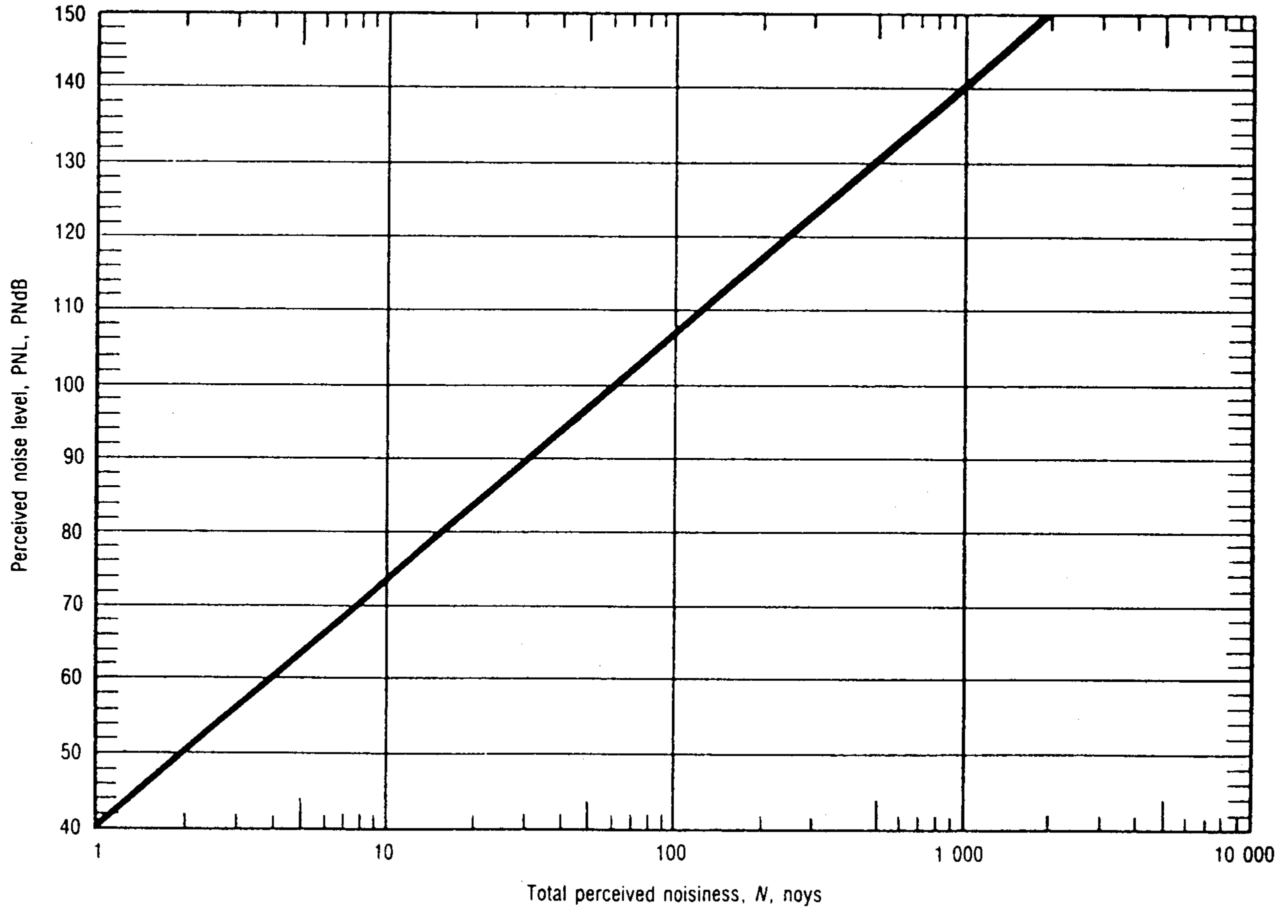


Figure 1-1. Perceived noise level as a function of total perceived noisiness

4.2 Perceived noise level

4.2.1 Instantaneous perceived noise levels, PNL(k), shall be calculated from instantaneous one-third octave band sound pressure levels, SPL(i,k), as follows:

Step 1. Convert each one-third octave band SPL(i,k), from 50 to 10 000 Hz, to perceived noisiness, $n(i,k)$, by reference to Table 1-1, or to the mathematical formulation of the noy table given in Section 7.

Step 2. Combine the perceived noisiness values, $n(i,k)$, found in Step 1 by the following formula:

$$N(k) = n(k) + 0.15\left\{\left[\sum_{i=1}^{24} n(i,k)\right]_i - n(k)\right\}$$

$$= 0.85\, n(k) + 0.15\sum_{i=1}^{24} n(i,k)$$

where $n(k)$ is the largest of the 24 values of $n(i,k)$ and $N(k)$ is the total perceived noisiness.

Step 3. Convert the total perceived noisiness, $N(k)$, into perceived noise level, PNL(k), by the following formula:

$$\text{PNL}(k) = 40.0 + \frac{10}{\log 2}\log N(k)$$

which is plotted in Figure 1-1. PNL(k) may also be obtained by choosing $N(k)$ in the 1 000 Hz column of Table 1-1 and then reading the corresponding value of SPL(i,k) which, at 1 000 Hz, equals PNL(k).

4.3 Correction for spectral irregularities

4.3.1 Noise having pronounced spectral irregularities (for example, the maximum discrete frequency components or tones) shall be adjusted by the correction factor $C(k)$ calculated as follows:

Step 1. Starting with the corrected sound pressure level in the 80 Hz one-third octave band (band number 3), calculate the changes in sound pressure level (or "slopes") in the remainder of the one-third octave bands as follows:

$s(3,k)$ = no value
$s(4,k)$ = SPL(4,k) − SPL(3,k)
•
•
•
$s(i,k)$ = SPL(i,k) − SPL[(i−1),k]
•
•
•
$s(24,k)$ = SPL(24,k) − SPL(23,k)

Step 2. Encircle the value of the slope, $s(i,k)$, where the absolute value of the change in slope is greater than five; that is, where

$$|\Delta s(i,k)| = |s(i,k) - s[(i-1),k]| > 5$$

Step 3.

a) If the encircled value of the slope $s(i,k)$ is positive and algebraically greater than the slope $s[(i-1),k]$ encircle SPL(i,k).

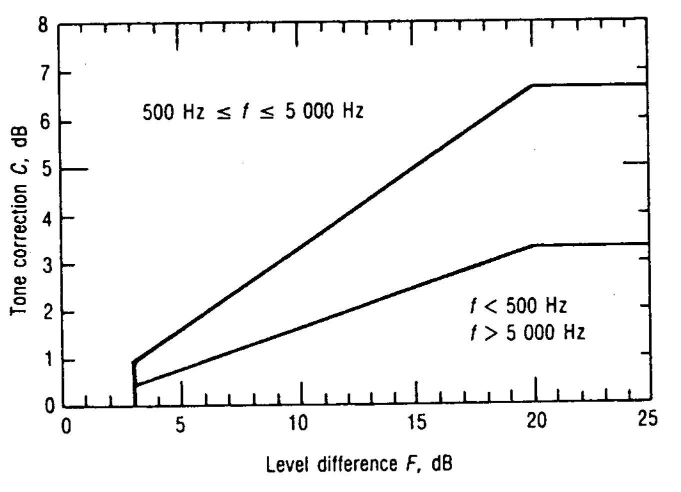
b) If the encircled value of the slope $s(i,k)$ is zero or negative and the slope $s[(i-1),k]$ is positive, encircle SPL[(i−1),k].

c) For all other cases, no sound pressure level value is to be encircled.

Step 4. Omit all SPL(i,k) encircled in Step 3 and compute new adjusted sound pressure levels SPL′(i,k) as follows:

a) For non-encircled sound pressure levels, let the new sound pressure levels equal the original sound pressure levels, SPL′(i,k) ≡ SPL(i,k).

Table 1-2. Tone correction factors



Frequency f, Hz	Level difference F, dB	Tone correction C, dB
50 ≤ f < 500	3* ≤ F < 20 20 ≤ F	F/6 3⅓
500 ≤ f ≤ 5 000	3* ≤ F < 20 20 ≤ F	F/3 6⅔
5 000 < f ≤ 10 000	3* ≤ F < 20 20 ≤ F	F/6 3⅓

* See Step 8, 4.3.1.

b) For encircled sound pressure levels in bands 1 to 23 inclusive, let the new sound pressure level equal the arithmetic average of the preceding and following sound pressure levels:

$$SPL'(i,k) = (1/2)\{SPL[(i-1),k] + SPL[(i+1),k]\}$$

c) If the sound pressure level in the highest frequency band ($i = 24$) is encircled, let the new sound pressure level in that band equal

$$SPL'(24,k) = SPL(23,k) + s(23,k)$$

Step 5. Recompute new slopes $s'(i,k)$, including one for an imaginary 25th band, as follows:

$s'(3,k) \equiv s'(4,k)$
$s'(4,k) = SPL'(4,k) - SPL'(3,k)$
•
•
•
$s'(i,k) = SPL'(i,k) - SPL'[(i-1),k]$
•
•
•
$s'(24,k) = SPL'(24,k) - SPL'(23,k)$
$s'(25,k) \equiv s'(24,k)$

Step 6. For i from 3 to 23, compute the arithmetic average of the three adjacent slopes as follows:

$$\bar{s}(i,k) = (1/3)\{s'(i,k) + s'[(i+1),k] + s'[(i+2),k]\}$$

Step 7. Compute final one-third octave-band background sound pressure levels, $SPL''(i,k)$, by beginning with band number 3 and proceeding to band number 24 as follows:

$SPL''(3,k) \equiv SPL(3,k)$
$SPL''(4,k) = SPL''(3,k) + \bar{s}(3,k)$
•
•
•
$SPL''(i,k) = SPL''[(i-1),k] + \bar{s}(i-1),k]$
•
•
•
$SPL''(24,k) = SPL''(23,k) + \bar{s}(23,k)$

Step 8. Calculate the differences, $F(i,k)$, between the original sound pressure level and the final background sound pressure level as follows:

$$F(i,k) = SPL(i,k) - SPL''(i,k)$$

and note only values equal to or greater than three.

Step 9. For each of the relevant one-third octave bands (3 to 24), determine tone correction factors from the sound pressure level differences $F(i,k)$ and Table 1-2.

Step 10. Designate the largest of the tone correction factors, determined in Step 9, as $C(k)$. An example of the tone correction procedure is given in Table 1-3.

Tone corrected perceived noise levels PNLT(k) shall be determined by adding the $C(k)$ values to corresponding PNLT(k) values, that is,

$$PNLT(k) = PNL(k) + C(k)$$

For any i-th one-third octave band, at any k-th increment of time, for which the tone correction factor is suspected to result from something other than (or in addition to) an actual tone (or any spectral irregularity other than aeroplane noise), an additional analysis shall be made using a filter with a bandwidth narrower than one-third of an octave. If the narrow band analysis corroborates these suspicions, then a revised value for the background sound pressure level, $SPL''(i,k)$, shall be determined from the narrow band analysis and used to compute a revised tone correction factor for that particular one-third octave band.

4.4 Maximum tone corrected perceived noise level

4.4.1 The maximum tone corrected perceived noise level, PNLTM, shall be the maximum calculated value of the tone corrected perceived noise level PNLT(k). It shall be calculated in accordance with the procedure of 4.3. To obtain a satisfactory noise time history, measurements shall be made at half-second time intervals.

Note — Figure 1-2 is an example of a flyover noise time history where the maximum value is clearly indicated.

4.4.2 If there are no pronounced irregularities in the spectrum, even when examined by a narrow-band analysis, then the procedure of 4.3 shall be disregarded since PNLT(k) would be identically equal to PNL(k). For this case, PNLTM shall be the maximum value of PNL(k) and would equal PNLM.

4.5 Duration correction

4.5.1 The duration correction factor D determined by the integration technique shall be defined by the expression:

$$D = 10 \log \left[\frac{1}{T} \int_{t(1)}^{t(2)} \text{antilog} \frac{PNLT}{10} \, dt \right] - PNLTM$$

where T is a normalizing time constant, PNLTM is the maximum value of PNLT.

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Table 1-3. Example of tone correction calculation for a turbofan engine

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪
Band (*i*)	*f* Hz	SPL dB	S dB Step 1	|ΔS| dB Step 2	SPL′ dB Step 4	S′ dB Step 5	$\bar{S}$ dB Step 6	SPL″ dB Step 7	*F* dB Step 8	*C* dB Step 9
1	50	—	—	—	—	—	—	—	—	—
2	63	—	—	—	—	—	—	—	—	—
3	80	70	—	—	70	− 8	−2⅓	70	—	
4	100	62	− 8	—	62	− 8	+3⅓	67⅔	—	
5	125	(70)	+⑧	16	71	+ 9	+6⅔	71	—	
6	160	80	+10	2	80	+ 9	+2⅔	77⅔	—	
7	200	82	+②	8	82	+ 2	−1⅓	80⅓	—	
8	250	(83)	+ 1	1	79	− 3	−1⅓	79	4	⅔
9	315	76	−⑦	8	76	− 3	+ ⅓	77⅔	—	
10	400	(80)	+④	11	78	+ 2	+1	78	—	
11	500	80	0	4	80	+ 2	0	79	—	
12	630	79	− 1	1	79	− 1	0	79	—	
13	800	78	− 1	0	78	− 1	− ⅓	79	—	
14	1 000	80	+ 2	3	80	+ 2	− ⅔	78⅔	—	
15	1 250	78	− 2	4	78	− 2	− ⅓	78	—	
16	1 600	76	− 2	0	76	− 2	+ ⅓	77⅔	—	
17	2 000	79	+ 3	5	79	+ 3	+1	78	—	
18	2 500	(85)	+ 6	3	79	0	− ⅓	79	6	2
19	3 150	79	−⑥	12	79	0	−2⅔	78⅔	—	
20	4 000	78	− 1	5	78	− 1	−6⅓	76	—	
21	5 000	71	−⑦	6	71	− 7	−8	69⅔	—	
22	6 300	60	−11	4	60	−11	−8⅔	61⅔	—	
23	8 000	54	− 6	5	54	− 6	−8	53	—	
24	10 000	45	− 9	3	45	− 9	—	45	—	
						− 9				

Step 1	③(*i*) — ③(*i*−1)
Step 2	|④(*i*) — ④(*i*−1)|
Step 3	see instructions
Step 4	see instructions
Step 5	⑥(*i*) — ⑥(*i*−1)

Step 6	[⑦(*i*)+⑦(*i*+1)+ +⑦(*i*+2)]÷3
Step 7	⑨(*i*−1)+⑧(*i*−1)
Step 8	③(*i*) — ⑨(*i*)
Step 9	see Table 1-2

4.5.1.1 If PNLTM is greater than 100 TPNdB, $t(1)$ shall be the first point of time after which PNLT becomes greater than PNLTM − 10 and $t(2)$ shall be the point of time after which PNLT remains constantly less than PNLTM − 10.

4.5.1.2 If PNLTM is less than 100 TPNdB, $t(1)$ shall be the first point of time after which PNLT becomes greater than 90 TPNdB and $t(2)$ shall be the point of time after which PNLT remains constantly less than 90 TPNdB.

4.5.1.3 If PNLTM is less than 90 TPNdB, the duration correction shall be taken as equal to 0.

4.5.2 Since PNLT is calculated from measured values of SPL, there will, in general, be no obvious equation for PNLT as a function of time. Consequently, the equation shall be rewritten with a summation sign instead of an integral sign as follows:

$$D = 10 \log \left[\left(\frac{1}{T}\right) \sum_{k=0}^{d/\Delta t} \Delta t \cdot \operatorname{antilog} \frac{\mathrm{PNLT}(k)}{10} \right] - \mathrm{PNLTM}$$

where Δt is the length of the equal increments of time for which PNLT(k) is calculated and d is the time interval to the nearest 1.0 s during which PNLT(k) remains greater or equal either to PNLTM − 10 or to 90 according to the cases specified in 4.5.1.1 to 4.5.1.3 above.

4.5.3 To obtain a satisfactory history of the perceived noise level,

a) half-second time intervals for Δt, or

b) a shorter time interval with approved limits and constants

shall be used.

4.5.4 The following values for T and Δt shall be used in calculating D in the procedure given in 4.5.2:

$$T = 10 \text{ s, and}$$
$$\Delta t = 0.5 \text{ s}$$

Using the above values, the equation for D becomes

$$D = 10 \log \left[\sum_{k=0}^{2d} \operatorname{antilog} \frac{\mathrm{PNLT}(k)}{10} \right] - \mathrm{PNLTM} - 13$$

where the integer d is the duration time defined by the points corresponding to the values PNLTM − 10 or 90 as the case may be.

4.5.5 If in the procedures given in 4.5.2, the limits of PNLTM − 10 or 90 fall between the calculated PNLT(k) values (the usual case), the PNLT(k) values defining the

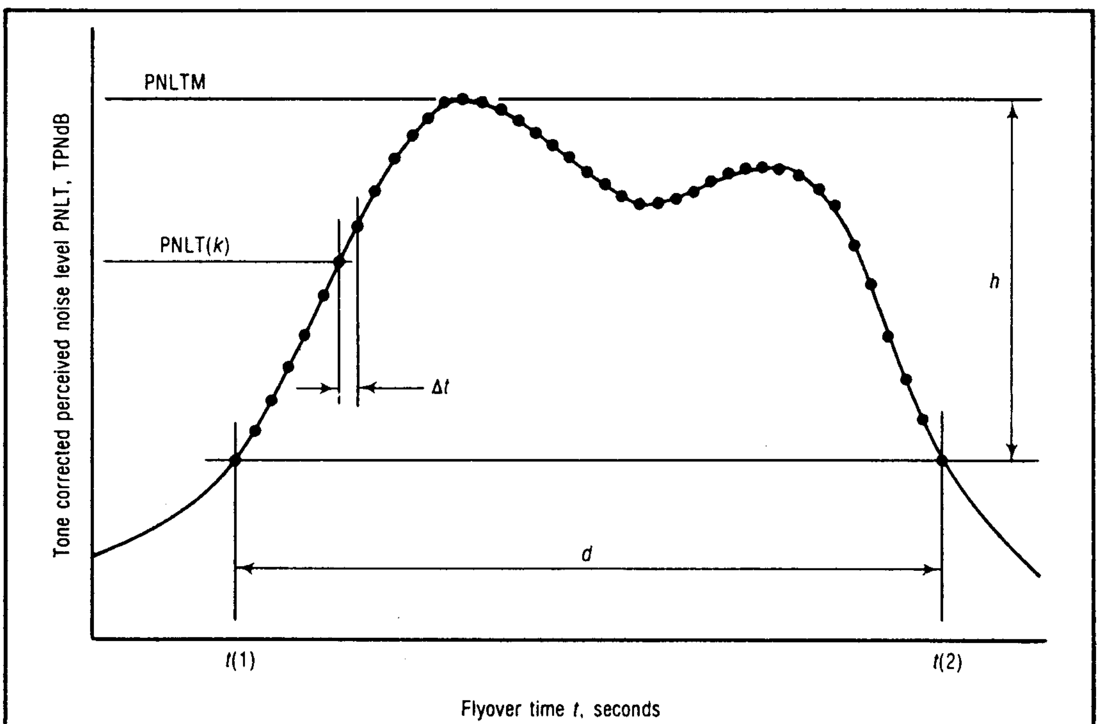

Figure 1-2. Example of perceived noise level corrected for tones as a function of aircraft flyover time

limits of the duration interval shall be chosen from the PNLT(k) values closest to PNLTM − 10 or 90 as the case may be.

4.6 Effective perceived noise level

4.6.1 The total subjective effect of an aeroplane flyover, designated "effective perceived noise level", EPNL, shall be equal to the algebraic sum of the maximum value of the tone corrected perceived noise level, PNLTM, and the duration correction, D. That is,

$$EPNL = PNLTM + D$$

where PNLTM and D are calculated in accordance with the procedures given in 4.2, 4.3, 4.4 and 4.5. If the duration correction D is negative and greater than PNLTM − 90 in absolute values, D shall be taken as equal to 90 − PNLTM.

5. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND CORRECTING MEASURED DATA

5.1 General

5.1.1 Data representing physical measurements or corrections to measured data shall be recorded in permanent form and appended to the record except that corrections to measurements for normal equipment response deviations need not be reported. All other corrections shall be approved. Attempts shall be made to keep to a minimum the individual errors inherent in each of the operations employed in obtaining the final data.

5.2 Data reporting

5.2.1 Measured and corrected sound pressure levels shall be presented in one-third octave band levels obtained with equipment conforming to the Standards described in Section 3 of this appendix.

5.2.2 The type of equipment used for measurement and analysis of all acoustic aeroplane performance and meteorological data shall be reported.

5.2.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

a) air temperature and relative humidity;

b) maximum, minimum, and average wind velocities;

c) atmospheric pressure.

5.2.4 Comments on local topography, ground cover, and events that might interfere with sound recordings shall be reported.

5.2.5 The following aeroplane information shall be reported:

a) type, model, serial numbers (if any) of aeroplane and engines;

b) gross dimensions of aeroplane and location of engines;

c) aeroplane gross mass for each test run;

d) aeroplane configuration such as flap and landing gear position;

e) indicated airspeed in kilometres per hour (knots);

f) engine performance in terms of net thrust, engine pressure ratios, jet exhaust temperatures and fan or compressor shaft rotational speeds as determined from aeroplane instruments and manufacturer's data;

g) aeroplane height above ground determined by a method independent of cockpit instrumentation such as radar tracking, theodolite triangulation, or photographic scaling techniques to be approved by the certification authorities.

5.2.6 Aeroplane speed and position and engine performance parameters shall be recorded at an approved sampling rate sufficient to correct to the noise certification reference conditions prescribed in this section and shall be synchronized with the noise measurement.

5.2.6.1 Lateral position relative to the extended centre line of the runway, configuration and gross mass shall be reported.

5.3 Noise certification reference conditions

5.3.1 Aeroplane position and performance data and the noise measurements shall be corrected to the following noise certification reference conditions:

a) meteorological conditions:

1) sea level atmospheric pressure of 1 013.25 hPa;

2) ambient air temperature of 25°C, i.e. ISA + 10°C except that, at the discretion of the certificating authority, an alternative reference ambient air temperature of 15°C, i.e. ISA may be used;

3) relative humidity of 70 per cent; and

4) zero wind;

b) aeroplane conditions:

1) maximum take-off mass and landing mass at which noise certification is requested;

2) approach angle of 3°; and

3) aeroplane height of 120 m (395 ft) above the approach noise measuring station.

5.4 Data correction

5.4.1 The noise data shall be corrected to the noise certification reference conditions as stated in 5.3. The measured atmospheric conditions shall be those obtained in accordance with Section 2 of this appendix. Atmospheric attenuation of sound requirements are given in Section 8 of this appendix. If a reference ambient air temperature of 15°C is used (see 5.3.1 a) 2)) a further correction of +1 EPNdB shall be added to the noise levels obtained at the flyover measurement point.

5.4.2 The measured flight path shall be corrected by an amount equal to the difference between the applicant's predicted flight paths for the test conditions and for the noise certification reference conditions.

Note.— Necessary corrections relating to aeroplane flight path or performance may be derived from approved data other than certification test data.

5.4.2.1 The flight path correction procedure for approach noise shall be made with reference to a fixed aeroplane reference height and the reference approach angle. The effective perceived noise level correction shall be less than 2 EPNdB to allow for:

a) the aeroplane not passing vertically above the measuring point;

b) the difference between the reference height and the height of the aeroplane's ILS antenna from the approach measuring point; and

c) the difference between the reference and the test approach angles.

Note.— Detailed correction requirements are given in Section 9 of this appendix.

5.4.3 Test results on specific measurement shall not be accepted if the difference in EPNL computed from measured data and that corrected to reference conditions exceeds 15 EPNdB.

5.4.4 If aeroplane sound pressure levels do not exceed the ambient sound pressure levels by at least 10 dB in any one-third octave band, approved corrections for the contribution of ambient sound pressure level to the observed sound pressure level shall be applied.

5.5 Validity of results

5.5.1 Three average EPNL values and their 90 per cent confidence limits shall be produced from the test results, each such value being the arithmetical average of the corrected acoustical measurements for all valid test runs at the appropriate measurement point (take-off, approach or sideline). If more than one acoustic measurement system is used at any single measurement location (such as for the symmetrical sideline measuring points), the resulting data for each test run shall be averaged as a single measurement.

5.5.2 The minimum sample size acceptable for each of the three certification measuring points shall be six. The samples shall be large enough to establish statistically for each of the three average noise certification levels a 90 per cent confidence limit not exceeding ±1.5 EPNdB. No test result shall be omitted from the average process unless otherwise specified by the certification authorities.

5.5.3 The average EPNL values and their 90 per cent confidence limits obtained by the foregoing process shall be those by which the noise performance of the aeroplane is assessed against the noise certification criteria, and shall be reported.

6. NOMENCLATURE

6.1 Symbols and units

Note.— The meanings of the various symbols in this appendix are as follows. It is recognized that differences may exist in the units and meanings of similar symbols in Appendix 2.

Symbol	*Unit*	*Meaning*
antilog	—	*Antilogarithm to the base 10.*
$C(k)$	dB	*Tone correction factor.* The factor to be added to PNL(k) to account for the presence of spectral irregularities such as tones at the k-th increment of time.
d	s	*Duration time.* The length of the significant noise time history being the time interval between the limits of $t(1)$ and $t(2)$ to the nearest second.
D	dB	*Duration correction.* The factor to be added to PNLTM to account for the duration of the noise.
EPNL	EPNdB	*Effective perceived noise level.* The value of PNL adjusted for both the spectral irregularities and the duration of the noise. (The unit EPNdB is used instead of the unit dB.)
$f(i)$	Hz	*Frequency.* The geometrical mean frequency for the i-th one-third octave band.
$F(i,k)$	dB	*Delta-dB.* The difference between the original sound pressure level and the final background sound pressure level in the i-th one-third octave band at the k-th interval of time.
h	dB	*dB-down.* The level to be subtracted from PNLTM that defines the duration of the noise.
H	%	*Relative humidity.* The ambient atmospheric relative humidity.
i	—	*Frequency band index.* The numerical indicator that denotes any one of the 24 one-third octave bands with geometrical mean frequencies from 50 to 10 000 Hz.
k	—	*Time increment index.* The numerical indicator that denotes the number of equal time increments that have elapsed from a reference zero.
log	—	*Logarithm to the base 10.*
log $n(a)$	—	*Noy discontinuity co-ordinate.* The log n value of the intersection point of the straight lines representing the variation of SPL with log n.
$M(b)$, $M(c)$, etc.	—	*Noy inverse slope.* The reciprocals of the slopes of straight lines representing the variation of SPL with log n.
n	noy	*Perceived noisiness.* The perceived noisiness at any instant of time that occurs in a specified frequency range.
$n(i,k)$	noy	*Perceived noisiness.* The perceived noisiness at the k-th instant of time that occurs in the i-th one-third octave band.
$n(k)$	noy	*Maximum perceived noisiness.* The maximum value of all of the 24 values of $n(i)$ that occurs at the k-th instant of time.
$N(k)$	noy	*Total perceived noisiness.* The total perceived noisiness at the k-th instant of time calculated from the 24-instantaneous values of $n(i,k)$.
$p(b)$, $p(c)$, etc.	—	*Noy slope.* The slopes of straight lines representing the variation of SPL with log n.
PNL	PNdB	*Perceived noise level.* The perceived noise level at any instant of time. (The unit PNdB is used instead of the unit dB.)

Symbol	*Unit*	*Meaning*
PNL(*k*)	PNdB	*Perceived noise level.* The perceived noise level calculated from the 24 values of SPL(*i,k*) at the *k*-th increment of time. (The unit PNdB is used instead of the unit dB.)
PNLM	PNdB	*Maximum perceived noise level.* The maximum value of PNL(*k*). (The unit PNdB is used instead of the unit dB.)
PNLT	TPNdB	*Tone corrected perceived noise level.* The value of PNL adjusted for the spectral irregularities that occur at any instant of time. (The unit TPNdB is used instead of the unit dB.)
PNLT(*k*)	TPNdB	*Tone corrected perceived noise level.* The value of PNL(*k*) adjusted for the spectral irregularities that occur at the *k*-th increment of time. (The unit TPNdB is used instead of the unit dB.)
PNLTM	TPNdB	*Maximum tone corrected perceived noise level.* The maximum value of PNLT(*k*). (The unit TPNdB is used instead of the unit dB.)
$s(i,k)$	dB	*Slope of sound pressure level.* The change in level between adjacent one-third octave band sound pressure levels at the *i*-th band for the *k*-th instant of time.
$\Delta s(i,k)$	dB	*Change in slope of sound pressure level.*
$s'(i,k)$	dB	*Adjusted slope of sound pressure level.* The change in level between adjacent adjusted one-third octave band sound pressure levels at the *i*-th band for the *k*-th instant of time.
$\bar{s}(i,k)$	dB	*Average slope of sound pressure level.*
SPL	dB re 20 μPa	*Sound pressure level.* The sound pressure level at any instant of time that occurs in a specified frequency range.
SPL(*a*)	dB re 20 μPa	*Noy discontinuity co-ordinate.* The SPL value of the intersection point of the straight lines representing the variation of SPL with log *n*.
SPL(*b*) SPL(*c*)	dB re 20 μPa	*Noy intercept.* The intercepts on the SPL-axis of the straight lines representing the variation of SPL with log *n*.
SPL(*i,k*)	dB re 20 μPa	*Sound pressure level.* The sound pressure level at the *k*-th instant of time that occurs in the *i*-th one-third octave band.
SPL'(*i,k*)	dB re 20 μPa	*Adjusted sound pressure level.* The first approximation to background sound pressure level in the *i*-th one-third octave band for the *k*-th instant of time.
SPL(*i*)	dB re 20 μPa	*Maximum sound pressure level.* The sound pressure level that occurs in the *i*-th one-third octave band of the spectrum for PNLTM.
$SPL(i)_c$	dB re 20 μPa	*Corrected maximum sound pressure level.* The sound pressure level that occurs in the *i*-th one-third octave band of the spectrum for PNLTM corrected for atmospheric sound absorption.
SPL"(*i,k*)	dB re 20 μPa	*Final background sound pressure level.* The second and final approximation to background sound pressure level in the *i*-th one-third octave band for the *k*-th instant of time.
t	s	*Elapsed time.* The length of time measured from a reference zero.
*t*1, *t*2	s	*Time limit.* The beginning and end of the significant noise time history defined by *h*.
Δt	s	*Time increment.* The equal increments of time for which PNL(*k*) and PNLT(*k*) are calculated.
T	s	*Normalizing time constant.* The length of time used as a reference in the integration method for computing duration corrections, where $T = 10$ s.
t(°C)	°C	*Temperature.* The ambient atmospheric temperature.
$\alpha(i)$	dB/100 m	*Test atmospheric absorption.* The atmospheric attenuation of sound that occurs in the *i*-th one-third octave band for the measured atmospheric temperature and relative humidity.

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Symbol	*Unit*	*Meaning*
$\alpha(i)_o$	dB/100 m	*Reference atmospheric absorption.* The atmospheric attenuation of sound that occurs in the i-th one-third octave band for a reference atmospheric temperature and relative humidity.
β	degrees	*First constant* climb angle.*
γ	degrees	*Second constant** climb angle.*
δ ε	degrees degrees	*Thrust cutback angles.* The angles defining the points on the take-off flight path at which thrust reduction is started and ended respectively.
η	degrees	*Approach angle.*
η_r	degrees	*Reference approach angle.*
θ	degrees	*Take-off noise angle.* The angle between the flight path and noise path for take-off operations. It is identical for both measured and corrected flight paths.
λ	degrees	*Approach noise angle.* The angle between the flight path and the noise path for approach operations. It is identical for both measured and corrected flight paths.
Δ_1	EPNdB	*PNLT correction.* The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences in atmospheric absorption and noise path length between reference and test conditions.
Δ_2	EPNdB	*Noise path duration correction.* The correction to be added to the EPNL calculated from measured data to account for noise level changes due to the noise duration because of differences in flyover altitude between reference and test conditions.
Δ_3	EPNdB	*Mass correction.* The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences between maximum mass and actual mass of the test aeroplane.
Δ_4	EPNdB	*Approach angle correction.* The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences between the reference and the test approach angles.
ΔAB $\Delta\beta$ $\Delta\gamma$ $\Delta\delta$ $\Delta\varepsilon$	metres degrees degrees degrees degrees	*Take-off profile changes.* The algebraic changes in the basic parameters defining the take-off profile due to differences between reference and test conditions.

* Gear up, speed of at least V_2 + 19 km/h (V_2 + 10 kt), take-off thrust.
** Gear up, speed of at least V_2 + 19 km/h (V_2 + 10 kt), after cut-back.

6.2 Flight profile identification positions

Position	*Description*
A	Start of take-off roll.
B	Lift-off.
C	Start of first constant climb.
D	Start of thrust reduction.
E	Start of second constant climb.
E_c	Start of second constant climb on corrected flight path.
F	End of noise certification take-off flight path.
F_c	End of noise certification corrected take-off flight path.
G	Start of noise certification approach flight path.
G_r	Start of noise certification approach on reference flight path.
H	Position on approach path directly above noise measuring station.
H_r	Position on reference approach path directly above noise measuring station.
I	Start of level-off.
I_r	Start of level-off on reference approach flight path.
J	Touchdown.

Position	*Description*
K	Flyover noise measurement point.
L	Lateral noise measurement point(s) (not on flight track).
M	End of noise certification take-off flight track.
N	Approach noise measurement point.
O	Threshold of approach end of runway.
P	Start of noise certification approach flight track.
Q	Position on measured take-off flight path corresponding to apparent PNLTM at station K. See 9.2.1.
Q_c	Position on corrected take-off flight path corresponding to PNLTM at station K. See 9.2.1.
R	Position on measured take-off flight path nearest to station K.
R_c	Position on corrected take-off flight path nearest to station K.
S	Position on measured approach flight path corresponding to PNLTM at station N.
S_r	Position on reference approach flight path corresponding to PNLTM at station N.
T	Position on measured approach flight path nearest to station N.
T_r	Position on reference approach flight path nearest to station N.
X	Position on measured take-off flight path corresponding to PNLTM at station L.

6.3 Flight profile distances

Distance	*Unit*	*Meaning*
AB	metres	*Length of take-off roll.* The distance along the runway between the start of take-off roll and lift off.
AK	metres	*Take-off measurement distance.* The distance from the start of roll to the take-off noise measurement station along the extended centre line of the runway.
AM	metres	*Take-off flight track distance.* The distance from the start of roll to the take-off flight track position along the extended centre line of the runway for which the position of the aeroplane need no longer be recorded.
KQ	metres	*Measured take-off noise path.* The distance from station K to the measured aeroplane position Q.
KQ_c	metres	*Corrected take-off noise path.* The distance from station K to the corrected aeroplane position Q_c.
KR	metres	*Measured take-off minimum distance.* The distance from station K to point R on the measured flight path.
KR_c	metres	*Corrected take-off minimum distance.* The distance from station K to point R_c on the corrected flight path.
LX	metres	*Measured sideline noise path.* The distance from station L to the measured aeroplane position X.
NH	metres (feet)	*Aeroplane approach height.* The height of the aeroplane above the approach measuring station.
NH_r	metres (feet)	*Reference approach height.* The height of the reference approach path above the approach measuring station.
NS	metres	*Measured approach noise path.* The distance from station N to the measured aeroplane position S.
NS_r	metres	*Reference approach noise path.* The distance from station N to the reference aeroplane position S_r.
NT	metres	*Measured approach minimum distance.* The distance from station N to point T on the measured flight path.
NT_r	metres	*Reference approach minimum distance.* The distance from station N to point T_r on the corrected flight path.
ON	metres	*Approach measurement distance.* The distance from the runway threshold to the approach measurement station along the extended centre line of the runway.
OP	metres	*Approach flight track distance.* The distance from the runway threshold to the approach flight track position along the extended centre line of the runway for which the position of the aeroplane need no longer be recorded.

7. MATHEMATICAL FORMULATION OF NOY TABLES

Note 1.— The relationship between sound pressure level and perceived noisiness given in Table 1-1 is illustrated in Figure 1-3. The variation of SPL *with* log *n for a given one-third octave band is expressed by either one or two straight lines depending upon the frequency range. Figure 1-3 a) illustrates the double line case for frequencies below 400 Hz and above 6 300 Hz and Figure 1-3 b) illustrates the single line case for all other frequencies.*

The important aspects of the mathematical formulation are:

a) the slopes of the straight lines p(b) and p(c);

b) the intercepts of the lines on the SPL*-axis,* SPL*(b) and* SPL*(c); and*

c) *the coordinates of the discontinuity,* SPL*(a) and* log *n(a).*

Note 2.— Mathematically the relationship is expressed as follows:

Case 1: Figure 1-3 a): $f < 400$ Hz
$f > 6\,300$ Hz

$$\mathrm{SPL}(a) = \frac{p(c)\,\mathrm{SPL}(b) - p(b)\,\mathrm{SPL}(c)}{p(c) - p(b)}$$

$$\log n(a) = \frac{\mathrm{SPL}(c) - \mathrm{SPL}(b)}{p(b) - p(c)}$$

a) $\mathrm{SPL} < \mathrm{SPL}(a)$

$$n = \mathrm{antilog}\ \frac{\mathrm{SPL} - \mathrm{SPL}(b)}{p(b)}$$

b) $\mathrm{SPL} \geq \mathrm{SPL}(a)$

$$n = \mathrm{antilog}\ \frac{\mathrm{SPL} - \mathrm{SPL}(c)}{p(c)}$$

c) $\log n < \log n(a)$

$$\mathrm{SPL} = p(b) \log n + \mathrm{SPL}(b)$$

d) $\log n \geq \log n(a)$

$$\mathrm{SPL} = p(c) \log n + \mathrm{SPL}(c)$$

Case 2: Figure 1-3 b): $400 \leq f \leq 6\,300$ Hz

$$n = \mathrm{antilog}\ \frac{\mathrm{SPL} - \mathrm{SPL}(c)}{p(c)}$$

$$\mathrm{SPL} = p(c) \log n + \mathrm{SPL}(c)$$

Note 3.— If the reciprocals of the slopes are defined as:

$$M(b) = 1/p(b)$$

$$M(c) = 1/p(c)$$

the equations in Note 2 can be written,

Case 1: Figure 1-3 a): $f < 400$ Hz
$f > 6\,300$ Hz

$$\mathrm{SPL}(a) = \frac{M(b)\,\mathrm{SPL}(b) - M(c)\,\mathrm{SPL}(c)}{M(b) - M(c)}$$

$$\log n(a) = \frac{M(b)\,M(c)\,[\mathrm{SPL}(c) - \mathrm{SPL}(b)]}{M(c) - M(b)}$$

a) $\mathrm{SPL} < \mathrm{SPL}(a)$

$$n = \mathrm{antilog}\ M(b)\,[\mathrm{SPL} - \mathrm{SPL}(b)]$$

b) $\mathrm{SPL} \geq \mathrm{SPL}(a)$

$$n = \mathrm{antilog}\ M(c)\,[\mathrm{SPL} - \mathrm{SPL}(c)]$$

c) $\log n < \log n(a)$

$$\mathrm{SPL} = \frac{\log n}{M(b)} + \mathrm{SPL}(b)$$

d) $\log n \geq \log n(a)$

$$\mathrm{SPL} = \frac{\log n}{M(c)} + \mathrm{SPL}(c)$$

Case 2: Figure 1-3 b): $400 \leq f \leq 6\,300$ Hz

$$n = \mathrm{antilog}\ M(c)\,[\mathrm{SPL} - \mathrm{SPL}(c)]$$

$$\mathrm{SPL} = \frac{\log n}{M(c)} + \mathrm{SPL}(c)$$

Note 4.— Table 1-4 lists the values of the important constants necessary to calculate sound pressure level as a function of perceived noisiness.

8. SOUND ATTENUATION IN AIR

8.1 The atmospheric attenuation of sound shall be determined in accordance with the procedure presented below.

8.2 The relationship between sound attenuation, frequency, temperature and humidity is expressed by the following equations:

$$\alpha(i) = 10^{[2.05 \log (f_o/1000) + 1.1394 \times 10^{-3}\theta - 1.916984]} + \eta(\delta) \times 10^{[\log (f_o) + 8.42994 \times 10^{-3}\theta - 2.755624]}$$

where

$$\delta = \sqrt{\frac{1010}{f_o}}\ 10^{(\log H - 1.328924 + 3.179768 \times 10^{-2}\theta)} \times 10^{(-2.173716 \times 10^{-4}\theta^2 + 1.7496 \times 10^{-6}\theta^3)}$$

$\eta(\delta)$ is given by Table 1-5 and f_o by Table 1-6;

$\alpha(i)$ being the attenuation coefficient in dB/100 m;

θ being the temperature in °C; and

H being the relative humidity.

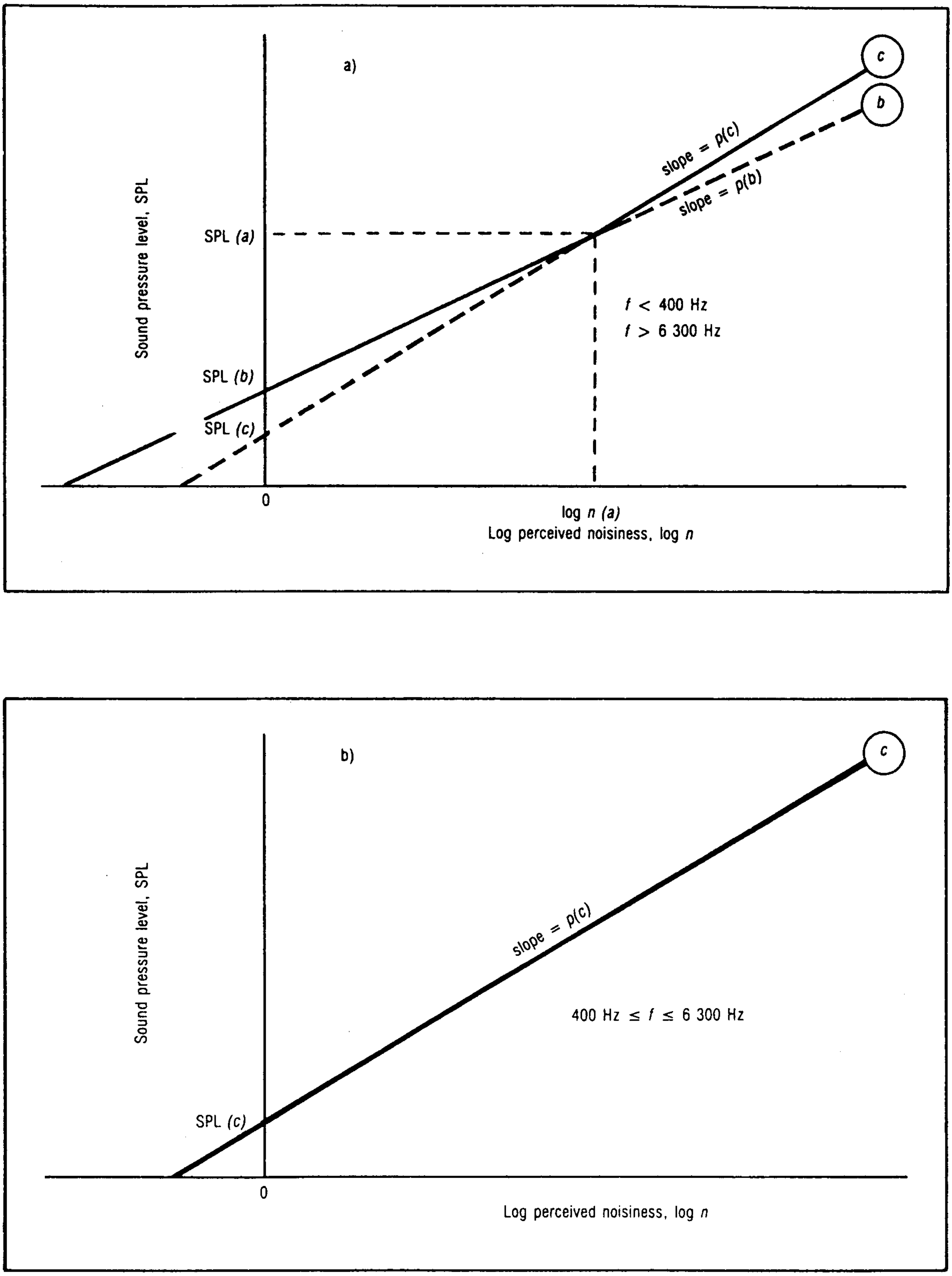

Figure 1-3. Sound pressure level as a function of perceived noisiness

Table 1-4. Constants for mathematically formulated noy values

Band (i)	f Hz	M(b)	SPL (b) dB	SPL (a) dB	M(c)	SPL (c) dB
1	50	0.043478	64	91.0	0.030103	52
2	63	0.040570	60	85.9	↑	51
3	80	0.036831	56	87.3		49
4	100	"	53	79.9		47
5	125	0.035336	51	79.8		46
6	160	0.033333	48	76.0		45
7	200	"	46	74.0		43
8	250	0.032051	44	74.9		42
9	315	0.030675	42	94.6		41
10	400	—	—	—		40
11	500	—	—	—		40
12	630	—	—	—		40
13	800	—	—	—		40
14	1 000	—	—	—	↓	40
15	1 250	—	NOT APPLICABLE	—	0.030103	38
16	1 600	—	—	—	0.029960	34
17	2 000	—	—	—	↑	32
18	2 500	—	—	—		30
19	3 150	—	—	—		29
20	4 000	—	—	—		29
21	5 000	—	—	—		30
22	6 300	—	—	—		31
23	8 000	0.042285	37	44.3	↓	34
24	10 000	0.042285	41	50.7	0.029960	37

Table 1-5

δ	η	δ	η
0.00	0.000	2.30	0.495
0.25	0.315	2.50	0.450
0.50	0.700	2.80	0.400
0.60	0.840	3.00	0.370
0.70	0.930	3.30	0.330
0.80	0.975	3.60	0.300
0.90	0.996	4.15	0.260
1.00	1.000	4.45	0.245
1.10	0.970	4.80	0.230
1.20	0.900	5.25	0.220
1.30	0.840	5.70	0.210
1.50	0.750	6.05	0.205
1.70	0.670	6.50	0.200
2.00	0.570	7.00	0.200
		10.00	0.200

Table 1-6

one-third octave centre frequency	f_0 *(Hz)*	*one-third octave centre frequency*	f_0 *(Hz)*
50	50	800	800
63	63	1000	1000
80	80	1250	1250
100	100	1600	1600
125	125	2000	2000
160	160	2500	2500
200	200	3150	3150
250	250	4000	4000
315	315	5000	4500
400	400	6300	5600
500	500	8000	7100
630	630	10000	9000

Table 1-7. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 10%*										
	Temperature, °C										
Hz	−10	−5	0	5	10	15	20	25	30	35	40
50	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
125	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.2	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1
200	0.2	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.2
250	0.2	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2
315	0.2	0.4	0.5	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2
400	0.3	0.5	0.7	0.8	0.6	0.5	0.4	0.3	0.3	0.3	0.3
500	0.3	0.5	0.8	1.0	0.9	0.7	0.6	0.5	0.4	0.4	0.4
630	0.3	0.6	0.9	1.2	1.2	1.0	0.9	0.7	0.6	0.5	0.5
800	0.4	0.6	1.0	1.5	1.7	1.5	1.2	1.0	0.8	0.7	0.6
1000	0.4	0.7	1.2	1.8	2.1	2.0	1.7	1.4	1.2	1.0	0.9
1250	0.4	0.8	1.3	2.1	2.6	2.8	2.4	2.0	1.7	1.4	1.2
1600	0.5	0.9	1.4	2.3	3.3	3.8	3.4	2.9	2.4	2.0	1.7
2000	0.6	1.0	1.6	2.6	3.9	4.7	4.7	4.1	3.4	2.8	2.3
2500	0.7	1.1	1.8	2.9	4.5	5.8	6.4	5.6	4.8	4.0	3.3
3150	0.8	1.2	2.0	3.2	5.1	7.1	8.3	7.7	6.8	5.7	4.8
4000	0.9	1.4	2.3	3.6	5.7	8.5	10.5	11.0	9.6	8.3	6.9
5000	1.0	1.6	2.4	3.8	6.1	9.2	11.7	12.8	11.3	9.9	8.3
6300	1.3	1.9	2.8	4.3	6.8	10.4	14.2	16.4	15.5	13.7	11.7
8000	1.6	2.3	3.4	5.0	7.7	11.8	17.0	20.8	22.0	19.4	16.8
10000	2.1	2.9	4.1	6.0	8.9	13.4	19.9	25.9	29.5	27.2	24.1
12500	2.9	3.7	5.0	7.1	10.3	15.3	22.7	31.2	36.9	37.6	33.4

Table 1-8. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 20%*										
	Temperature, °C										
Hz	−10	−5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
125	0.2	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1
160	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2
315	0.4	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
400	0.5	0.6	0.5	0.4	0.3	0.3	0.2	0.2	0.3	0.3	0.3
500	0.6	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.4
630	0.7	1.0	1.0	0.8	0.7	0.5	0.4	0.4	0.4	0.4	0.5
800	0.8	1.2	1.4	1.2	0.9	0.7	0.6	0.5	0.5	0.6	0.6
1000	0.9	1.4	1.8	1.6	1.3	1.0	0.8	0.7	0.7	0.7	0.8
1250	0.9	1.6	2.2	2.2	1.8	1.5	1.2	1.0	0.9	0.9	1.0
1600	1.1	1.9	2.7	3.1	2.6	2.1	1.7	1.4	1.2	1.2	1.3
2000	1.2	2.0	3.2	3.9	3.6	3.0	2.5	2.0	1.7	1.5	1.6
2500	1.3	2.3	3.7	4.9	5.0	4.2	3.5	2.8	2.3	2.0	2.0
3150	1.5	2.5	4.2	6.0	6.8	5.8	4.9	4.0	3.3	2.8	2.7
4000	1.7	2.9	4.8	7.2	8.7	8.2	7.1	5.9	4.9	4.0	3.6
5000	1.9	3.1	5.1	7.9	9.8	9.7	8.4	7.0	5.9	4.8	4.2
6300	2.2	3.5	5.7	9.0	12.0	13.3	11.5	9.9	8.2	6.8	5.8
8000	2.7	4.1	6.5	10.4	14.8	17.4	16.2	14.1	12.0	10.0	8.3
10000	3.3	4.9	7.5	11.8	17.7	22.0	23.1	20.1	17.2	14.5	12.1
12500	4.1	5.9	8.8	13.4	20.5	27.1	30.6	27.5	24.2	20.6	17.4

Table 1-9. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 30%*										
	Temperature, °C										
Hz	−10	−5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.4	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2
400	0.6	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.7	0.6	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4
630	0.9	0.9	0.7	0.5	0.4	0.3	0.3	0.4	0.4	0.4	0.5
800	1.1	1.3	1.0	0.8	0.6	0.5	0.4	0.5	0.5	0.6	0.6
1000	1.3	1.6	1.4	1.1	0.9	0.7	0.6	0.6	0.6	0.7	0.8
1250	1.5	2.0	1.9	1.6	1.2	0.9	0.8	0.7	0.8	0.9	1.0
1600	1.7	2.5	2.7	2.2	1.8	1.4	1.1	1.0	1.0	1.1	1.3
2000	1.9	3.0	3.6	3.1	2.5	2.0	1.6	1.4	1.3	1.4	1.6
2500	2.1	3.5	4.4	4.2	3.5	2.8	2.2	1.9	1.7	1.8	2.0
3150	2.3	4.0	5.5	5.9	4.9	4.0	3.3	2.6	2.3	2.3	2.5
4000	2.6	4.5	6.8	7.9	6.9	5.8	4.7	3.8	3.3	3.1	3.3
5000	2.8	4.8	7.4	9.0	8.2	6.9	5.7	4.6	3.9	3.6	3.7
6300	3.2	5.3	8.6	11.1	11.3	9.6	8.0	6.6	5.4	4.8	4.7
8000	3.8	6.1	9.9	13.9	15.6	13.6	11.5	9.5	7.9	6.8	6.4
10000	4.5	7.1	11.4	16.9	20.3	19.1	16.6	13.9	11.6	9.7	8.8
12500	5.5	8.3	13.0	20.0	25.3	26.6	23.0	19.6	16.4	13.8	12.1

Table 1-10. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 40%*										
	Temperature, °C										
Hz	−10	−5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.6	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.9	0.7	0.5	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	1.2	1.0	0.8	0.6	0.4	0.4	0.4	0.5	0.5	0.6	0.6
1000	1.4	1.4	1.1	0.8	0.6	0.5	0.5	0.6	0.6	0.7	0.8
1250	1.8	1.9	1.5	1.2	0.9	0.7	0.7	0.7	0.8	0.9	1.0
1600	2.1	2.6	2.1	1.7	1.3	1.0	0.9	0.9	1.0	1.1	1.3
2000	2.5	3.2	2.9	2.4	1.9	1.5	1.2	1.2	1.3	1.4	1.6
2500	2.8	4.0	4.1	3.3	2.6	2.1	1.7	1.6	1.7	1.8	2.0
3150	3.2	4.9	5.6	4.7	3.8	3.0	2.4	2.1	2.1	2.3	2.5
4000	3.6	5.9	7.2	6.5	5.4	4.3	3.5	3.0	2.8	3.0	3.3
5000	3.8	6.3	8.1	7.7	6.5	5.2	4.2	3.5	3.3	3.4	3.7
6300	4.3	7.2	10.0	10.7	9.0	7.3	6.0	4.9	4.4	4.3	4.7
8000	5.0	8.3	12.3	14.4	12.6	10.6	8.7	7.1	6.1	5.8	6.2
10000	5.8	9.5	14.8	18.4	17.8	15.2	12.7	10.5	8.8	8.1	8.1
12500	6.9	10.9	17.2	22.9	24.7	21.2	17.8	14.9	12.4	10.9	10.6

Table 1-11. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 50%*										
	Temperature, °C										
Hz	−10	−5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.3	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.5	0.4	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.7	0.6	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	1.0	0.8	0.6	0.5	0.4	0.4	0.4	0.5	0.5	0.6	0.6
1000	1.4	1.1	0.9	0.6	0.5	0.5	0.5	0.6	0.6	0.7	0.8
1250	1.8	1.6	1.2	0.9	0.7	0.6	0.7	0.7	0.8	0.9	1.0
1600	2.3	2.2	1.8	1.3	1.0	0.9	0.9	0.9	1.0	1.1	1.3
2000	2.8	3.1	2.4	1.9	1.5	1.2	1.1	1.2	1.3	1.4	1.6
2500	3.4	4.0	3.4	2.7	2.1	1.6	1.5	1.5	1.7	1.8	2.0
3150	4.0	5.1	4.7	3.8	3.0	2.3	2.0	1.9	2.1	2.3	2.5
4000	4.6	6.4	6.7	5.5	4.4	3.4	2.8	2.6	2.7	3.0	3.3
5000	4.9	7.2	7.9	6.5	5.2	4.2	3.4	3.1	3.1	3.4	3.7
6300	5.4	8.6	10.2	8.9	7.3	5.9	4.7	4.1	4.0	4.3	4.7
8000	6.2	10.2	13.1	12.5	10.5	8.6	6.9	5.8	5.4	5.7	6.2
10000	7.2	11.9	16.4	17.8	15.0	12.4	10.2	8.4	7.5	7.4	8.1
12500	8.4	13.6	[illegible]	23.4	20.6	17.5	14.4	[illegible]	10.4	9.9	10.5

Table 1-12. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 60%*										
	Temperature, °C										
Hz	−10	−5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.5	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.6	0.5	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.9	0.7	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6
1000	1.2	1.0	0.7	0.5	0.5	0.5	0.5	0.6	0.6	0.7	0.8
1250	1.7	1.3	1.0	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1600	2.3	1.9	1.5	1.1	0.9	0.8	0.9	0.9	1.0	1.1	1.3
2000	2.9	2.6	2.1	1.6	1.2	1.1	1.1	1.2	1.3	1.4	1.6
2500	3.6	3.6	2.9	2.2	1.7	1.4	1.4	1.5	1.7	1.8	2.0
3150	4.4	5.0	4.1	3.2	2.5	2.0	1.8	1.9	2.1	2.3	2.5
4000	5.3	6.6	5.7	4.6	3.6	2.8	2.5	2.5	2.7	3.0	3.3
5000	5.8	7.4	6.8	5.5	4.3	3.4	2.9	2.9	3.1	3.4	3.7
6300	6.6	9.2	9.3	7.7	6.1	4.9	4.0	3.8	4.0	4.3	4.7
8000	7.6	11.4	13.0	10.9	8.9	7.2	5.8	5.2	5.2	5.7	6.2
10000	8.7	13.8	16.9	15.3	12.8	10.4	8.5	7.3	7.0	7.4	8.1
12500	10.0	16.1	21.1	21.2	18.0	14.8	12.2	10.2	9.5	9.6	10.5

Table 1-13. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 70%*										
	Temperature, °C										
Hz	−10	−5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2
315	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.4	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4
630	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.8	0.6	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.6
1000	1.1	0.8	0.6	0.5	0.4	0.5	0.5	0.6	0.7	0.7	0.8
1250	1.5	1.1	0.9	0.7	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1600	2.1	1.7	1.2	0.9	0.8	0.8	0.9	1.0	1.0	1.1	1.3
2000	2.9	2.3	1.8	1.3	1.0	1.0	1.1	1.2	1.3	1.4	1.6
2500	3.7	3.2	2.5	1.9	1.5	1.3	1.4	1.5	1.7	1.8	2.0
3150	4.6	4.4	3.5	2.7	2.1	1.8	1.8	1.9	2.1	2.3	2.5
4000	5.7	6.3	5.1	4.0	3.1	2.5	2.3	2.5	2.7	3.0	3.3
5000	6.3	7.3	6.0	4.7	3.7	3.0	2.7	2.9	3.1	3.4	3.7
6300	7.5	9.3	8.2	6.6	5.2	4.2	3.6	3.6	4.0	4.3	4.7
8000	8.8	11.8	11.6	9.5	7.6	6.1	5.1	4.9	5.2	5.7	6.2
10000	10.2	14.8	16.4	13.7	11.1	9.0	7.4	6.8	6.8	7.4	8.1
12500	11.6	18.0	21.4	18.8	15.7	12.8	10.5	9.2	9.0	9.6	10.5

Table 1-14. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 80% — Temperature, °C*										
Hz	− 10	− 5.	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.5	0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.7	0.5	0.4	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
1000	1.0	0.7	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8
1250	1.3	1.0	0.7	0.6	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1600	1.9	1.5	1.1	0.8	0.7	0.8	0.9	0.9	1.0	1.1	1.3
2000	2.6	2.0	1.5	1.1	1.0	1.0	1.1	1.2	1.3	1.4	1.6
2500	3.6	2.9	2.2	1.6	1.3	1.3	1.4	1.5	1.7	1.8	2.0
3150	4.7	4.0	3.1	2.4	1.9	1.7	1.8	1.9	2.1	2.3	2.5
4000	5.9	5.6	4.5	3.4	2.7	2.3	2.3	2.5	2.7	3.0	3.3
5000	6.6	6.6	5.3	4.1	3.2	2.7	2.6	2.8	3.1	3.4	3.7
6300	8.1	9.1	7.4	5.9	4.6	3.7	3.4	3.6	4.0	4.3	4.7
8000	9.8	12.0	10.4	8.4	6.7	5.4	4.8	4.8	5.2	5.7	6.2
10000	11.5	15.3	14.8	12.2	9.8	7.8	6.7	6.4	6.8	7.4	8.1
12500	13.3	18.9	20.5	17.0	13.9	11.3	9.4	8.7	8.9	9.6	10.5

Table 1-15. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 90% — Temperature, °C*										
Hz	− 10	− 5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.6	0.4	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
1000	0.9	0.6	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8
1250	1.2	0.9	0.6	0.5	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1600	1.7	1.3	0.9	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.3
2000	2.4	1.8	1.3	1.0	0.9	1.0	1.1	1.2	1.3	1.4	1.6
2500	3.3	2.6	1.9	1.4	1.2	1.3	1.4	1.5	1.7	1.8	2.0
3150	4.6	3.6	2.8	2.1	1.7	1.6	1.8	1.9	2.1	2.3	2.5
4000	6.0	5.1	4.0	3.0	2.4	2.2	2.3	2.5	2.7	3.0	3.3
5000	6.7	6.0	4.8	3.7	2.9	2.6	2.6	2.8	3.1	3.4	3.7
6300	8.3	8.3	6.7	5.2	4.0	3.4	3.3	3.6	4.0	4.3	4.7
8000	10.4	11.7	9.5	7.6	6.0	4.9	4.5	4.8	5.2	5.7	6.2
10000	12.6	15.4	13.5	11.0	8.8	7.1	6.3	6.3	6.8	7.4	8.1
12500	14.8	19.4	18.6	15.4	12.4	10.1	3.7	8.3	8.9	9.6	10.5

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Table 1-16. Sound attenuation coefficient in dB/100 m

Band centre frequency	*Relative humidity = 100%*										
	Temperature, °C										
Hz	− 10	− 5	0	5	10	15	20	25	30	35	40
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
100	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
125	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
160	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
200	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
250	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2
315	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
400	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3
500	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.4
630	0.4	0.3	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5
800	0.6	0.4	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6
1000	0.8	0.6	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.8
1250	1.1	0.8	0.6	0.5	0.6	0.6	0.7	0.7	0.8	0.9	1.0
1600	1.6	1.2	0.8	0.7	0.7	0.8	0.9	0.9	1.0	1.1	1.3
2000	2.2	1.6	1.2	0.9	0.9	1.0	1.1	1.2	1.3	1.4	1.6
2500	3.0	2.3	1.7	1.3	1.2	1.3	1.4	1.5	1.7	1.8	2.0
3150	4.2	3.3	2.5	1.9	1.6	1.6	1.8	1.9	2.1	2.3	2.5
4000	5.9	4.7	3.6	2.7	2.2	2.1	2.3	2.5	2.7	3.0	3.3
5000	6.8	5.6	4.3	3.3	2.6	2.4	2.6	2.8	3.1	3.4	3.7
6300	8.5	7.6	6.0	4.7	3.7	3.3	3.3	3.6	4.0	4.3	4.7
8000	10.7	10.8	8.7	6.8	5.3	4.5	4.4	4.8	5.2	5.7	6.2
10000	13.3	15.1	12.5	10.0	7.9	6.5	6.0	6.3	6.8	7.4	8.1
12500	16.0	19.5	17.2	14.0	11.3	9.2	8.2	8.2	8.9	9.6	10.5

8.3 The equations given in 8.2 are convenient for calculation by means of a computer. For use in other cases, numerical values determined from the equations are given in Tables 1-7 to 1-16.

9. DETAILED CORRECTION PROCEDURES

9.1 Introduction

9.1.1 When the noise certification test conditions are not identical to the noise certification reference conditions, appropriate corrections shall be made to the EPNL calculated from the measured data by the methods of this section.

Note 1.— Differences between reference and test conditions which lead to corrections can result from the following:

a) atmospheric absorption of sound under test conditions different from reference;

b) test flight path at altitude different from reference; and

c) test mass different from maximum.

Note 2.— Negative correction can arise if the atmospheric absorption of sound under test conditions is less than reference and also if the test flight path is at a lower altitude than reference.

The take-off test flight path can occur at a higher altitude than reference if the meteorological conditions permit superior aeroplane performance ("cold day" effect). Conversely, the "hot day" effect can cause the take-off test flight path to occur at a lower altitude than reference. The approach test flight path can occur at either higher or lower altitudes than reference irrespective of the meteorological conditions.

9.1.2 The measured noise values shall be properly corrected to the reference conditions, either by the correction procedures presented as follows or by an integrated programme which shall be approved as being equivalent.

9.1.2.1 Correction procedures shall consist of one or more values added algebraically to the EPNL calculated as if the tests were conducted completely under the noise certification reference conditions.

9.1.2.2 The flight profiles shall be determined for both take-off and approach, and for both reference and test conditions. The test procedures shall require noise and flight path recordings with a synchronized time signal from which the test profile can be delineated, including the aeroplane position for which PNLTM is observed at the noise measuring station. For take-off, a flight profile corrected to reference conditions shall be derived from data approved by the certificating authority.

Note.— For approach, the reference profile is defined by the reference conditions in 5.3.1.

9.1.2.3 The differing noise path lengths from the aeroplane to the noise measuring station corresponding to PNLTM shall be determined for the test and reference conditions. The SPL values in the spectrum of PNLTM shall then be corrected for the effects of:

a) change in atmospheric sound absorption;

b) atmospheric sound absorption on the change in noise path length; and

c) inverse square law on the change in noise path length.

9.1.2.4 The corrected values of SPL shall then be converted to PNLT from which PNLTM is subtracted.

Note.— The difference represents the correction to be added algebraically to the EPNL calculated from the measured data.

9.1.3 The minimum distances from both the test and reference profiles to the noise measuring station shall be calculated and used to determine a noise duration correction due to the change in the altitude of aeroplane flyover. The duration correction shall be added algebraically to the EPNL calculated from the measured data.

9.1.4 From manufacturer's data (approved by the certificating authority) in the form of curves, tables or in some other manner giving the variation of EPNL with take-off mass and also for landing mass, corrections shall be determined to be added to the EPNL calculated from the measured data to account for noise level changes due to differences between maximum take-off mass and landing mass and test aeroplane mass.

9.1.5 From manufacturer's data (approved by the certificating authority) in the form of curves, tables or in some manner giving the variation of EPNL with approach angle, corrections shall be determined to be added algebraically to the EPNL calculated from measured data to account for noise level changes due to differences between the reference and the test approach angles.

9.2 Take-off profiles

Note.—

a) Figure 1-4 illustrates a typical take-off profile. The aeroplane begins the take-off roll at point A, *lifts off at point* B, *and initiates the first constant climb at point* C *at an angle* β. *The noise abatement thrust cutback is started at point* D *and completed at point* E *where the second constant climb is defined by the angle* γ *(usually expressed in terms of the gradient in per cent).*

b) The end of the noise certification take-off flight path is represented by aeroplane position F *whose vertical projection on the flight track (extended centre line of the runway) is point* M. *The position of the aeroplane is recorded for a distance* AM *of at least 11 km (6 NM).*

c) Position K *is the take-off noise measuring station whose distance* AK *is the specified take-off measurement distance. Position* L *is the sideline noise measuring station located on a line parallel to and the specified distance from the runway centre line where the noise level during take-off is greatest.*

d) The thrust settings after thrust reduction, if used, under the test conditions are such as would produce at least the minimum certification gradient for the reference conditions of atmosphere and mass.

e) The take-off profile is associated with the following five parameters: AB, *the length of take-off roll;* β, *the first constant climb angle;* γ, *the second constant climb angle; and* δ *and* ε, *the thrust cutback angles. These five parameters are functions of the aeroplane performance, mass and atmospheric conditions (ambient air temperature, pressure, and wind velocity). If the test atmospheric conditions are not equal to the reference atmospheric conditions, the corresponding test and reference profile parameters will be different as shown in Figure 1-5. The profile parameter changes (identified as* ΔAB, Δβ, Δγ, Δδ *and* Δε*) can be derived from the manufacturer's data (approved by the certificating authority) and are used to define the flight profile corrected to the atmospheric reference conditions, the aeroplane mass being unchanged from that of the test. The relationships between the measured and corrected take-off flight profiles can then be used to determine the corrections which are applied to the EPNL calculated from the measured data.*

f) Figure 1-6 illustrates portions of the measured and corrected take-off flight paths including the significant geometrical relationships influencing sound propagation. EF *represents the second constant measured flight path* *with climb angle γ, and E_c F_c represents the second constant corrected flight path at different altitude and with different climb angle γ + Δγ.*

g) *Position* Q *represents the aeroplane location on the measured take-off flight path for which PNLTM is observed at the noise measuring station* K, *and* Q_c *is the corresponding position on the corrected flight path. The measured and corrected noise propagation paths are* KQ *and* KQ_c, *respectively, which are assumed to form the same angle θ with their flight paths. This assumption of constant angle θ is one which may not be valid in all cases. Future refinement should be sought. However, for the present application of this test procedure, any differences are considered small.*

h) *Position* R *represents the point on the measured take-off flight path nearest the noise measuring station* K, *and* R_c *is the corresponding position on the corrected flight path. The minimum distance to the measured and corrected flight paths are indicated by the lines* KR *and* KR_c, *respectively, which are normal to their flight paths.*

9.2.1 If two peak values of PNLT are observed during flyover which differ by less than 2 TPNdB that noise level which, when corrected to reference conditions, gives the greater value shall be used in the computation for EPNL at the reference conditions. In that case the point corresponding to the second peak shall be obtained on the corrected flight path by applying manufacturer's approved data.

9.3 Approach profiles

Note.—

a) *Figure 1-7 illustrates a typical approach profile. The beginning of the noise certification approach profile is represented by aeroplane position* G *whose vertical projection on the flight track (extended centre line of the runway) is point* P. *The position of the aeroplane is recorded for a distance* OP *from the runway threshold* O *of at least 7.4 km (4 NM).*

b) *The aeroplane approaches at an angle η, passes vertically over the noise measuring station* N *at a height of* NH, *begins the level-off at position* I, *and touches down at position* J.

c) *The approach profile is defined by the approach angle η and the height* NH *which are functions of the aeroplane operating conditions controlled by the pilot. If the measured approach profile parameters are different from the corresponding reference approach parameters (Figure 1-8), corrections are applied to the EPNL calculated from the measured data.*

d) *Figure 1-9 illustrates portions of the measured and reference approach flight paths including the significant geometrical relationships influencing sound propagation.* GI *represents the measured approach path with approach angle η, and* G_rI_r *represents the reference approach flight path at reference altitude and the reference approach angle* $η_r$.

e) *Position* S *represents the aeroplane location on the measured approach flight path for which PNLTM is observed at the noise measuring station* N, *and* S_r *is the corresponding position on the reference approach flight path. The measured and corrected noise propagation paths are* NS *and* NS_r *respectively, which form the same angle λ with their flight paths.*

f) *Position* T *represents the point on the measured approach flight path nearest the noise measuring station* N, *and* T_r *is the corresponding point on the reference approach flight path. The minimum distances to the measured and reference flight paths are indicated by the lines* NT *and* NT_r, *respectively, which are normal to their flight paths.*

9.4 PNLT corrections

9.4.1 Whenever the ambient atmospheric conditions of temperature and relative humidity differ from the reference conditions and/or whenever the measured take-off and approach flight paths differ from the reference flight paths respectively, corrections to the EPNL values calculated from the measured data shall be applied. These corrections shall be calculated as described below:

9.4.1.1 *Take-off*

9.4.1.1.1 Referring to a typical take-off flight path shown in Figure 1-6, the spectrum of PNLTM observed at station K, for the aeroplane at position Q, shall be decomposed into its individual SPL(i) values. A set of corrected values shall be computed as follows:

$$\begin{aligned} SPL(i)_c = {} & SPL(i) + 0.01[\alpha(i) - \alpha(i)_o]\ KQ \\ & + 0.01\alpha(i)_o\ (KQ - KQ_c) \\ & + 20 \log (KQ/KQ_c) \end{aligned}$$

— the term 0.01 $[\alpha(i) - \alpha(i)_o]$ KQ accounts for the effects of the change in atmospheric sound absorption where $\alpha(i)$ and $\alpha(i)_o$ are the sound absorption coefficients for the test and reference conditions respectively for the i-th one-third octave band and KQ is the measured take-off noise path;

— the term 0.01 $\alpha(i)_o$ (KQ − KQ_c) accounts for the effect of atmospheric sound absorption on the change in the noise path length, where KQ_c is the corrected take-off noise path; and

— the term 20 log (KQ/KQ_c) accounts for the effects of the inverse square law on the change in the noise path length.

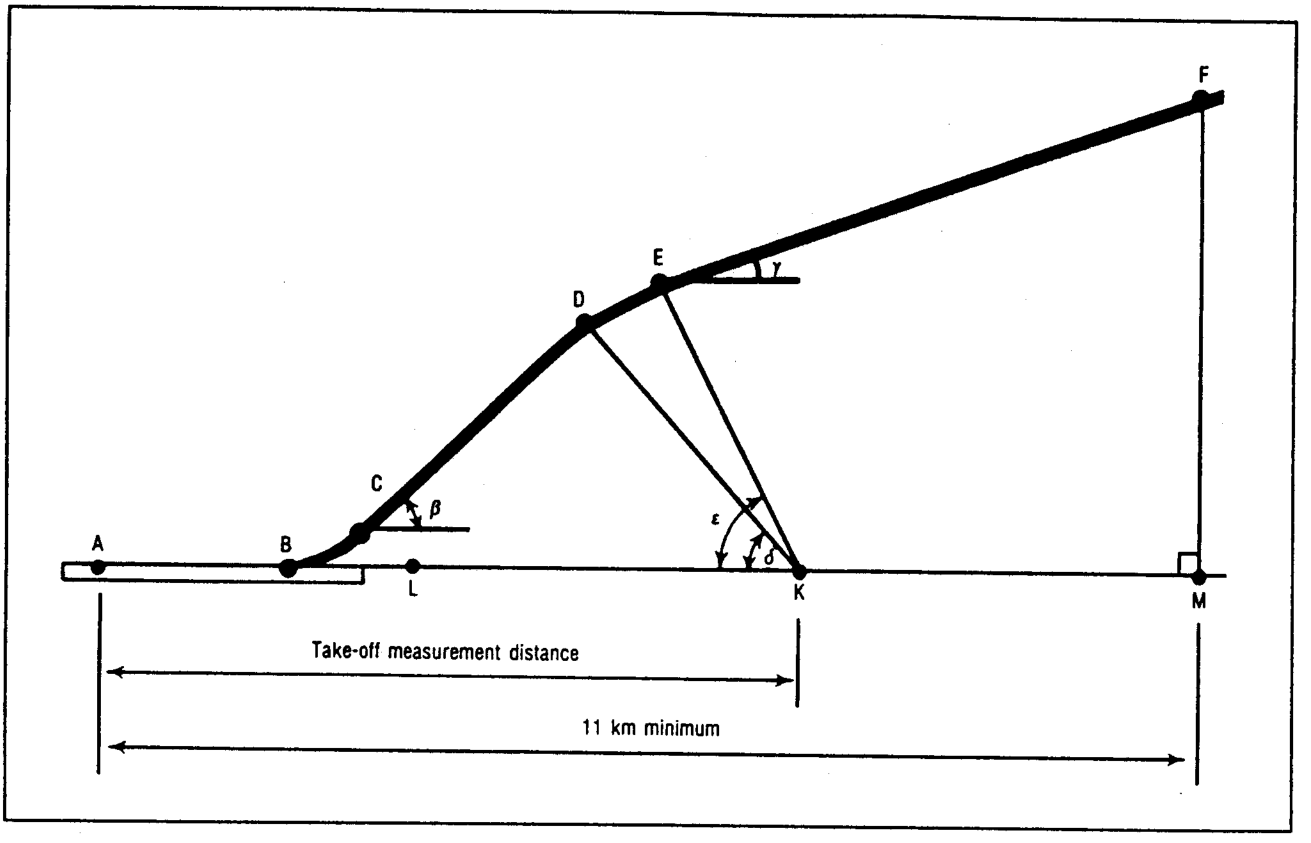


Figure 1-4. Measured take-off profile

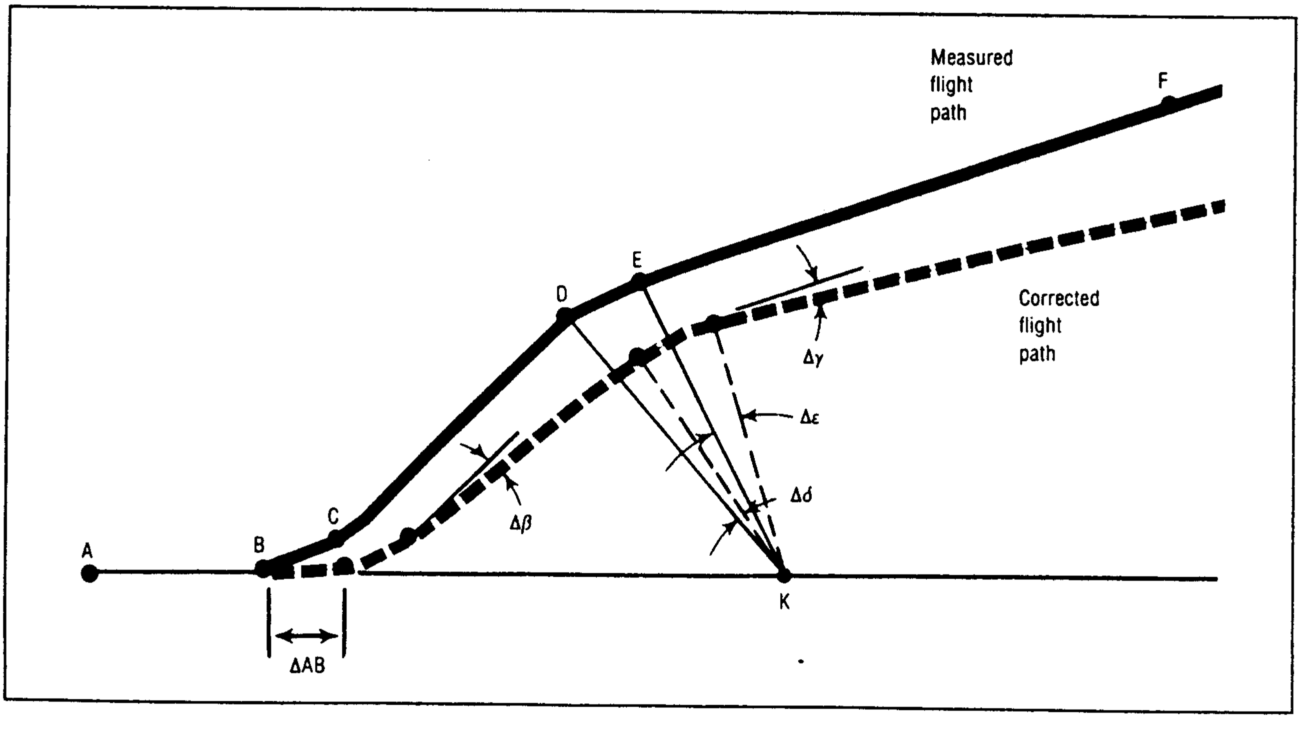


Figure 1-5. Comparison of measured and corrected take-off profiles

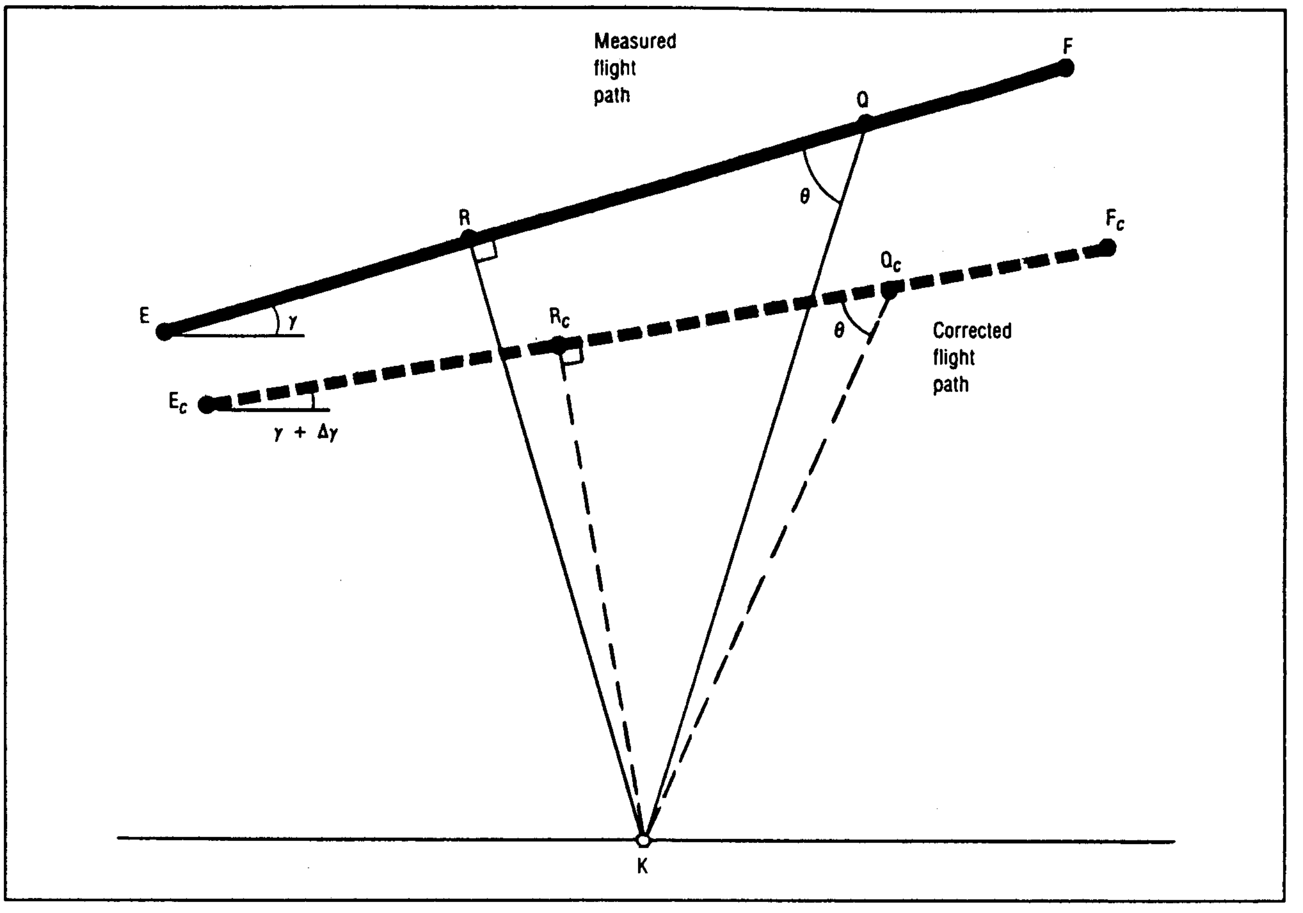


Figure 1-6. Take-off profile characteristics influencing sound level

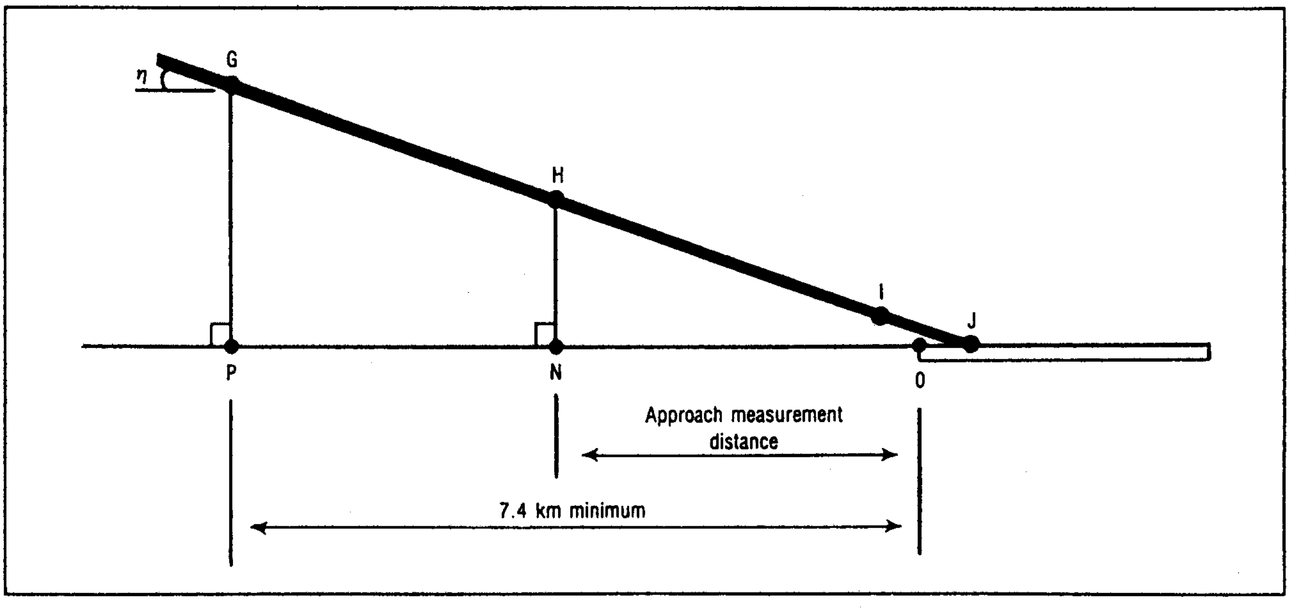


Figure 1-7. Measured approach profile

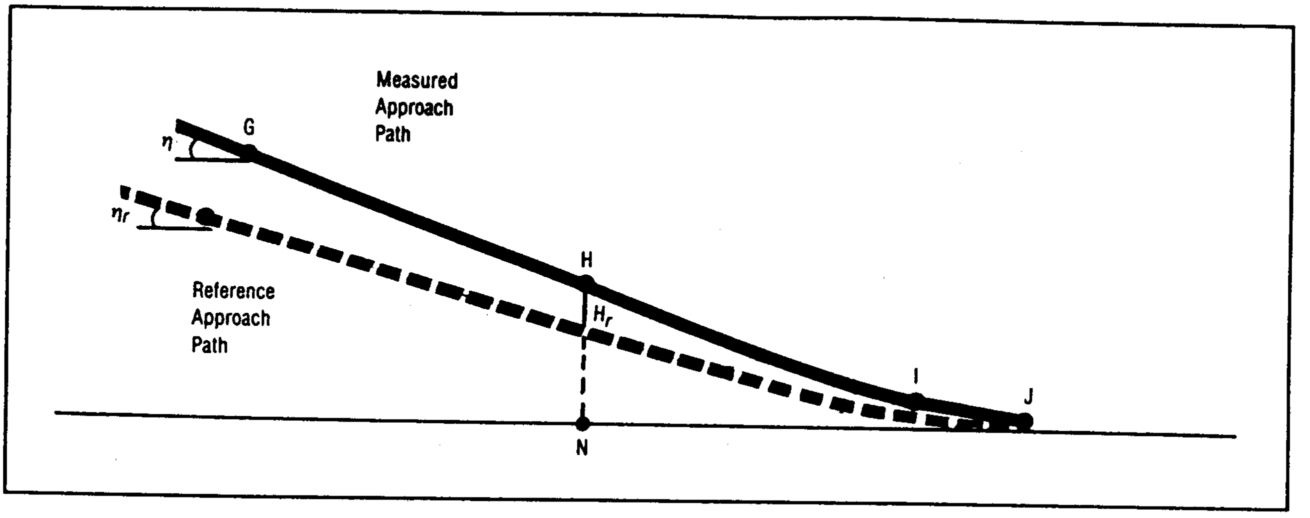


Figure 1-8. Comparison of measured and corrected approach profiles

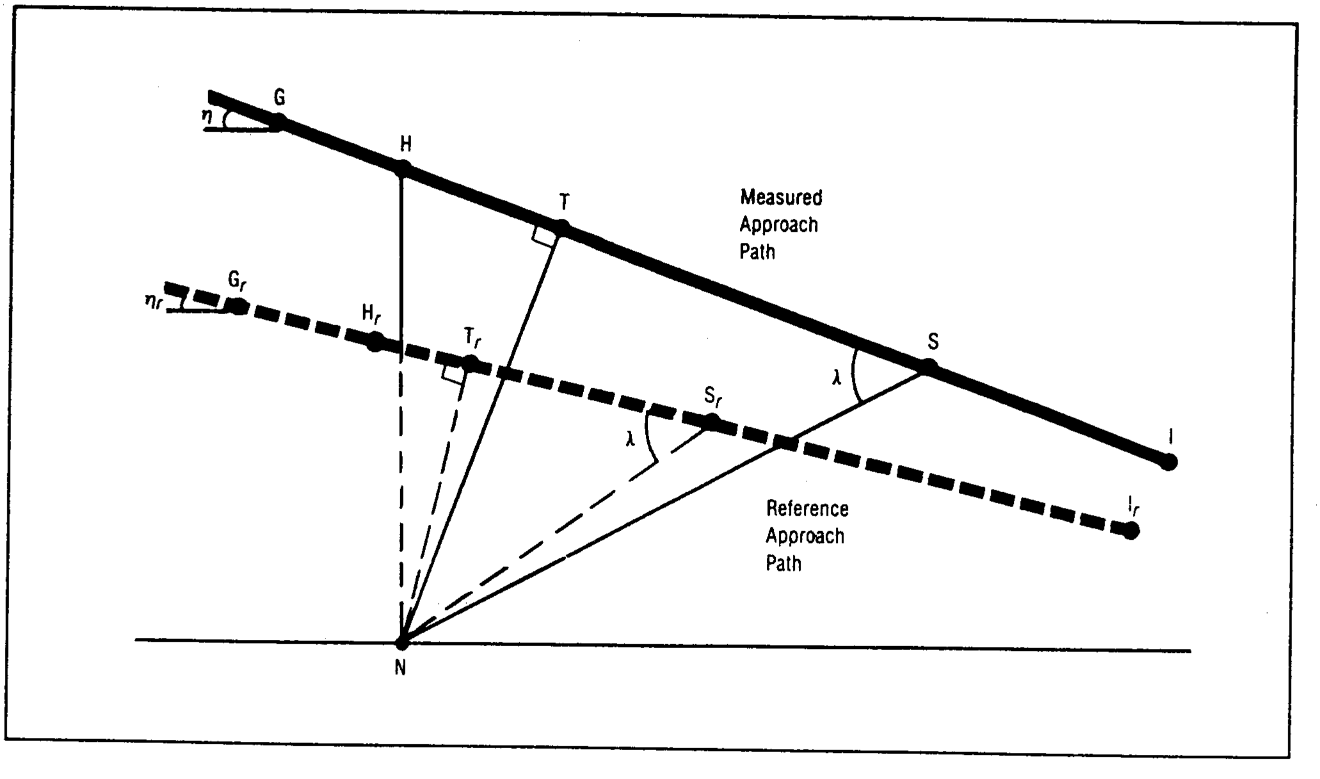


Figure 1-9. Approach profile characteristics influencing sound level

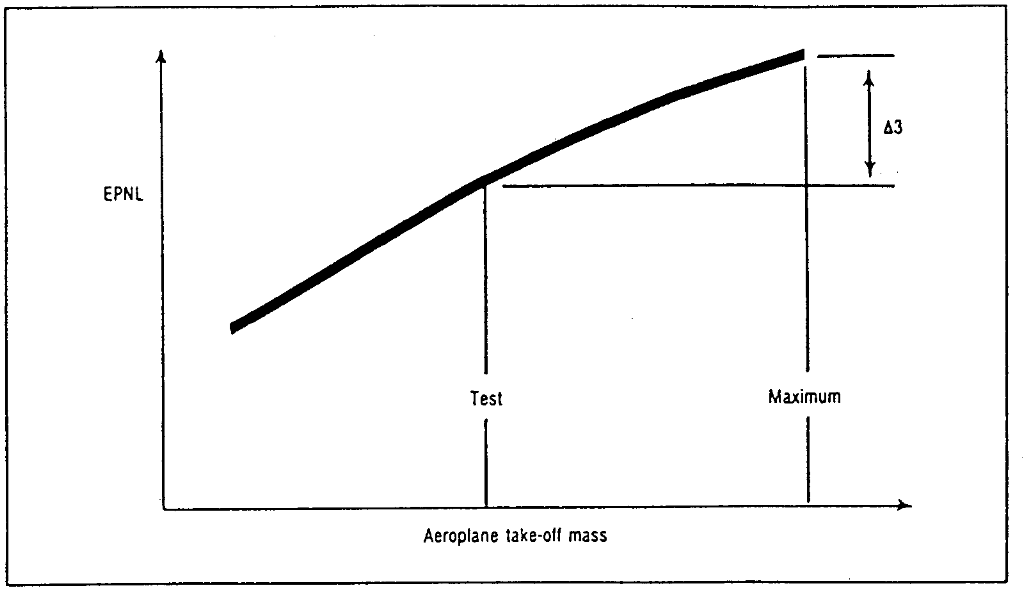


Figure 1-10. Take-off mass correction for EPNL

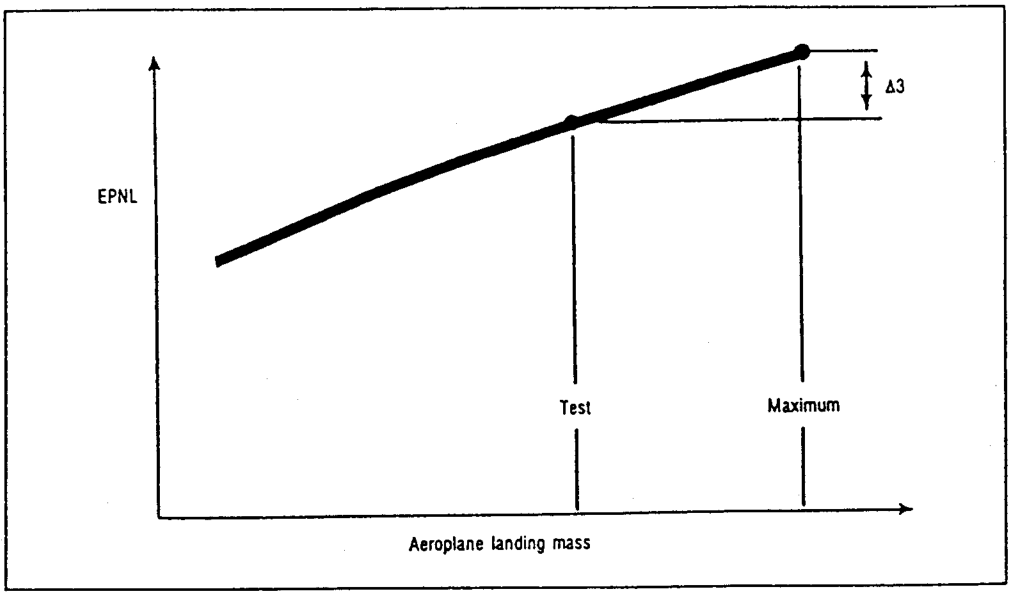


Figure 1-11. Approach mass correction for EPNL

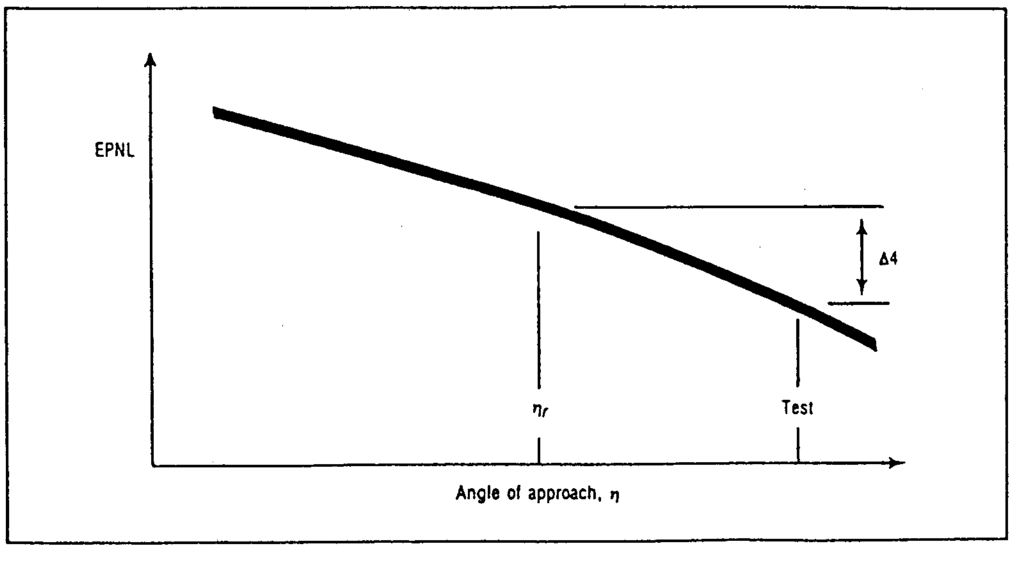


Figure 1-12. Approach angle correction for EPNL

9.4.1.1.2 The corrected values of $SPL(i)_c$ shall then be converted to PNLT and a correction term calculated as follows:

$$\Delta_1 = PNLT - PNLTM$$

which represents the correction to be added algebraically to the EPNL calculated from the measured data.

9.4.1.2 *Approach*

9.4.1.2.1 The same procedure shall be used for the approach flight path except that the values for $SPL(i)_c$ relate to the approach noise paths shown in Figure 1-9 as follows:

$$SPL(i)_c = SPL(i) + 0.01\ [\alpha(i) - \alpha(i)_o]\ NS$$
$$+ 0.01\ \alpha(i)_o\ (NS - NS_r)$$
$$20 \log (NS/NS_r)$$

where NS and NS_r are the measured and reference approach noise paths, respectively. The remainder of the procedure shall be the same as for the take-off flight path.

9.4.1.3 *Lateral*

9.4.1.3.1 The same procedure shall be used for the lateral flight path except that the values for $SPL(i)_c$ relate only to the measured lateral noise path as follows:

$$SPL(i)_c = SPL(i) + 0.01\ [\alpha(i) - \alpha(i)_o]\ LX$$

where LX shall be the measured lateral noise path from station L (Figure 1-4) to position X of the aeroplane for which PNLTM is observed at station L. Only the correction term accounting for the effects of change in atmospheric sound absorption shall be considered. The difference between the measured and corrected noise path lengths shall be assumed negligible for the lateral flight path. The remainder of the procedure shall be the same as for the take-off flight path.

9.5 Duration correction

9.5.1 Whenever the measured take-off and approach flight paths differ from the corrected and reference flight paths, respectively, duration corrections to the EPNL values calculated from the measured data shall be applied. These corrections shall be calculated as described below:

9.5.1.1 *Take-off*

9.5.1.1.1 Referring to the take-off flight path shown in Figure 1-6, a correction term shall be calculated as follows:

$$\Delta_2 = -7.5 \log (KR/KR_c)$$

which represents the corrections to be added algebraically to the EPNL calculated from the measured data. The lengths KR and KR_c shall be the measured and corrected take-off minimum distances, respectively, from the noise measuring station K to the measured and corrected flight paths. The negative sign shall indicate that, for the particular case of a duration correction, the EPNL calculated from the measured data shall be reduced if the measured flight path is at a greater altitude than the corrected flight path.

9.5.1.2 *Approach*

9.5.1.2.1 The same procedure shall be used for the approach flight path except that the correction relates to the approach minimum distances shown in Figure 1-9 as follows:

$$\Delta_2 = -7.5 \log (NT/NT_r)$$

where NT is the measured approach minimum distance from the noise measuring station N to the measured flight path.,

9.5.1.3 *Lateral*

9.5.1.3.1 No duration correction shall be computed for the lateral flight path because the differences between the measured and corrected flight paths are assumed negligible.

9.6 Mass correction

9.6.1 Whenever the aeroplane mass, during either the noise certification take-off or approach test, is different from the corresponding maximum take-off or landing mass, a correction shall be applied to the EPNL value calculated from the measured data. The corrections shall be determined from the manufacturer's data (approved by the certificating authority) in the form of tables or curves such as schematically indicated in Figures 1-10 and 1-11. The manufacturer's data shall be applicable to the noise certification reference atmospheric conditions.

9.7 Approach angle correction

9.7.1 Whenever the aeroplane approach angle during the noise certification approach test is different from the reference approach angle, a correction shall be applied to the EPNL value calculated from the measured data. The corrections shall be determined from the manufacturer's data (approved by the certificating authority) in the form of tables or curves such as schematically indicated in Figure 1-12. The manufacturer's data shall be applicable to the noise certification reference atmospheric conditions and to the test landing mass.

APPENDIX 2. EVALUATION METHOD FOR NOISE CERTIFICATION OF:

1.— SUBSONIC JET AEROPLANES — Application for Certificate of Airworthiness for the Prototype accepted on or after 6 October 1977

2.— PROPELLER-DRIVEN AEROPLANES OVER 5 700 kg — Application for Certificate of Airworthiness for the Prototype accepted on or after 1 January 1985 and before 17 November 1988

3.— PROPELLER-DRIVEN AEROPLANES OVER 9 000 kg — Application for Certificate of Airworthiness for the Prototype accepted on or after 17 November 1988

4.— HELICOPTERS

Note.— See Chapters 3 and 8, Part II.

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

a) noise certification test and measurement conditions;

b) measurement of aeroplane and helicopter noise received on the ground;

c) calculation of effective perceived noise level from measured noise data; and

d) reporting of data to the certificating authority and correcting measured data.

Note 2.— The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests, and to permit comparison between tests of various types of aircraft conducted in various geographical locations.

Note 3.— A complete list of symbols and units, the mathematical formulation of perceived noisiness, a procedure for determining atmospheric attenuation of sound, and detailed procedures for correcting noise levels from non-reference to reference conditions are included in Sections 6 to 9 of this appendix.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

2.1.1 This section prescribes the conditions under which noise certification shall be conducted and the measurement procedures that shall be used.

Note.— Many applications for a noise certificate involve only minor changes to the aircraft type design. The resultant changes in noise can often be established reliably without the necessity of resorting to a complete test as outlined in this appendix. For this reason certificating authorities are encouraged to permit the use of appropriate "equivalent procedures". Also, there are equivalent procedures that may be used in full certification tests, in the interest of reducing costs and providing reliable results. Guidance material on the use of equivalent procedures in the noise certification of *subsonic jet and propeller-driven aeroplanes and helicopters is provided in the* Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

2.2 Test environment

2.2.1 Locations for measuring noise from an aircraft in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted, or tall grass, shrubs, or wooded areas. No obstructions which significantly influence the sound field from the aircraft shall exist within a conical space above the point on the ground vertically below the microphone, the cone being defined by an axis normal to the ground and by a half-angle 80° from this axis.

Note.— Those people carrying out the measurements could themselves constitute such obstructions.

2.2.2 Except as provided in 2.2.3, the tests shall be carried out under the following atmospheric conditions:

a) no precipitation;

b) ambient air temperature not above 35°C and not below 10°C and relative humidity not above 95 per cent and not below 20 per cent over the whole noise path between a point 10 m (33 ft) above the ground and the aircraft;

Note.— Care should be taken to ensure that the noise measuring, aircraft flight path tracking and meteorological instrumentation are operated within their environmental limitations.

c) relative humidity and ambient temperature over the whole noise path between a point 10 m (33 ft) above the ground and the aircraft such that the sound attenuation in the one-third octave band centred on 8 kHz will not be more than 12 dB/100 m;

d) variation relative to the average value obtained over the noise propagation path at PNLTM of the atmospheric absorption coefficient in the 3 150 Hz one-third octave band, may exceed ±0.5 dB/100 m provided that 'layered' sections of the atmosphere are used to compute equivalent weighted sound attenuations in each one-third octave band, sufficient sections being used to the satisfaction of the certificating authority; where multiple layering is not required, equivalent sound attenuations in each one-third octave band shall be determined by averaging the atmospheric absorption coefficients for each such band at 10 m (33 ft) above ground level and at the flight level of the test aircraft at the time of PNLTM, for each measurement;

e) windspeed not above 22 km/h (12 kt) and cross-wind speed not above 13 km/h (7 kt) at 10 m (33 ft) above ground over the 10 dB-down time interval, except for helicopters, for which the windspeed may not exceed 19 km/h (10 kt) and the cross-wind speed may not exceed 9 km/h (5 kt) at 10 m (33 ft) above ground;

Note 1.— For aeroplanes, these limits are based on the use of an anemometer with a built-in detector time constant of 30 s. For anemometers with shorter detector times the effects of short term gusts during the 10 dB-down period must be considered and in such instances the maximum value of gusts should not exceed 28 km/h (15 kt) and a maximum average wind value of no more than 22 km/h (12 kt). The maximum value of cross-wind gust should not exceed 18 km/h (10 kt) and a maximum average cross-wind of 13 km/h (7 kt).

Note 2.— The cross-wind component is based on the continuous windspeed vector resolution in the cross-wind direction.

f) no anomalous wind conditions that would significantly affect the measured noise levels when the noise is recorded at the measuring points specified by the certificating authority.

When a multiple layering calculation is required by 2.2.2 (d) the atmosphere between the aircraft and 10 m (33 ft) above the ground shall be divided into layers of equal depth. The depth of the layers shall be determined by the minimum depth of the layer giving a variation of ±0.5 dB/100 m in the atmospheric absorption coefficient of the 3 150 Hz one-third octave band over any part of the noise propagation path with a minimum layer depth of 30 m. The mean of the values of the atmospheric absorption coefficients at the top and bottom of each layer may be used to characterize the absorption properties of each layer.

2.2.3 The requirements of 2.2.2 b), c) and d) shall only be applied at a point 10 m (33 ft) above ground for tests of helicopters.

2.2.4 The aerodrome control tower or another facility shall be approved for use as the central location at which measurements of atmospheric parameters are representative of those conditions existing over the geographical area in which noise measurements are made.

2.3 Flight path measurement

2.3.1 The aircraft height and lateral position relative to the flight track shall be determined by a method independent of normal flight instrumentation such as radar tracking, theodolite triangulation, or photographic scaling techniques to be approved by the certificating authority.

2.3.2 The aircraft position along the flight path shall be related to the noise recorded at the noise measurement locations by means of synchronizing signals over a distance sufficient to assure adequate data during the period that the noise is within 10 dB of the maximum value of PNLT.

2.3.3 Position and performance data required to make the adjustments referred to in Section 8 or 9 of this appendix shall be automatically recorded at an approved sampling rate. Measuring equipment shall be approved by the certificating authority.

3. MEASUREMENT OF AIRCRAFT NOISE RECEIVED ON THE GROUND

3.1 General

Note.— These measurements provided one-third octave band levels of the noise observed at each noise-measuring station, as a function of time, for the calculation of effective perceived noise level as described in Section 4.

3.1.1 The measurement system shall consist of equipment equivalent to the following:

a) a microphone system (see 3.2);

b) a recording and reproducing system (when on-line analysis is not employed) to store the measured noise data for subsequent analysis (see 3.3);

c) an analysis system to provide the output for calculation of EPNL (see 3.4);

d) calibration systems to ensure the continuous accuracy of the above systems (see 3.5).

3.1.2 The equipment used shall be shown by its manufacturers or by its users to meet the specifications of IEC 561* and 651* which form the basis of 3.2, 3.3, and 3.4, or to be of equivalent electro-acoustical performance, and shall be approved by the certificating authority.

3.1.3 The calibration and checking procedures to be used during each certification test series shall be shown to meet the corresponding specifications which are quoted in 3.5, or to be equivalent, and shall be approved by the certificating authority.

3.2 Microphone system

3.2.1 The microphone system shall consist of a microphone, preamplifier and wind screen meeting the specifications in 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7 and 3.2.8. Other systems may be approved for equivalency by the certificating authority on the basis of demonstrated equivalent over-all acoustic performance. Where two or more microphone systems of the same type are used, demonstration of at least one system to comply with the specifications in full will be sufficient to show type compliance.

Note.— This does not preclude the need to calibrate each system as defined in 3.5.

3.2.2 The microphone shall be of the pressure-sensitive type designed for nearly uniform grazing incidence response.

3.2.3 The microphone shall be mounted with the centre of the sensing element 1.2 m (4 ft) above the local ground surface and shall be oriented for grazing incidence, i.e. with the sensing element substantially in the plane defined by the nominal flight path of the aeroplane or helicopter and the measuring station as shown in Figure 2-1. The microphone mounting arrangement shall minimize the interference of the supports with the sound to be measured.

3.2.4 After an adequate "warm up" period, at least as long as that specified by the equipment manufacturer, the system output for constant acoustical input shall change by not more than 0.3 dB within any one hour nor by more than 0.4 dB within 5 hours.

3.2.5 A reference direction of incidence shall be specified for which the frequency response characteristics given in 3.2.6 apply. The change in sensitivity of the microphone system within angles of ±30° measured from the reference direction (see Figure 2-1) shall not exceed the following values:

Frequency (Hz)	*Change in sensitivity (dB)*
45 to 1 120	1
1 120 to 2 240	1.5
2 240 to 4 500	2.5
4 500 to 7 100	4
7 100 to 11 200	5

3.2.6 The free-field frequency response of the microphone system at the reference incidence direction shall lie within an envelope having the following values:

Frequency Range (Hz)	*Tolerance (dB)*
45 to 4 500	±1
4 500 to 5 600	±1.5
5 600 to 7 100	+1.5, −2
7 100 to 9 000	+1.5, −3
9 000 to 11 200	+2, −4

* Available from the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

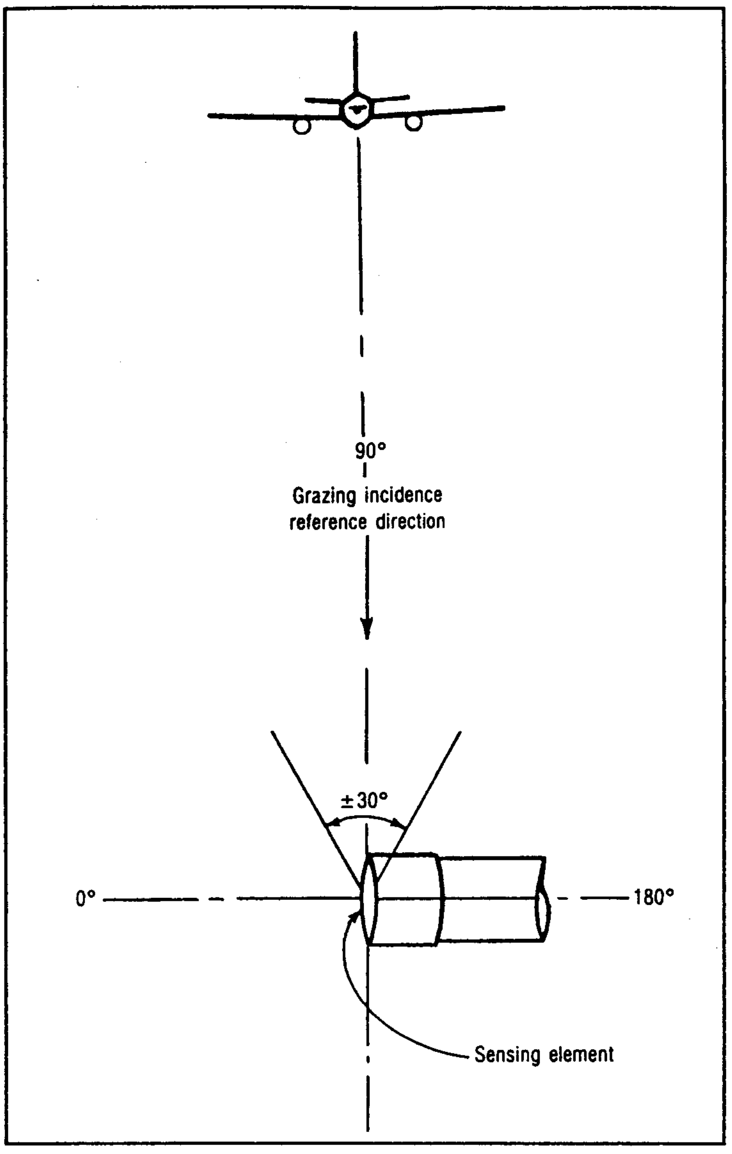


Figure 2-1. Reference direction of incidence and incidence angle definition for grazing incidence microphones

Note.— The requirements of this paragraph may be determined by a pressure response calibration (which may be obtained from an electrostatic calibrator in combination with manufacturer provided corrections) or an anechoic free-field facility.

3.2.7 With the wind screen in place, the variation in sensitivity in the plane of the diaphragm of the microphone system shall not exceed 1.0 dB over the frequency range 45 to 11 200 Hz.

3.2.8 Specifications concerning sensitivity to environmental factors such as temperature, relative humidity, and vibration shall be in accordance with the requirements of IEC Publication 651.

3.2.9 Each microphone system shall be calibrated as described in 3.5, and the correction for the frequency response of the microphone system shall be reported and applied in the determination of the noise level.

3.3 Recording and reproducing system

3.3.1 A recording system (such as a magnetic tape recorder) shall be used to store data for subsequent analysis, if required. The record/replay system (including tape) shall be shown to meet the specifications in 3.3.2, 3.3.3, 3.3.4 and 3.3.5 at the tape speeds used for the tests.

3.3.2 At standard recording level (i.e. 10 dB below the 3 per cent harmonic distortion level for direct recording, or ±40 per cent deviation for FM recording), in any selected one-third octave frequency band between 180 and 11 200 Hz, the corrected frequency response shall be flat within ±0.25 dB, and in any band between 45 and 180 Hz shall be flat within ±0.75 dB.

3.3.3 The amplitude fluctuations of a 1 kHz sinusoidal signal recorded at the standard recording level shall be within ±0.5 dB throughout any reel of the type of magnetic tape utilized. Measurements to verify this shall be made using a device with averaging properties equal to those used in the measuring chain (see 3.4).

3.3.4 The performance of the system shall be such that the background noise in any one-third octave band is at least 35 dB below the standard recording level (see 3.3.2).

Note.— With sharply falling spectra appropriate pre-emphasis and de-emphasis networks may need to be included in the system.

3.3.5 Attenuators included in the measuring chain to permit range changing shall operate in intervals of equal integral decibel steps, and the error between any two settings required for operating the equipment during noise certification measurements or for associated calibrations shall not exceed 0.2 dB.

3.3.6 The recording and reproducing system shall be calibrated as described in 3.5.

3.4 Analysis system

3.4.1 The output of the analysis system shall consist of one-third octave band sound levels as a function of time, obtained by processing the (recorded) noise measurements through:

a) a set of 24 one-third octave filters (or their equivalent) having geometric centre frequencies 50 Hz to 10 kHz;

b) an analyser with appropriate response and averaging properties, in which (in principle) the output from any one-third octave band is squared, averaged, converted to logarithmic form and digitized.

3.4.2 The one-third octave band filters shall satisfy the requirements of IEC Publication 225* and additionally have less than 0.5 dB ripple.

The correction for effective bandwidth relative to the response at the frequency of the acoustic calibrator used (see 3.5.5) shall be determined for the appropriate one-third octave band filter, by measuring the filter response to sinusoidal signals at a minimum of 20 frequencies equally spaced between the two adjacent preferred one-third octave frequencies or by using equivalent procedures approved by the certificating authority.

3.4.3 The detector or detectors shall operate over a minimum dynamic range of 60 dB and shall perform as true mean square devices for sinusoidal tone bursts having crest factors of up to 3 over the dynamic range extending from 0 to 30 dB below full scale reading within an accuracy of ±0.5 dB; the accuracy shall be within ±1 dB between 30 and 40 dB below full scale reading, and within ±2.5 dB over the remaining 20 dB of range.

Compliance with this requirement shall be determined by the method described in Appendix B of IEC Publication 179A**, with the signals applied directly to the input of each detector in turn.

3.4.4 The averaging properties of the integrator shall be tested as follows. White noise shall be passed through a one-third octave band filter with centre frequency 200 Hz and statistical bandwidth 46 ±1 Hz, and the output shall be fed in turn to each detector/integrator. The standard deviation of the measured levels shall be determined from a large number of samples of the filtered white noise taken at intervals of not less than 5 s. The value of the standard deviation shall be within the interval 0.48 ±0.06 dB for a probability limit of 95 per cent.

3.4.5 For each detector/integrator, the response to a sudden onset or interruption of a constant sinusoidal signal at the respective one-third octave band centre frequency shall be measured at sampling instants 0.5, 1, 1.5 and 2 s after the onset and 0.5 and 1 s after interruption. The rising response at 0.5 s shall be −4 ±1 dB, at 1 s −1.75 ±0.75 dB, at 1.5 s −1 ±0.5 dB and at 2 s −0.6 ±0.5 dB relative to the steady-state level. The falling response shall be such that the sum of the decibel readings (below initial steady-state level) and the corresponding rising response reading is 6.5 ±1 dB, at both 0.5 and 1 s and on subsequent records the sum of the onset plus decay must be greater than 7.5 dB. This equals to an exponential averaging process (SLOW response) with a normal 1 s time constant (i.e. 2 s averaging time).

Note 1.— For analysers with linear detection an approximation of this response would be given by:

$$
\begin{aligned}
SPL(i,k) = 10 \log [0.13\,(10^{0.1L(i,k-3)}) \\
+ 0.21\,(10^{0.1L(i,k-2)}) \\
+ 0.27\,(10^{0.1L(i,k-1)}) \\
+ 0.39\,(10^{0.1L(i,k)})]
\end{aligned}
$$

* As amended. The publication was first issued in 1966 by the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

** As amended. This publication was first issued in 1973 as a supplement to IEC publication 179.

Where the weighting coefficients for simulation of slow response are:

Current L(*i,k*) ½ *s record: 39 per cent*

Previous L(*i,k*–1) ½ *s record: 27 per cent*

Second L(*i,k*–2) ½ *s record: 21 per cent*

Third L(*i,k*–3) ½ *s record: 13 per cent*

and where:

L(*i,k*), L(*i,k*–1), L(*i,k*–2) *and* L(*i,k*–3) *are the as-measured ½ s values from the analyser. These are not the weighted values of* SPL(*i,k*), SPL(*i,k*–1), SPL(*i,k*–2) *as defined in Section 7.*

It should be noted that when this approximation is used the calibration signal should be established without this weighting.

Note 2.— Some analysers have been shown to have signal sampling rates that are insufficiently accurate to detect signals with crest factor ratios greater than three (common to helicopter noise) and are therefore not considered suitable for helicopter certification. Use of analysis systems with high signal sampling rates (greater than 60 kHz) or those with analog detectors prior to digitization at the output of each one-third octave filter is encouraged.

3.4.6 Analysers using true integration cannot meet 3.4.4 and 3.4.5 directly because the over-all averaging time, T_a is greater than the sampling interval, T_S (see 3.4.7). Compliance with these clauses shall then be demonstrated in terms of the output of the data processor. Furthermore, in cases where readout and integrator resetting of the total system (including the data processor) require a deadtime during acquisition, the percentage loss of the total data shall not exceed 1 per cent. When an analyser with true integration is used, this response can be obtained at times greater than 2.5 s from start-up, using a continuous exponential averaging process with the following equation:

$$SPL(i,k) = 10 \log \left[(1-1/R)10^{0.1\ SPL[i,(k-1)]} + (1/R)10^{0.1\ SPL(i,k)} \right]$$

where SPL(*i,k*) is the sound pressure level at the *k*-th instant of time that occurs in the *i*-th one-third octave and where R = 2.5 for linear 0.5 s data records.

3.4.7 The sampling interval T_S between successive data readouts shall not not exceed 500 ms and its precise value shall be known to within ±1 per cent. The instant in time by which a readout is characterized shall be 0.75 s earlier than the actual readout time for $T_a = 2$ s.

Note.— The definition of this instant in time is required to correlate the recorded noise with the position of the aircraft when that noise was emitted and takes into account the averaging period of the SLOW response.

3.4.8 In order to achieve adequate over-all precision, the resolution of the digitizing system output shall be equal to, or better than 0.25 dB.

3.5 Calibration and checking of system

3.5.1 Calibration and checking of the complete measurement and analysis system used during the noise certification tests shall be carried out to the satisfaction of the certificating authority at appropriate times during the tests and before or after them, by the methods quoted in 3.5.2, 3.5.3, 3.5.4, 3.5.5 and 3.5.6.

3.5.2 When on account of the use of a microphone system of known frequency response (see 3.2.5) the over-all system is calibrated for frequency response using an insert voltage technique, the frequency response of the electrical system shall be determined, during each test series, at a level within 10 dB of the full-scale reading used during the tests, utilizing pink or pseudorandom noise. The output of the noise generator shall have been checked by an approved standards laboratory within 6 months of the test series; and tolerable changes in the relative output at each one-third octave band shall be not more than 0.2 dB. Sufficient determinations shall be made to ensure that the over-all calibration of the system is known for each test.

Where a magnetic tape recorder forms part of the measuring chain, each reel of magnetic tape shall carry 30 s of this electrical calibration signal at its beginning and end for this purpose. In addition, data obtained from tape-recorded signals shall be accepted as reliable only if the level difference in the 10 kHz one-third octave band filtered levels of the two signals is not more than 0.75 dB.

3.5.3 The response of each detector/integrator shall be determined in accordance with 3.4.5.

3.5.4 The performance of switched attenuators in the equipment used during noise certification measurements and calibration shall be checked for each test series, using the most accurate part of the readout device to ensure that the maximum error does not exceed the resolution.

3.5.5 The response of the over-all electro-acoustical system shall be determined using an acoustic calibrator generating a known sound pressure level at a known frequency. The output of the acoustic calibrator shall have been checked by a standardizing laboratory within 6 months of the test series; tolerable changes in output shall be not more than 0.2 dB. A pistonphone operating at a nominal 124 dB (re 20 μPa) and 250 Hz is generally used for this purpose. Sufficient determinations shall be made during the day's work to ensure that the response of the equipment is known for each test.

The equipment shall be considered satisfactory if the variation over the period immediately prior to and immediately following each test series within a given day is not greater than 0.5 dB.

The insertion loss of the wind screen shall also have been checked over the useful frequency range by a standardizing laboratory within 6 months of the test series; tolerable changes in insertion loss shall be not more than 0.4 dB.

The insertion loss of the wind screen over the frequency range 40 Hz to 12.5 kHz shall also have been determined to the satisfaction of the certificating authority.

Note.— The insertion loss of a new wind screen may be taken from manufacturer's data.

3.5.6 The ambient noise, including both acoustical background and electrical noise of the measurement system, shall be recorded at the measurement points with the system gain set at the levels used for the aircraft noise measurements, at appropriate times during each test day. The recorded aircraft noise data shall be accepted only if the ambient noise levels when analysed in the same way and quoted in PNL (see 4.1.3 a)) are at least 20 dB below the maximum PNL of the aircraft.

Aircraft sound pressure levels within the 10 dB-down points (see 4.5.1) shall exceed the mean ambient noise levels determined above by at least 3 dB in each one-third octave band or be adjusted using the method described in Appendix 3 of the *Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft* (Doc 9501).

Where more than seven consecutive one-third octaves are within 3 dB of the ambient noise levels a time frequency extrapolation of the noise data shall be performed using a procedure such as described in the above-mentioned ICAO Environmental Technical Manual or by other such equivalent procedure approved by the certificating authority.

4. CALCULATION OF EFFECTIVE PERCEIVED NOISE LEVEL FROM MEASURED NOISE DATA

4.1 General

4.1.1 The basic element in the noise certification criteria shall be the noise evaluation measure designated effective perceived noise level, EPNL, in units of EPNdB, which is a single number evaluator of the subjective effects of aircraft noise on human beings. Simply stated, EPNL shall consist of instantaneous perceived noise level, PNL, corrected for spectral irregularities (the correction, called "tone correction factor", is made for the maximum tone only at each increment of time) and for duration.

4.1.2 Three basic physical properties of sound pressure shall be measured level, frequency distribution, and time variation. More specifically, the instantaneous sound pressure level in each of 24 one-third octave bands of the noise shall be required for each 500 ms increment of time during the aircraft noise measurement.

4.1.3 The calculation procedure which utilizes physical measurements of noise to derive the EPNL evaluation measure of subjective response shall consist of the following five steps:

a) the 24 one-third octave bands of sound pressure level are converted to perceived noisiness by the methods of Section 4.7. The noy values are combined and then converted to instantaneous perceived noise levels, PNL(k);

b) a tone correction factor, $C(k)$ is calculated for each spectrum to account for the subjective response to the presence of spectral irregularities;

c) the tone correction factor is added to the perceived noise level to obtain tone corrected perceived noise levels, PNLT(k), at each one-half second increment of time:

$$\text{PNLT}(k) = \text{PNL}(k) + C(k)$$

The instantaneous values of tone corrected perceived noise level are derived and the maximum value, PNLTM, is determined;

d) a duration correction factor, D, is computed by integration under the curve of tone corrected perceived noise level versus time;

e) effective perceived noise level, EPNL, is determined by the algebraic sum of the maximum tone corrected perceived noise level and the duration correction factor:

$$\text{EPNL} = \text{PNLTM} + D$$

4.2 Perceived noise level

4.2.1 Instantaneous perceived noise levels, PNL(k), shall be calculated from instantaneous one-third octave band sound pressure levels, SPL(i,k) as follows:

Step 1. Convert each one-third octave band SPL(i,k), from 50 to 10 000 Hz, to perceived noisiness $n(i,k)$, by reference to the Table of Perceived Noisiness in Appendix 4 of the *Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft* (Doc 9501), or to the mathematical formulation of the noy table given in Section 4.7.

Step 2. Combine the perceived noisiness values, $n(i,k)$, found in step 1 by the following formula:

$$N(k) = n(k) + 0.15 \left\{ \left[\sum_{i=1}^{24} n(i,k)\right] - n(k) \right\}$$

$$= 0.85\ n(k) + 0.15 \sum_{i=1}^{24} n(i,k)$$

where $n(k)$ is the largest of the 24 values of $n(i,k)$ and $N(k)$ is the total perceived noisiness.

Step 3. Convert the total perceived noisiness, $N(k)$, into perceived noise level, PNL(k), by the following formula:

$$\text{PNL}(k) = 40.0 + \frac{10}{\log 2} \log N(k)$$

Note.— PNL(k) is plotted in Figure 4-1 of Appendix 4 of Doc 9501.

4.3 Correction for spectral irregularities

4.3.1 Noise having pronounced spectral irregularities (for example, the maximum discrete frequency components or tones) shall be adjusted by the correction factor $C(k)$ calculated as follows:

Step 1. Except for helicopters which start at 50 Hz (band number 1), start with the corrected sound pressure level in the 80 Hz one-third octave band (band number 3), calculate the changes in sound pressure level (or "slopes") in the remainder of the one-third octave bands as follows:

$s(3,k)$ = no value

$s(4,k) = \text{SPL}(4,k) - \text{SPL}(3,k)$

•

•

$s(i,k) = \text{SPL}(i,k) - \text{SPL}(i-1,k)$

•

•

$s(24,k) = \text{SPL}(24,k) - \text{SPL}(23,k)$

Step 2. Encircle the value of the slope, $s(i,k)$, where the absolute value of the change in slope is greater than five; that is, where:

$$|\Delta s(i,k)| = |s(i,k) - s(i-1,k)| > 5$$

Step 3.

a) If the encircled value of the slope $s(i,k)$, is positive and algebraically greater than the slope $s(i-1,k)$ encircle SPL(i,k).

b) If the encircled value of the slope $s(i,k)$ is zero or negative and the slope $s(i-1,k)$ is positive, encircle SPL($i-1,k$).

c) For all other cases, no sound pressure level value is to be encircled.

Step 4. Compute new adjusted sound pressure levels SPL′(i,k) as follows:

a) For non-encircled sound pressure levels, let the new sound pressure levels equal the original sound pressure levels, SPL′(i,k) = SPL(i,k).

b) For encircled sound pressure levels in bands 1 to 23 inclusive, let the new sound pressure level equal the arithmetic average of the preceding and following sound pressure levels:

$$\text{SPL}'(i,k) = \tfrac{1}{2}\,[\text{SPL}(i-1,k) + \text{SPL}(i+1,k)]$$

c) If the sound pressure level in the highest frequency band (i = 24) is encircled, let the new sound pressure level in that band equal:

$$\text{SPL}'(24,k) = \text{SPL}(23,k) + s(23,k)$$

Step 5. Recompute new slope $s'(i,k)$, including one for an imaginary 25-th band, as follows:

$s'(3,k) = s'(4,k)$

$s'(4,k) = \text{SPL}'(4,k) - \text{SPL}'(3,k)$

•

•

$s'(i,k) = \text{SPL}'(i,k) - \text{SPL}'(i-1,k)$

•

•

$s'(24,k) = \text{SPL}'(24,k) - \text{SPL}'(23,k)$

$s'(25,k) = s'(24,k)$

Step 6. For i from 3 to 23 (or 1 to 23 for helicopters) compute the arithmetic average of the three adjacent slopes as follows:

$$\bar{s}(i,k) = \tfrac{1}{3}\,[s'(i,k) + s'(i+1,k) + s'(i+2,k)]$$

Step 7. Compute final one-third octave-band sound pressure levels, SPL″(i,k), by beginning with band number 3 (or band number 1 for helicopters) and proceeding to band number 24 as follows:

$\text{SPL}''(3,k) = \text{SPL}(3,k)$
$\text{SPL}''(4,k) = \text{SPL}''(3,k) + \bar{s}(3,k)$

•

•

$\text{SPL}''(i,k) = \text{SPL}''(i-1,k) + \bar{s}(i-1,k)$

•

•

$\text{SPL}''(24,k) = \text{SPL}''(23,k) + \bar{s}(23,k)$

Step 8. Calculate the differences, $F(i,k)$ between the original sound pressure level and the final background sound pressure level as follows:

$$F(i,k) = \text{SPL}(i,k) - \text{SPL}''(i,k)$$

and note only values equal to or greater than one and a half.

Step 9. For each of the relevant one-third octave bands (3 to 24), determine tone correction factors from the sound pressure level differences $F(i,k)$ and Table 2-1.

Step 10. Designate the largest of the tone correction factors, determined in Step 9, as $C(k)$. An example of the tone correction procedure is given in Table 4-2 of Appendix 4 of Doc 9501.

Tone corrected perceived noise levels PNLT(k) shall be determined by adding the $C(k)$ values to corresponding PNL(k) values, that is:

$$\text{PNLT}(k) = \text{PNL}(k) + C(k)$$

For any i-th one-third octave band, at any k-th increment of time, for which the tone correction factor is suspected to result from something other than (or in addition to) an actual tone (or any spectral irregularity other than aircraft noise), an additional analysis shall be made using a filter with a bandwidth narrower than one-third of an octave. If the narrow band analysis corroborates these suspicions, then a revised value for the background sound pressure level SPL″(i,k), shall be determined from the narrow band analysis and used to compute a revised tone correction factor for that particular one-third octave band.

Note.— Other methods of rejecting spurious tone corrections such as those described in Appendix 2 of the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501) may be used.*

4.3.2 This procedure will underestimate EPNL if an important tone is of a frequency such that it is recorded in two adjacent one-third octave bands. It shall be demonstrated to the satisfaction of the certificating authority:

either that this has not occurred,

or that if it has occurred that the tone correction has been adjusted to the value it would have had if the tone had been recorded fully in a single one-third octave band.

4.4 Maximum tone corrected perceived noise level

4.4.1 The maximum tone corrected perceived noise level PNLTM, shall be the maximum calculated value of the tone corrected perceived noise level PNLT(k). It shall be calculated in accordance with the procedure of 4.3. To obtain a satisfactory noise time history, measurements shall be made at 500 ms time intervals.

Note 1.— Figure 2-2 is an example of a flyover noise time history where the maximum value is clearly indicated.

Note 2.— In the absence of a tone correction factor, PNLTM would equal PNLM.

4.4.2 After the value of PNLTM is obtained, the frequency band for the largest tone correction factor is identified for the two preceding and two succeeding 500 ms data samples. The following test shall be applied to these four samples to identify the possibility of tone suppression by one-third octave band sharing of that tone. The frequency band of the maximum tone correction factor for the four samples is tested for a shift to lower frequencies (limited to three consecutive one-third octave bands) from the first to the fourth data sample. If the value of the tone correction factor $C(k)$ for PNLTM is less than the average value of $C(k)$ for the five consecutive time intervals the average value of $C(k)$ shall be used to compute a new value for PNLTM.

4.5 Duration correction

4.5.1 The duration correction factor D determined by the integration technique shall be defined by the expression:

$$D = 10 \log \left[\left(\frac{1}{T} \right) \int_{t1}^{t2} \text{antilog} \frac{\text{PNLT}}{10} \, dt \right] - \text{PNLTM}$$

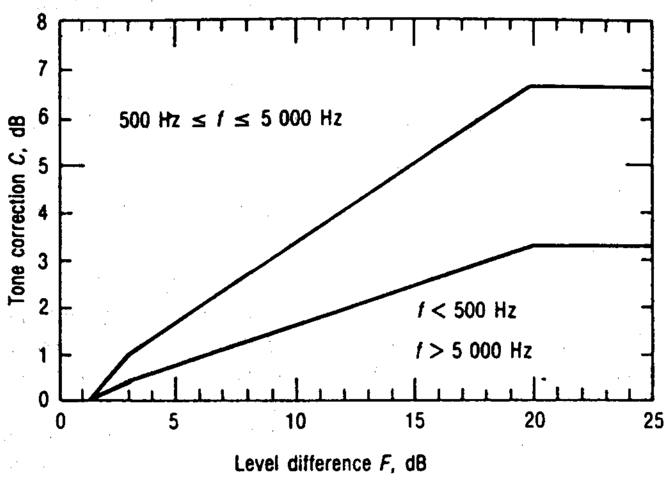
where T is a normalizing time constant, PNLTM is the maximum value of PNLT, $t1$ is the first point of time after which PNLT becomes greater than PNLTM − 10 and $t2$ is the point of time after which PNLT remains constantly less than PNLTM − 10.

4.5.2 Since PNLT is calculated from measured values of SPL, there will, in general, be no obvious equation for PNLT as a function of time. Consequently, the equation shall be rewritten with a summation sign instead of an integral sign as follows:

$$D = 10 \log \left[\left(\frac{1}{T} \right) \sum_{k=0}^{d/\Delta t} \Delta t \cdot \text{antilog} \frac{\text{PNLT}(k)}{10} \right] - \text{PNLTM}$$

where Δt is the length of the equal increments of time for which PNLT(k) is calculated and d is the time interval to the nearest 1,0 s during which PNLT(k) remains greater or equal to PNLTM − 10

Table 2-1. Tone correction factors



Frequency f, Hz	Level difference F, dB	Tone correction C, dB
$50 \le f < 500$	$1\frac{1}{2}^* \le F < 3$	$F/3 - \frac{1}{2}$
	$3 \le F < 20$	$F/6$
	$20 \le F$	$3\frac{1}{3}$
$500 \le f \le 5\,000$	$1\frac{1}{2}^* \le F < 3$	$2\,F/3 - 1$
	$3 \le F < 20$	$F/3$
	$20 \le F$	$6\frac{2}{3}$
$5\,000 < f \le 10\,000$	$1\frac{1}{2}^* \le F < 3$	$F/3 - \frac{1}{2}$
	$3 \le F < 20$	$F/6$
	$20 \le F$	$3\frac{1}{3}$

* See Step 8, 4.3.1.

4.5.3 To obtain a satisfactory history of the perceived noise level,

a) half-second time intervals for Δt, or

b) a shorter time interval with approved limits and constants,

shall be used.

4.5.4 The following values for T and Δt shall be used in calculating D in the procedure given in 4.5.2:

$T = 10$ s, and
$\Delta t = 0.5$ s

Using the above values, the equation for D becomes

$$D = 10 \log \left[\sum_{k=0}^{2d} \text{antilog} \frac{\text{PNLT}(k)}{10} \right] - \text{PNLTM} - 13$$

where the integer d is the duration time defined by the points corresponding to the values PNLTM − 10.

4.5.5 - If in the procedures given in 4.5.2, the limits of PNLTM − 10 fall between the calculated PNLT(k) values (the usual case), the PNLT(k) values defining the limits of the duration interval shall be chosen from the PNLT(k) values closest to PNLTM − 10.

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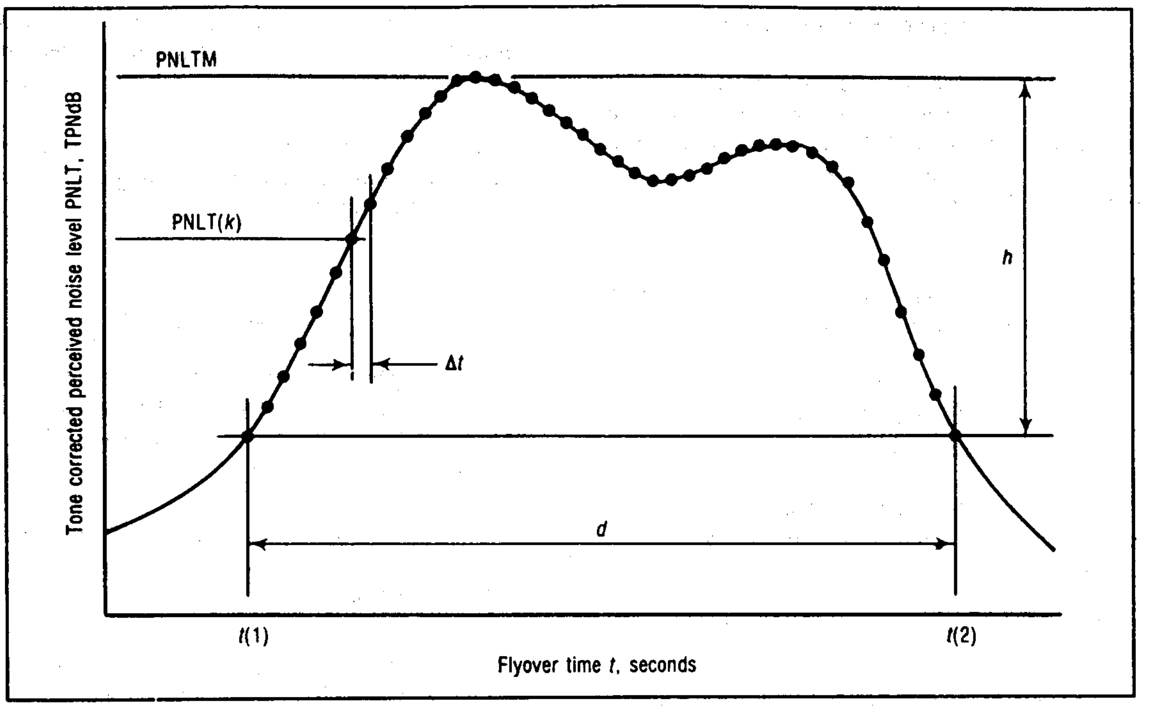

Figure 2-2. Example of perceived noise level corrected for tones as a function of aeroplane flyover time

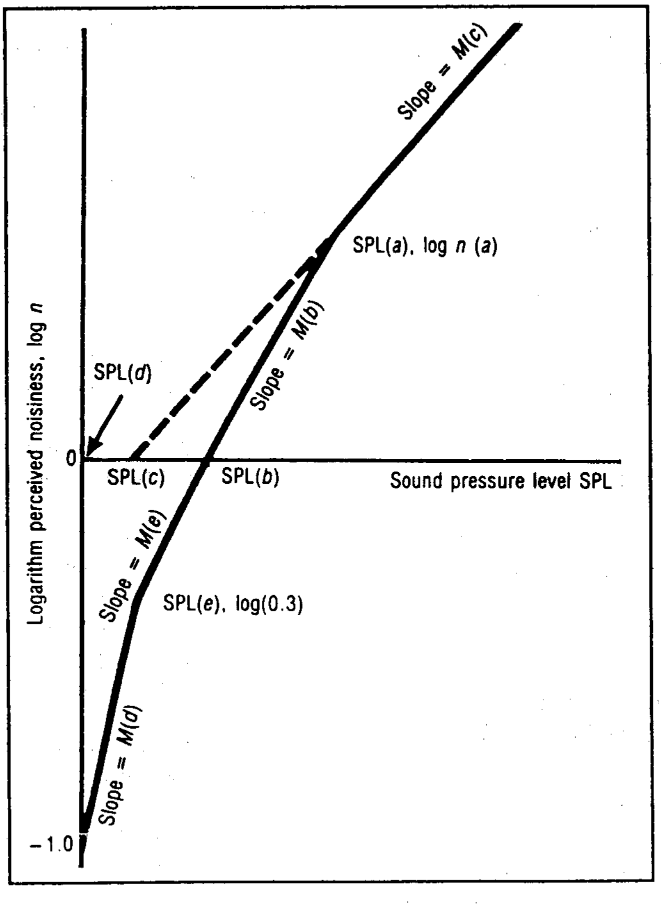

Figure 2-3. Perceived noisiness as a function of sound pressure level

4.6 Effective perceived noise level

4.6.1 The total subjective effect of an aircraft noise event, designated effective perceived noise level, EPNL, shall be equal to the algebraic sum of the maximum value of the tone corrected perceived noise level, PNLTM, and the duration correction *D*. That is:

$$EPNL = PNLTM + D$$

where PNLTM and *D* are calculated in accordance with the procedures given in 4.2, 4.3, 4.4 and 4.5.

4.7 Mathematical formulation of noy tables

4.7.1 The relationship between sound pressure level (SPL) and the logarithm of perceived noisiness is illustrated in Table 2-2 and Figure 2-3.

4.7.2 The important aspects of the mathematical formulation are:

a) the slopes ($M(b)$, $M(c)$, $M(d)$ and $M(e)$) of the straight lines;

b) the intercepts ($SPL(b)$ and $SPL(c)$) of the lines on the SPL axis; and

c) the coordinates of the discontinuities, $SPL(a)$ and $\log n(a)$; $SPL(d)$ and $\log n = -1.0$; and $SPL(e)$ and $\log n = \log (0.3)$.

4.7.3 The equations are as follows:

a) $SPL \geq SPL(a)$
$n = \text{antilog } \{M(c) [SPL - SPL(c)]\}$

b) $SPL(b) \leq SPL < SPL(a)$
$n = \text{antilog } \{M(b) [SPL - SPL(b)]\}$

c) $SPL(e) \leq SPL < SPL(b)$
$n = 0.3 \text{ antilog}_{10} \{M(e) [SPL - SPL(e)]\}$

d) $SPL(d) \leq SPL < SPL(e)$
$n = 0.1 \text{ antilog } \{M(d) [SPL - SPL(d)]\}$

4.7.4 Table 2-2 lists the values of the constants necessary to calculate perceived noisiness as a function of sound pressure level.

5. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY

5.1 General

5.1.1 Data representing physical measurements or corrections to measured data shall be recorded in permanent form and appended to the record.

5.1.2 All corrections shall be approved by certificating authority. In particular the corrections to measurements for equipment response deviations shall be reported.

5.1.3 Estimates of the individual errors inherent in each of the operations employed in obtaining the final data shall be reported, if required.

5.2 Data reporting

5.2.1 Measured and corrected sound pressure levels shall be presented in one-third octave band levels obtained with equipment conforming to the Standards described in Section 3 of this appendix.

5.2.2 The type of equipment used for measurement and analysis of all acoustic performance and meteorological data shall be reported.

5.2.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

a) air temperature and relative humidity;

b) maximum, minimum and average wind velocities; and

c) atmospheric pressure.

5.2.4 Comments on local topography, ground cover, and events that might interfere with sound recordings shall be reported.

5.2.5 The following information shall be reported:

a) type, model and serial numbers (if any) of aircraft, engines, propellers, or rotors (as applicable);

b) gross dimensions of aircraft and location of engines and rotors (if applicable);

c) aircraft gross mass for each test run and centre of gravity range for each series of test runs;

d) aircraft configuration such as flap, airbrakes and landing gear positions and propeller pitch angles (if applicable);

e) whether auxiliary power units (APU), when fitted, are operating;

f) conditions of pneumatic engine bleeds and engine power take-offs;

g) indicated airspeed in kilometres per hour (knots);

Table 2-2. Constants for mathematically formulated noy values

BAND (*i*)	*f* HZ	SPL (*a*)	SPL (*b*)	SPL (*c*)	SPL (*d*)	SPL (*e*)	*M*(*b*)	*M*(*c*)	*M*(*d*)	*M*(*e*)
1	50	91.0	64	52	49	55	0.043478	0.030103	0.079520	0.058098
2	63	85.9	60	51	44	51	0.040570		0.068160	”
3	80	87.3	56	49	39	46	0.036831		”	0.052288
4	100	79.9	53	47	34	42	”		0.059640	0.047534
5	125	79.8	51	46	30	39	0.035336		0.053013	0.043573
6	160	76.0	48	45	27	36	0.033333			”
7	200	74.0	46	43	24	33	”			0.040221
8	250	74.9	44	42	21	30	0.032051			0.037349
9	315	94.6	42	41	18	27	0.030675	0.030103		0.034859
10	400	∞	40	40	16	25	0.030103			
11	500		40	40	16	25				
12	630		40	40	16	25				
13	800		40	40	16	25				
14	1 000		40	40	16	25			0.053013	
15	1 250		38	38	15	23	0.030103		0.059640	0.034859
16	1 600		34	34	12	21	0.029960	NOT APPLICABLE	0.053013	0.040221
17	2 000		32	32	9	18			”	0.037349
18	2 500		30	30	5	15			0.047712	0.034859
19	3 150		29	29	4	14			”	
20	4 000		29	29	5	14			0.053013	
21	5 000		30	30	6	15			”	0.034859
22	6 300	∞	31	31	10	17	0.029960		0.068160	0.037349
23	8 000	44.3	37	34	17	23	0.042285	0.029960	0.079520	”
24	10 000	50.7	41	37	21	29	”	”	0.059640	0.043573

h) 1) *for jet aeroplanes:* engine performance in terms of net thrust, engine pressure ratios, jet exhaust temperatures and fan or compressor shaft rotational speeds as determined from aeroplane instruments and manufacturer's data;

2) *for propeller-driven aeroplanes:* engine performance in terms of brake horsepower and residual thrust or equivalent shaft horsepower or engine torque and propeller rotational speed as determined from aeroplane instruments and manufacturer's data;

3) *for helicopters:* engine performance and rotor speed in rpm during each demonstration;

i) aircraft flight path and ground speed during each demonstration; and

j) any modifications or non-standard equipment likely to affect the noise characteristics of the aircraft.

5.3 Reporting of noise certification reference conditions

5.3.1 Aircraft position and performance data and the noise measurements shall be corrected to the noise certification reference conditions as specified in the relevant chapter of Part II, and these conditions, including reference parameters, procedures and configurations shall be reported.

5.4 Validity of results

5.4.1 Three average reference EPNL values and their 90 per cent confidence limits shall be produced from the test results and reported, each such value being the arithmetical average of the adjusted acoustical measurements for all valid test runs at the appropriate measurement point (take-off, approach, or lateral or overflight, in the case of helicopters). If more than one acoustic measurement system is used at any single measurement location, the resulting data for each test run shall be averaged as a single measurement. For helicopters, the three microphone test results for each flight should be averaged as a single measurement. The calculation shall be performed by:

a) computing the arithmetic average for each flight phase using the values from each reference microphone point;

b) computing the over-all arithmetic average for each appropriate reference condition (take-off, overflight, or approach) using the values in a) and the related 90 per cent confidence limits.

5.4.2 The minimum sample size acceptable for each of the three certification measuring points for aeroplanes and for each set of three microphones for helicopters is six. The samples shall be large enough to establish statistically for each of the three average noise certification levels a 90 per cent confidence limit not exceeding ±1.5 EPNdB. No test result shall be omitted from the averaging process unless otherwise specified by the certificating authority.

Note.— Methods for calculating the 90 per cent confidence interval are given in Appendix 1 of the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

5.4.3 The average EPNL figures obtained by the foregoing process shall be those by which the noise performance of the aircraft is assessed against the noise certification criteria.

6. NOMENCLATURE: SYMBOLS AND UNITS

Symbol	*Unit*	*Meaning*
antilog	—	*Antilogarithm to the base 10.*
$C(k)$	dB	*Tone correction factor.* The factor to be added to PNL(k) to account for the presence of spectral irregularities such as tones at the k-th increment of time.
d	s	*Duration time.* The length of the significant noise time history being the time interval between the limits of $t(1)$ and $t(2)$ to the nearest second.
D	dB	*Duration correction.* The factor to be added to PNLTM to account for the duration of the noise.
EPNL	EPNdB	*Effective perceived noise level.* The value of PNL adjusted for both the spectral irregularities and the duration of the noise. (The unit EPNdB is used instead of the unit dB.)

Symbol	*Unit*	*Meaning*
$f(i)$	Hz	*Frequency.* The geometrical mean frequency for the i-th one-third octave band.
$F(i,k)$	dB	*Delta-dB.* The difference between the original sound pressure level and the final background sound pressure level in the i-th one-third octave band at the k-th interval of time.
h	dB	*dB-down.* The level to be subtracted from PNLTM that defines the duration of the noise.
H	%	*Relative humidity.* The ambient atmospheric relative humidity.
i	—	*Frequency band index.* The numerical indicator that denotes any one of the 24 one-third octave bands with geometrical mean frequencies from 50 to 10 000 Hz.
k	—	*Time increment index.* The numerical indicator that denotes the number of equal time increments that have elapsed from a reference zero.
log	—	*Logarithm to the base 10.*
log $n(a)$	—	*Noy discontinuity co-ordinate.* The log n value of the intersection point of the straight lines representing the variation of SPL with log n.
$M(b)$, $M(c)$, etc.	—	*Noy inverse slope.* The reciprocals of the slopes of straight lines representing the variation of SPL with log n.
n	noy	*Perceived noisiness.* The perceived noisiness at any instant of time that occurs in a specified frequency range.
$n(i,k)$	noy	*Perceived noisiness.* The perceived noisiness at the k-th instant of time that occurs in the i-th one-third octave band.
$n(k)$	noy	*Maximum perceived noisiness.* The maximum value of all of the 24 values of $n(i)$ that occurs at the k-th instant of time.
$N(k)$	noy	*Total perceived noisiness.* The total perceived noisiness at the k-th instant of time calculated from the 24-instantaneous values of $n(i,k)$.
$p(b)$, $p(c)$, etc.	—	*Noy slope.* The slopes of straight lines representing the variation of SPL with log n.
PNL	PNdB	*Perceived noise level.* The perceived noise level at any instant of time. (The unit PNdB is used instead of the unit dB.)
PNL(k)	PNdB	*Perceived noise level.* The perceived noise level calculated from the 24 values of SPL(i,k) at the k-th increment of time. (The unit PNdB is used instead of the unit dB.)
PNLM	PNdB	*Maximum perceived noise level.* The maximum value of PNL(k). (The unit PNdB is used instead of the unit dB.)
PNLT	TPNdB	*Tone corrected perceived noise level.* The value of PNL adjusted for the spectral irregularities that occur at any instant of time. (The unit TPNdB is used instead of the unit dB.)
PNLT(k)	TPNdB	*Tone corrected perceived noise level.* The value of PNL(k) adjusted for the spectral irregularities that occur at the k-th increment of time. (The unit TPNdB is used instead of the unit dB.)
PNLTM	TPNdB	*Maximum tone corrected perceived noise level.* The maximum value of PNLT(k). (The unit TPNdB is used instead of the unit dB.)
$PNLT_r$	TPNdB	*Tone corrected perceived noise level* adjusted for reference conditions.
$s(i,k)$	dB	*Slope of sound pressure level.* The change in level between adjacent one-third octave band sound pressure levels at the i-th band for the k-th instant of time.

Symbol	*Unit*	*Meaning*
$\Delta s(i,k)$	dB	*Change in slope of sound pressure level.*
$s'(i,k)$	dB	*Adjusted slope of sound pressure level.* The change in level between adjacent adjusted one-third octave band sound pressure levels at the i-th band for the k-th instant of time.
$\bar{s}(i,k)$	dB	*Average slope of sound pressure level.*
SPL	dB re 20μPa	*Sound pressure level.* The sound pressure level at any instant of time that occurs in a specified frequency range.
SPL(a)	dB re 20 μPa	*Noy discontinuity co-ordinate.* The SPL value of the intersection point of the straight lines representing the variation of SPL with log n.
SPL(b) SPL(c)	dB re 20 μPa	*Noy intercept.* The intercepts on the SPL-axis of the straight lines representing the variation of SPL with log n.
SPL(i,k)	dB re 20 μPa	*Sound pressure level.* The sound pressure level at the k-th instant of time that occurs in the i-th one-third octave band.
SPL'(i,k)	dB re 20 μPa	*Adjusted sound pressure level.* The first approximation to background sound pressure level in the i-th one-third octave band for the k-th instant of time.
SPL(i)	dB re 20 μPa	*Maximum sound pressure level.* The sound pressure level that occurs in the i-th one-third octave band of the spectrum for PNLTM.
SPL$(i)_r$	dB re 20 μPa	*Corrected maximum sound pressure level.* The sound pressure level that occurs in the i-th one-third octave band of the spectrum for PNLTM corrected for atmospheric sound absorption.
SPL"(i,k)	dB re 20 μPa	*Final background sound pressure level.* The second and final approximation to background sound pressure level in the i-th one-third octave band for the k-th instant of time.
t	s	*Elapsed time.* The length of time measured from a reference zero.
$t1$, $t2$	s	*Time limit.* The beginning and end, respectively, of the significant noise time history defined by h.
Δt	s	*Time increment.* The equal increments of time for which PNL(k) and PNLT(k) are calculated.
T	s	*Normalizing time constant.* The length of time used as a reference in the integration method for computing duration corrections, where $T = 10$ s.
t (°C)	°C	*Temperature.* The ambient atmospheric temperature.
$\alpha(i)$	dB/100 m	*Test atmospheric absorption.* The atmospheric attenuation of sound that occurs in the i-th one-third octave band for the measured atmospheric temperature and relative humidity.
$\alpha(i)_0$	dB/100 m	*Reference atmospheric absorption.* The atmospheric attenuation of sound that occurs in the i-th one-third octave band for a reference atmospheric temperature and relative humidity.
A_1	degrees	*First constant* climb angle.*
A_2	degrees	*Second constant** climb angle.*
δ ε	degrees degrees	*Thrust cutback angles.* The angles defining the points on the take-off flight path at which thrust reduction is started and ended respectively.
η	degrees	*Approach angle.*

* Gear up, speed of at least V_2 + 19 km/h (V_2 + 10 kt), take-off thrust.
** Gear up, speed of at least V_2 + 19 km/h (V_2 + 10 kt), after cut-back.

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Symbol	*Unit*	*Meaning*
η_r	degrees	*Reference approach angle.*
θ	degrees	*Noise angle (relative to flight path).* The angle between the flight path and noise path. It is identical for both measured and corrected flight paths.
ψ	degrees	*Noise angle (relative to ground).* The angle between the noise paths and the grounds. It is identified for both measured and corrected flight paths.
μ	degrees	*Engine noise emission parameter.* (See 9.3.4.)
Δ_1	EPNdB	*PNLT correction.* The correction to be added to the EPNL calculated from measured data to account for noise level changes due to differences in atmospheric absorption and noise path length between reference and test conditions.
Δ_2	EPNdB	*Adjustment to duration correction.* The adjustment to be made to the EPNL calculated from measured data to account for noise level changes due to the noise duration between reference and test conditions.
Δ_3	EPNdB	*Source noise adjustment.* The adjustment to be made to the EPNL calculated from measured data to account for noise level changes due to differences between reference and test engine regime.

7. SOUND ATTENUATION IN AIR

7.1 The atmospheric attenuation of sound shall be determined in accordance with the procedure presented below.

7.2 The relationship between sound attenuation, frequency, temperature and humidity is expressed by the following equations:

$$\alpha(i) = 10^{[2.05 \log (f_i/1000) + 1.1394 \times 10^{-3}\,\theta - 1.916984]}$$

$$+ \eta(\delta) \times 10^{[\log (f_i) + 8.42994 \times 10^{-3}\,\theta - 2.755624]}$$

$$\delta = \sqrt{\frac{1010}{f_o}}\; 10^{(\log H - 1.328924 + 3.179768 \times 10^{-2}\theta)}$$

$$\times\ 10^{(-2.173716 \times 10^{-4}\theta^2 + 1.7496 \times 10^{-6}\theta^3)}$$

where:

$\eta(\delta)$ is given by Table 2-3 and f_o by Table 2-4;

$\alpha(i)$ being the attenuation coefficient in dB/100 m;

θ being the temperature in °C; and

H being the relative humidity expressed as a percentage.

7.3 The equations given in 7.2 are convenient for calculation by means of a computer.

8. ADJUSTMENT OF HELICOPTER FLIGHT TEST RESULTS

8.1 General

8.1.1 Adjustments shall be made to the measured noise data by the methods of this section. Compliance with the test conditions of Chapter 8, 8.7.5 is necessary for the test to be acceptable. Adjustments shall be made for differences between test and reference flight procedures and shall account for differences in the following:

a) helicopter flight path and velocity relative to the flight path reference point;

b) sound attenuation in air;

c) in the overflight case, parameters affecting the noise generating mechanisms such as those described in 8.5.

8.1.2 Adjustments to the measured noise data shall be made using the methods prescribed in 8.3 and 8.4, for differences in the following:

a) attenuation of the noise along its path as affected by "inverse square" and atmospheric attenuation;

b) duration of the noise as affected by distance and speed of aircraft relative to the flight path reference point;

Table 2.3 Values of $\eta(\delta)$

δ	$\eta(\delta)$	δ	$\eta(\delta)$
0.00	0.000	2.50	0.450
0.25	0.315	2.80	0.400
0.50	0.700	3.00	0.370
0.60	0.840	3.30	0.330
0.70	0.930	3.60	0.300
0.80	0.975	4.15	0.260
0.90	0.996	4.45	0.245
1.00	1.000	4.80	0.230
1.10	0.970	5.25	0.220
1.20	0.900	5.70	0.210
1.30	0.840	6.05	0.205
1.50	0.750	6.50	0.200
1.70	0.670	7.00	0.200
2.00	0.570	10.00	0.200
2.30	0.495		

A term of quadratic interpolation shall be used where necessary.

Table 2-4. Value of f_o

Centre frequency of the 1/3 octave band (Hz)	f_o *(Hz)*	*Centre frequency of the 1/3 octave band (Hz)*	f_o *(Hz)*
50	50	800	800
63	63	1 000	1 000
80	80	1 250	1 250
100	100	1 600	1 600
125	125	2 000	2 000
160	160	2 500	2 500
200	200	3 150	3 150
250	250	4 000	4 000
315	315	5 000	4 500
400	400	6 300	5 600
500	500	8 000	7 100
630	630	10 000	9 000

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c) the adjustment procedure described in this section shall apply to the lateral microphones in the take-off, overflight and approach cases. Although the noise emission is strongly dependent on the directivity pattern, variable from one helicopter type to another, the propagation angle θ, defined in Appendix 2, 9.3.2, Figure 2-11, shall be the same for the test and reference flight paths. The elevation angle ψ shall not be constrained as in the third note of Appendix 2, 9.3.2, but must be determined and reported. The certification authority shall specify the acceptable limitations on ψ. Corrections to data obtained when these limits are exceeded shall be applied using procedures approved by the certificating authority. In the particular case of lateral noise measurement, sound propagation is affected not only by "inverse square" and atmospheric attenuation, but also by ground absorption and reflection effects which depend mainly on the angle ψ.

Note 1.— Chapter 8, 8.7.5 in Part II of this volume places limits on the maximum adjustments that may be made between test and reference flight procedures and conditions.

Note 2.— Adjustments of noise levels for test to reference conditions may be made, subject to agreement by the certificating authority, by the methods of this section. The corrections are derived from sets of curves linking the instant at which the PNLTM is emitted for each reference procedure with appropriate parameters, for example:

a) the height, average ground speed, and advancing blade tip Mach number for overflight;

b) the glide slope and height for approach;

c) the height, torque and ground speed for take-off.

The sensitivity curves provide noise level variations as a function of the parameter for which a correction is necessary.

8.2 Flight profiles

Note.— Flight profiles for the test conditions are described by their geometry relative to the ground, together with the associated helicopter speed.

8.2.1 Take-off profile

Note 1.— Figure 2-4 illustrates typical test and reference profiles.

a) During actual testing the helicopter is initially stabilized in level flight at the best rate of climb speed, Vy, at a point A *and continues to a point* B *where take-off power is applied and a steady climb is initiated. A steady climb shall be maintained throughout the 10 dB-down period and beyond to the end of the certification flight path (point* F*).*

b) Position K_1 *is the take-off flight path reference point and* NK_1 *is the distance from the initiation of the steady climb to the take-off flight path reference point. Positions* K_1' *and* K_1'' *are associated noise measurement points located on a line at right angles to and at the specified distance from the take-off flight track* TM.

c) The distance TM *is the distance over which the helicopter position is measured and synchronized with the noise measurements (see 2.3.2 of this appendix).*

Note 2.— The position of point B *may vary within the limits allowed by the certificating authority.*

8.2.2 Overflight profile

Note.— Figure 2-5 illustrates a typical overflight profile.

a) The helicopter is stabilized in level flight at point D *and flies through point* W, *overhead the flight path reference point, to point* E, *the end of the noise certification overflight flight path.*

b) Position K_2 *is the overflight flight path reference point and* K_2W *is the height of the helicopter overhead the overflight flight path reference point. Positions* K_2' *and* K_2'' *are associated noise measurement points located on a line at right angles to and at the specified distance from the overflight flight track* RS.

c) The distance RS *is the distance over which the helicopter position is measured and synchronized with the noise measurements (see 2.3.2 of this appendix).*

8.2.3 Approach profile

Note.— Figure 2-6 illustrates a typical approach profile.

a) The helicopter is initially stabilized at the specified approach path angle at point G *and continues through point* H, *point* I *and then to touchdown.*

b) Position K_3 *is the approach flight path reference point and* K_3H *is the height of the helicopter overhead the approach flight path reference point. Positions* K_3' *and* K_3'' *are associated noise measurement locations on a line at right angles to and at the specified distance from the approach flight path track* PU.

c) The distance PU *is the distance over which the helicopter position is measured and synchronized with the noise measurements (see 2.3.2 of this appendix).*

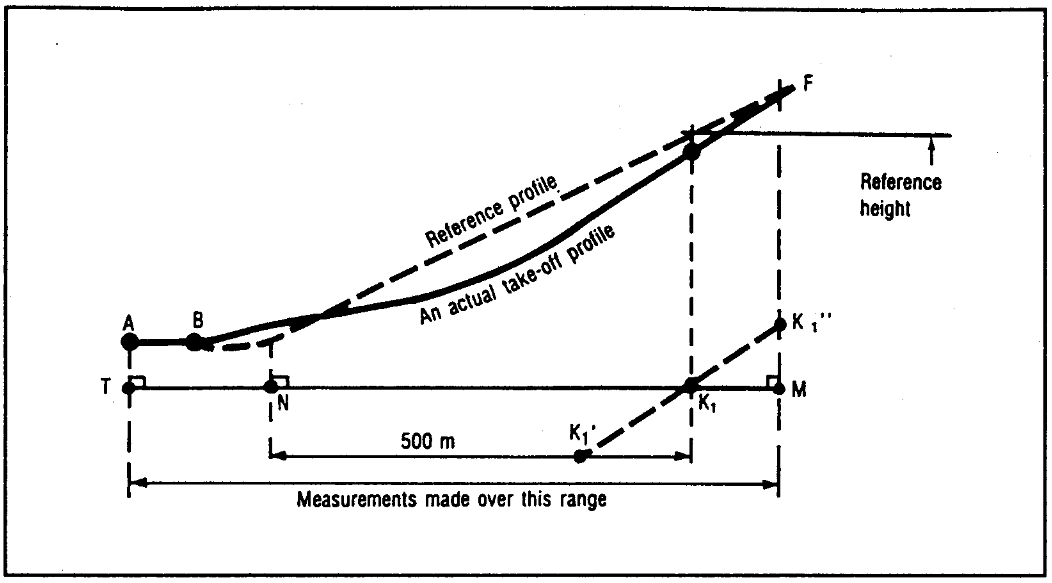


Figure 2-4. Typical test and reference profiles

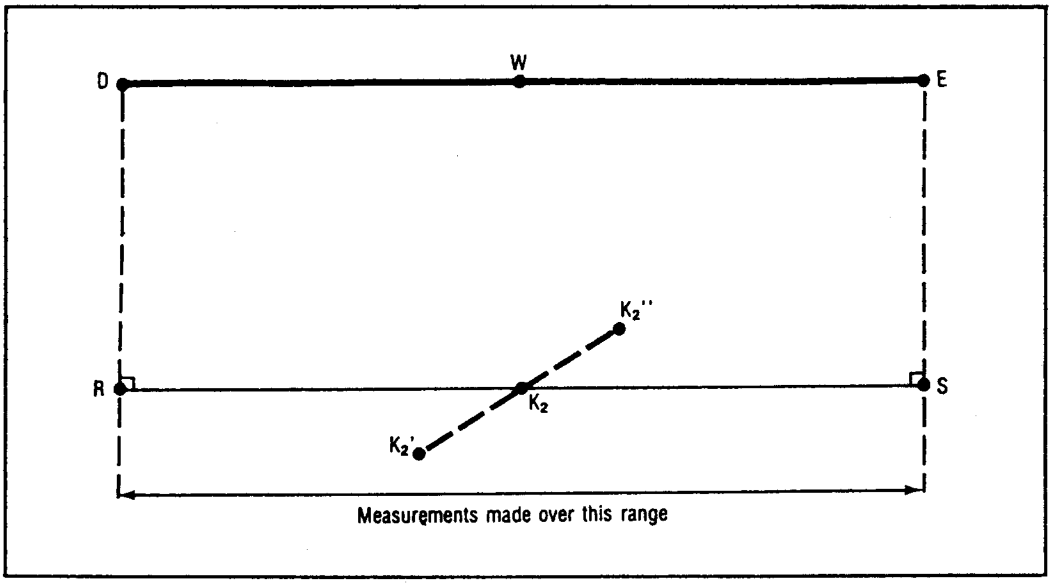


Figure 2-5. Typical overflight profile

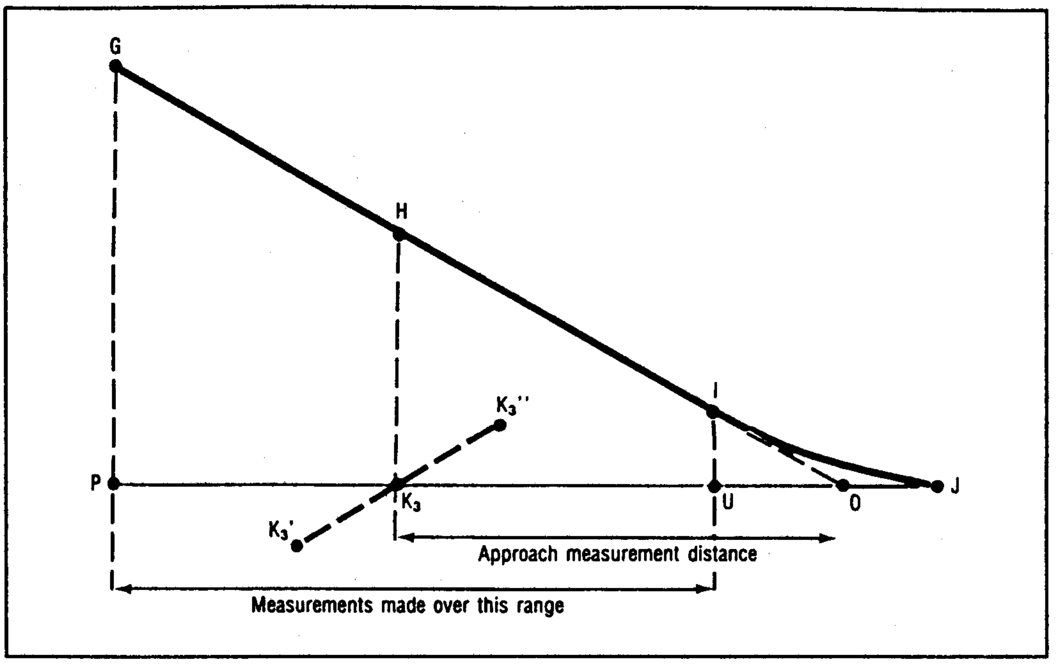


Figure 2-6. Typical approach profile

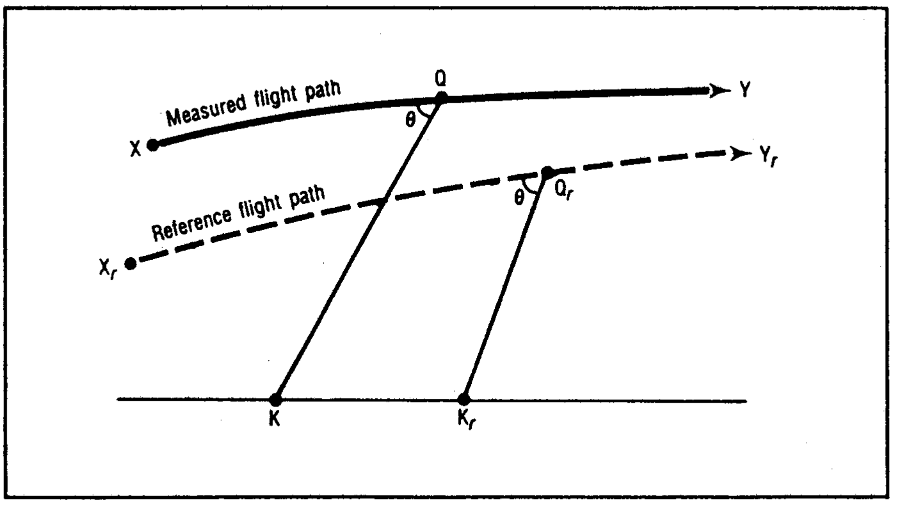


Figure 2-7. Profile characteristics influencing sound level

8.3 Adjustments of PNL and PNLT

Note.— The portions of the test flight path and reference flight path which are significant for the EPNL calculation are illustrated in Figure 2-7 for take-off, overflight and approach measurements.

a) XY represents the useful portion of the measured flight path and X_rY_r that of the corresponding reference flight path.

b) Q represents the helicopter position on the measured flight path at which the noise was emitted and observed as PNLTM at the noise measuring point K. Q_r is the corresponding position on the reference flight path and K_r the reference noise measuring point. QK and Q_rK_r are respectively the measured and reference noise propagation paths, Q_r being located on the assumption that QK and Q_rK_r form the same angle θ with their respective flight paths.

8.3.1 The one-third octave band levels $SPL(i)$ comprising PNL (the PNL at the moment of PNLTM observed at K) shall be adjusted to reference levels $SPL(i)_r$ as follows:

$$SPL(i)_r = SPL(i) + 0.01\,[\alpha(i) - \alpha(i)_o]\,QK$$

$$+ 0.01\,\alpha(i)_o\,(QK - Q_rK_r)$$

$$+ 20\log(QK/Q_rK_r)$$

In this expression:

— the term $0.01\,[\alpha(i) - \alpha(i)_o]\,QK$ accounts for the effect of the change in sound attenuation coefficient and $\alpha(i)$ and $\alpha(i)_o$ are the coefficients for the test and reference atmospheric conditions respectively, obtained from Section 7 of this Appendix;

— the term $0.01\,\alpha(i)_o\,(QK - Q_rK_r)$ accounts for the effect of the change in the noise path length on the sound attenuation;

— the term $20\log(QK/Q_rK_r)$ accounts for the effect of the change in the noise path length due to the "inverse square" law;

— QK and Q_rK_r are measured in metres and $\alpha(i)$ and $\alpha(i)_o$ are in dB/100 m.

Note.— When $SPL(i)$ *is zero (for example as a result of applying background noise corrections)* $SPL(i)_r$ *must also be kept equal to zero in the adjustment process.*

8.3.2 The corrected values $SPL(i)_r$ shall be converted to $PNLT_r$ and a correction term calculated as follows:

$$\Delta_1 = PNLT_r - PNLTM$$

8.3.3 Δ_1 shall be added algebraically to the EPNL calculated from the measured data.

8.3.4 If, during a test flight, several peak values of PNLT are observed which are within 2 dB of PNLTM, the procedure defined in 8.3.1, 8.3.2 and 8.3.3 shall be applied at each peak and the adjustment term so calculated shall be added to each peak to give corresponding adjusted peak values of PNLT. If these peak values exceed that at the moment of PNLTM, the maximum value of such excess shall be added as a further adjustment to the EPNL calculated from the measured data.

8.4 Adjustments of duration correction

8.4.1 Whenever the measured flight paths and/or the ground velocities in the test conditions differ from the reference flight paths and/or the ground velocities in the reference conditions, duration adjustments shall be applied to the EPNL values calculated from the measured data. The adjustments shall be calculated as described below.

8.4.2 Referring to the flight path shown in Figure 2-7, the adjustment term shall be calculated as follows:

$$\Delta_2 = -7.5\log(QK/Q_rK_r) + 10\log(V/V_r)$$

which represents the adjustment to be added algebraically to the EPNL calculated from the measured data.

8.5 Correction of noise at source

For overflight, if any combination of the following three factors:

a) airspeed deviations from reference;

b) rotor speed deviations from reference;

c) temperature deviations from reference;

results in an agreed noise correlating parameter whose value deviates from the reference value of this parameter, then source noise adjustments shall be determined from manufacturer's data approved by the certificating authority. This correction should normally be made using a sensitivity curve of PNLTM versus advancing blade tip Mach number; however, the correction may be made using an alternative parameter, or parameters, approved by the certificating authority.

Note 1.— If it is not possible to attain the reference value of advancing blade tip Mach number or the agreed reference noise correlating parameter then an extrapolation of the sensitivity curve is permitted providing that the data cover a range of values of the noise correlating parameter agreed by *the certificating authority between test and reference conditions. The advancing blade tip Mach number or agreed noise correlating parameter shall be computed from as measured data. A separate curve of source noise versus advancing blade tip Mach number or another agreed noise correlating parameter shall be derived for each of the three certification microphone locations, centre line, sideline left and sideline right, defined relative to the direction of flight on each test run.*

Note 2.— When using advancing blade tip Mach number it should be computed using true airspeed, on-board outside air temperature (OAT), and rotor speed.

8.6 Flight path identification positions and parameters

8.6.1 General

Position/ parameter	*Description*
K	Noise measurement point
K_r	Reference measurement point
Q	Position on measured flight path corresponding to apparent PNLTM at position K (see 8.3.2)
Q_r	Position on corrected flight path corresponding to PNLTM at position K_r (see 8.3.2)
V	Helicopter test ground speed
V_r	Helicopter reference ground speed
V_H	Maximum speed in level flight at power not exceeding maximum continuous power
V_{NE}	Never exceed speed
V_y	Speed for best rate of climb

8.6.2 Take-off (see Figure 2-4)

Position	*Description*
A	Start of noise certification take-off flight path
B	Start of transition to climb
F	End of noise certification take-off flight path
K_1	Take-off flight path reference point
K_1', K_1''	Associated noise measurement points (of 3-microphone array)
M	End of noise certification take-off flight track
N	Point on ground vertically below start of transition to climb
T	Start of noise certification take-off flight track, point on ground vertically below A

8.6.3 Overflight (see Figure 2-5)

Position	*Description*
D	Start of noise certification overflight flight path
E	End of noise certification overflight flight path
K_2	Overflight flight path reference point
K_2', K_2''	Associated noise measurement points (of 3-microphone array)
R	Start of noise certification overflight flight track
S	End of noise certification overflight flight track

8.6.4 Approach (see Figure 2-6)

Position	*Description*
G	Start of noise certification approach flight path
H	Position on approach path vertically above approach flight path reference point
I	End of noise certification approach flight path
J	Touchdown
K_3	Approach flight path reference point
K_3', K_3''	Associated noise measurement points (of 3-microphone array)
O	Intersection of the approach path with the ground plane
P	Start of noise certification approach flight track
U	Point on ground vertically below start of flare

8.7 Flight path distance

Distance	*Unit*	*Meaning*
NK_1	metres	*Take-off measurement distance.* The distance from start of transition to climb to the take-off flight path reference point.
TM	metres	*Take-off flight track distance.* The distance over which the position of the helicopter is to be recorded.
K_2W	metres (feet)	*Helicopter overflight height.* The height of the helicopter above the overflight flight reference point.
RS	metres	*Overflight flight track distance.* The distance over which the position of the helicopter is to be recorded.
K_3H	metres (feet)	*Helicopter approach height.* The height of the helicopter above the approach flight reference point.

Distance	*Unit*	*Meaning*
OK_3	metres	*Approach measurement distance.* The distance from the intersection of the approach path with the ground plane to the approach flight path reference point.
PU	metres	*Approach flight track distance.* The distance over which the position of the aircraft is to be recorded.
QK	metres	*Measured noise path.* The distance from the measured helicopter position Q to the noise measurement position K.
Q_rK_r	metres	*Reference noise path.* The distance from the reference helicopter position Q_r to the reference noise measurement position K_r.

9. ADJUSTMENT OF AEROPLANE FLIGHT TEST RESULTS

9.1 When certification test conditions are not identical to reference conditions, appropriate adjustments shall be made to the measured noise data by the methods of this Section.

Note.— Differences between test and reference conditions result in differences in the following:

— *aeroplane flight path and velocity relative to measurement point*

— *sound attenuation in air*

— *parameters affecting engine-noise generating mechanisms.*

9.1.1 Adjustments to the measured noise values shall be made by one of the methods described in 9.3 and 9.4 for differences in the following:

— attenuation of the noise along its path as affected by "inverse square" and atmospheric attenuation

— duration of the noise as affected by distance and speed of aeroplane relative to measuring point

— source noise emitted by engine as affected by the relevant parameters.

9.1.2 Either the "simplified" method or the "integrated" method shall be used when:

a) the amounts of the adjustments are less than 8 dB on take-off and lateral noise and 4 dB on approach; or

b) the amounts of the adjustments on take-off or lateral are more than 4 dB and the resulting numbers are not within 1 dB of the limiting noise levels.

9.1.3 When the amounts of the adjustments or the corresponding margin are outside the limits specified in 9.1.2, apart from the lateral case, the "integrated" method shall be used for all noise measurement adjustments.

Note.— See also Part II, Chapter 3, 3.7.6.

9.2 Flight profiles

Note.— Flight profiles for both test and reference conditions are described by their geometry relative to the ground, together with the associated aircraft speed relative to the ground, and the associated engine control parameter(s) used for determining the noise emission of the aeroplane.

9.2.1 Take-off profile

Note.— Figure 2-8 illustrates a typical take-off profile.

a) The aeroplane begins the take-off roll at point A, *lifts off at point* B *and begins its first climb at constant angle at point* C. *Where thrust or power (as appropriate) cut-back is used, it is started at point* D *and completed at point* E. *From here the aeroplane begins a second climb at constant angle up to point* F, *the end of the noise certification take-off flight path.*

b) Position K_1 *is the take-off noise measuring station and* AK_1 *is the distance from start of roll to the flyover measuring point. Position* K_2 *is the lateral noise measuring station located on a line parallel to and the specified distance from the runway centre line where the noise level during take-off is greatest.*

c) The distance AF *is the distance over which the aeroplane position is measured and synchronized with the noise measurements (see 2.3.2 of this appendix).*

9.2.2 Approach profile

Note.— Figure 2-9 illustrates a typical approach profile.

a) The aeroplane begins its noise certification approach flight path at point G *and touches down on the runway at point* J, *and at a distance* OJ *from the threshold.*

b) Position K_3 *is the approach noise measuring station and* K_3O *is the distance from the approach noise measurement point to the threshold.*

c) The distance GI *is the distance over which the aeroplane position is measured and synchronized with the noise measurements (see 2.3.2 of this appendix).*

The aeroplane reference point during approach measurements shall be the ILS antenna.

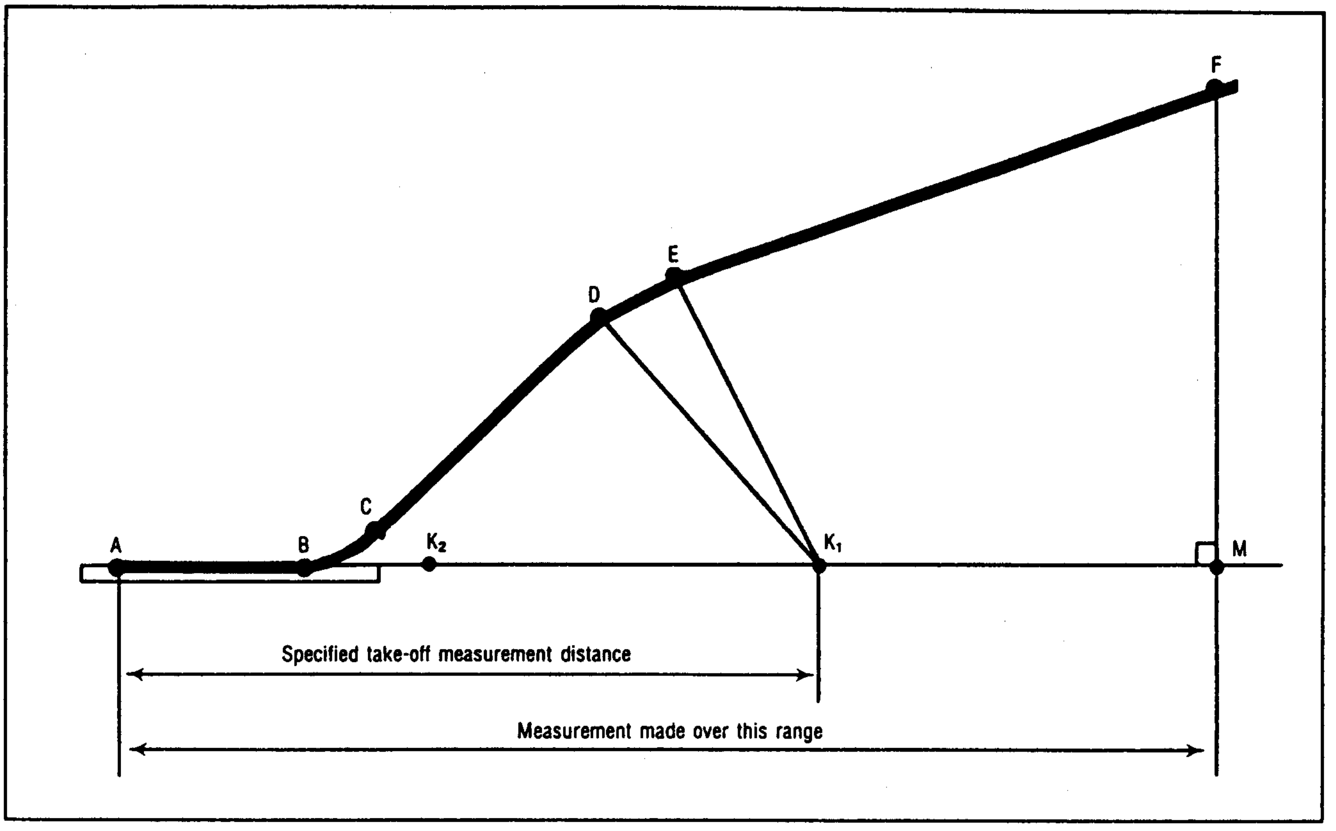


Figure 2-8. Typical take-off profile

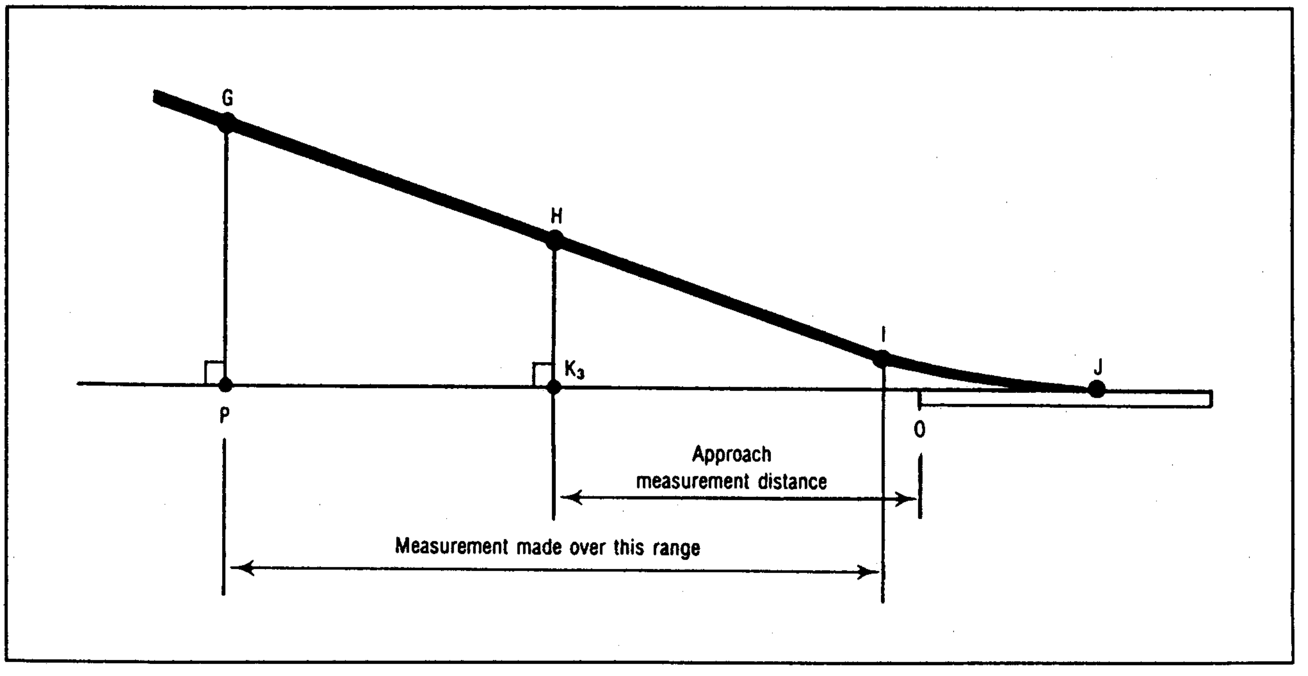


Figure 2-9. Typical approach profile

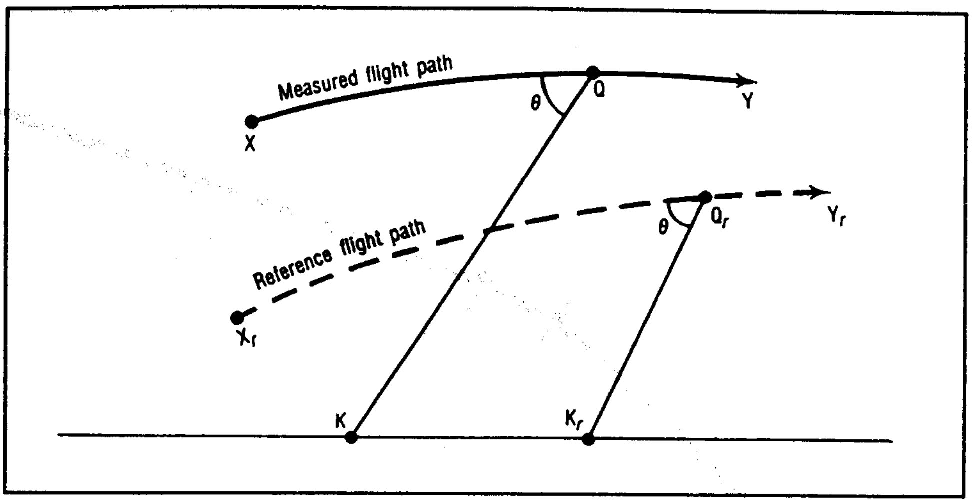


Figure 2-10. Profile characteristics influencing sound level

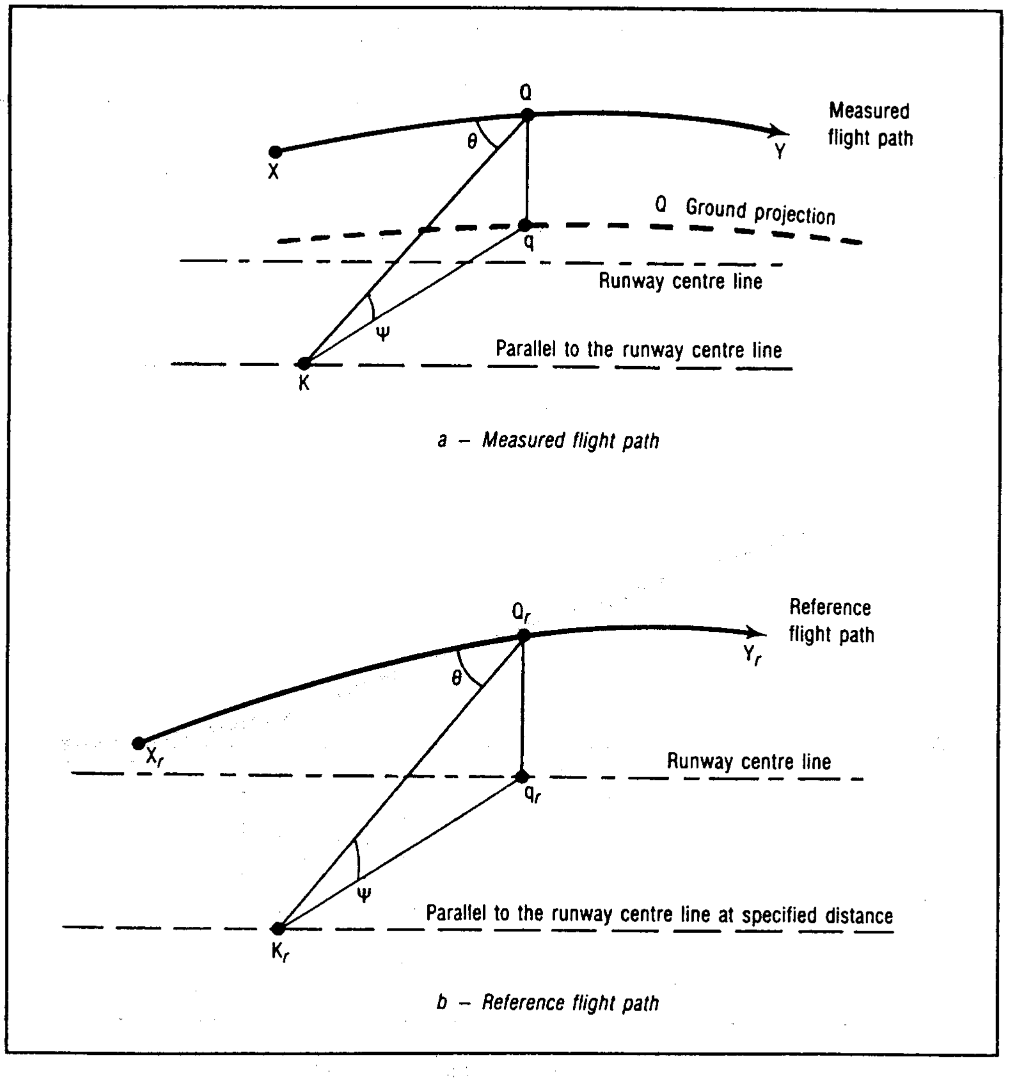


Figure 2-11. Lateral measurement — determination of reference station

9.3 "Simplified" method of adjustment

9.3.1 General

Note.— The "simplified" adjustment method consists of applying adjustments to the EPNL calculated from the measured data for the differences between measured and reference conditions at the moment of PNLTM.

9.3.2 Adjustments to PNL and PNLT

Note 1.— The portions of the test flight path and the reference flight path which are significant for the EPNL calculation are illustrated in Figure 2-10 for the flyover and approach noise measurements.

a) XY *represents the useful portion of the measured flight path, and* X_rY_r *that of the corresponding reference flight path.*

b) Q *represents the aeroplane position on the measured flight path at which the noise was emitted and observed as PNLTM at the noise measuring station* K. Q_r *is the corresponding position on the reference flight path and* K_r *the reference measuring station.* QK *and* Q_rK_r *are respectively the measured and reference noise propagation paths,* Q_r *being found from the assumption that* QK *and* Q_rK_r *form the same angle* θ *with their respective flight paths.*

Note 2.— The portions of test flight path and reference flight path which are significant for the EPNL calculation are illustrated in Figure 2-11 a) and b) for the lateral noise measurements.

a) XY *represents the useful portion of the measured flight path (Figure 2-11 a)), and* X_rY_r *that of the corresponding reference flight path (Figure 2-11 b)).*

b) Q *represents the aeroplane position on the measured flight path at which the noise was emitted and observed as PNLTM at the noise measuring station* K. Q_r *is the corresponding position on the reference flight path and* K_r *the reference measuring station.* QK *and* Q_rK_r *are respectively the measured and reference noise propagation paths. In this case* K_r *is only specified as being on a particular lateral line;* K_r *and* Q_r *are therefore found from the assumptions that* QK *and* Q_rK_r*:*

1) form the same angle θ *with their respective flight paths, and*

2) form the same angle ψ *with the ground.*

Note 3.— In the particular case of lateral noise measurement, sound propagation is affected not only by "inverse square" and atmospheric attenuation, but also by ground absorption and reflection effects which depend mainly on the angle ψ.

9.3.2.1 The one-third octave band levels SPL(*i*) comprising PNL (the PNL at the moment of PNLTM observed at K) shall be adjusted to reference levels $SPL(i)_r$ as follows:

$$SPL(i)_r = SPL(i) + 0.01\,[\alpha(i) - \alpha(i)_o]\,QK + 0.01\,\alpha(i)_o\,(QK - Q_rK_r) + 20\log(QK/Q_rK_r)$$

In this expression,

— the term $0.01\,[\alpha(i) - \alpha(i)_o]\,QK$ accounts for the effect of the change in sound attenuation coefficient, and $\alpha(i)$ and $\alpha(i)_o$ are the coefficients for the test and reference atmospheric conditions respectively, obtained from Section 7;

— the term $0.01\,\alpha(i)_o\,(QK - Q_rK_r)$ accounts for the effect of the change in the noise path length on the sound attenuation;

— the term $20\log(QK/Q_rK_r)$ accounts for the effect of the change in the noise path length due to the "inverse square" law;

— QK and Q_rK_r are measured in metres and $\alpha(i)$ and $\alpha(i)_o$ are in dB/100 m.

Note.— When SPL(*i*) *is zero (for example as a result of applying background noise corrections)* $SPL(i)_r$ *must also be kept equal to zero in the adjustment process.*

9.3.2.1.1 The corrected values $SPL(i)_r$ shall be converted to $PNLT_r$, and a correction term calculated as follows:

$$\Delta_1 = PNLT_r - PNLTM$$

9.3.2.1.2 Δ_1 shall be added algebraically to the EPNL calculated from the measured data.

9.3.2.2 If, during a test flight, several peak values of PNLT are observed which are within 2 dB of PNLTM, the procedure defined in 9.3.2.1 shall be applied at each peak and the adjustment term calculated as in 9.3.2.1 shall be added to each peak to give corresponding adjusted peak values of PNLT. If these peak values exceed that at the moment of PNLTM, the maximum value of such exceedance shall be added as a further adjustment to the EPNL calculated from the measured data.

9.3.3 Adjustments to duration correction

9.3.3.1 Whenever the measured flight paths and/or the ground velocities in the test conditions differ from the reference flight paths and/or the ground velocities in the reference conditions, duration adjustments shall be applied to the EPNL values calculated from the measured data. The adjustments shall be calculated as described below.

9.3.3.2 Referring to the flight path shown in Figure 2-10 the adjustment term shall be calculated as follows:

$$\Delta_2 = -7.5 \log (QK/Q_rK_r) + 10 \log (V/V_r)$$

which represents the adjustment to be added algebraically to the EPNL calculated from the measured data.

9.3.4 Source noise adjustments

9.3.4.1 The source noise adjustment shall be applied to take account of differences between the parameters affecting engine noise measured in the certification flight tests and those calculated or specified in the reference conditions. The adjustment shall be determined from manufacturers' data approved by the certificating authority.

Note.— Typical data are illustrated in Figure 2-12 which shows a curve of EPNL versus the engine control parameter μ, *the EPNL data being corrected to all the other relevant reference conditions (aeroplane mass, speed and altitude, air temperature) and for the difference in noise between the installed engine and the flight manual standard of engine at each value of* μ. *Data of this type are required around the values of* μ *used for lateral, flyover and approach noise measurements.*

9.3.4.2 The adjustment term Δ_3 shall be obtained by subtracting the EPNL value corresponding to the parameter μ from the EPNL value corresponding to the parameter μ_r and shall be added algebraically to the EPNL value calculated from the measured data.

Note.— See Figure 2-12 in which μ *is the value of the engine control parameter in the flight test conditions,* μ_r *is the corresponding value in the reference conditions.*

9.3.5 Symmetry adjustments

9.3.5.1 For the lateral noise, a symmetry adjustment shall be made (see Chapter 3, 3.3.2.2) as follows:

— if the symmetrical measurement point is opposite the point where the highest noise level is obtained on the main lateral measurement line, the certification noise level shall be the (arithmetical) mean of the noise levels measured at these two points (see Figure 2-13 a));

— if not, it shall be assumed that the variation of noise with the altitude of the aeroplane is the same on both sides (i.e. there is a constant difference between the lines of noise versus altitude on the two sides (see Figure 2-13 b)). The certification noise level shall then be the maximum value of the mean between these lines.

9.4 "Integrated" method of adjustment

9.4.1 General

Note.— The "integrated" adjustment method consists of recomputing under reference conditions points on the PNLT time history corresponding to measured points obtained during the tests, and computing EPNL directly for the new time history obtained in this way. The main principles are described below.

9.4.2 PNLT computations

Note 1.— The portions of the test flight path and the reference profile which are significant for the EPNL computation are illustrated in Figure 2-14 for the flyover and approach noise measurements.

a) *XY represents the useful portion of the measured flight path and* X_rY_r *that of the corresponding reference flight path;*

b) *The points* Q_0, Q_1, Q_n *represent aeroplane positions on the measured flight path at time* t_0, t_1 *and* t_n *respectively. Consider the point* Q_1 *at which the noise was emitted and observed as one-third octave values* $SPL(i)_1$ *at the noise measuring station* K *at time* t_1. *The point* Q_{r1} *represents the corresponding position on the reference flight path for noise observed as* $SPL(i)_{r1}$ *at the reference measuring station* K_r *at time* t_{r1}. Q_1K *and* $Q_{r1}K_r$ *are respectively the measured and reference noise propagation paths which in each case form the angle* θ_1 *with their respective flight paths.* Q_{r0} *and* Q_{rn} *are similarly the points on the reference flight path corresponding to* Q_0 *and* Q_n *on the measured flight path.* Q_0 *and* Q_n *are chosen so that between* Q_{r0} *and* Q_{rn} *all values of* $PNLT_r$ *(computed and described below) within 10 dB of the peak value are included.*

Note 2.— The portions of the test flight path and the reference profile which are significant for the EPNL computation are illustrated in Figure 2-15 a) and b) for the lateral noise measurements.

a) *XY represents the useful portion of the measured flight path and* X_rY_r *that of the corresponding reference flight path;*

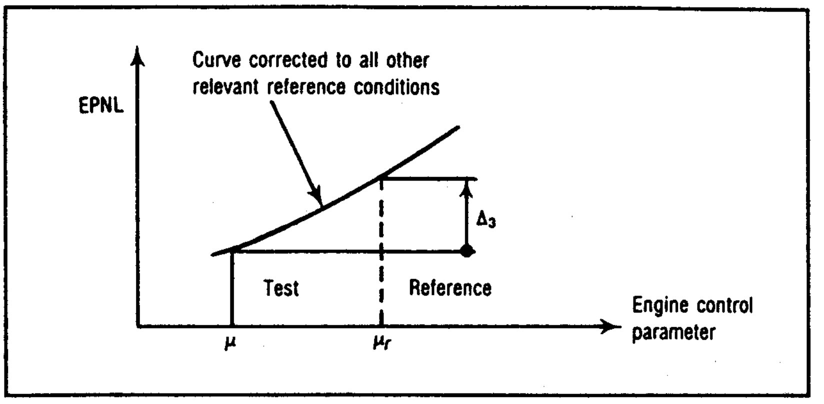


Figure 2-12. Noise thrust correction

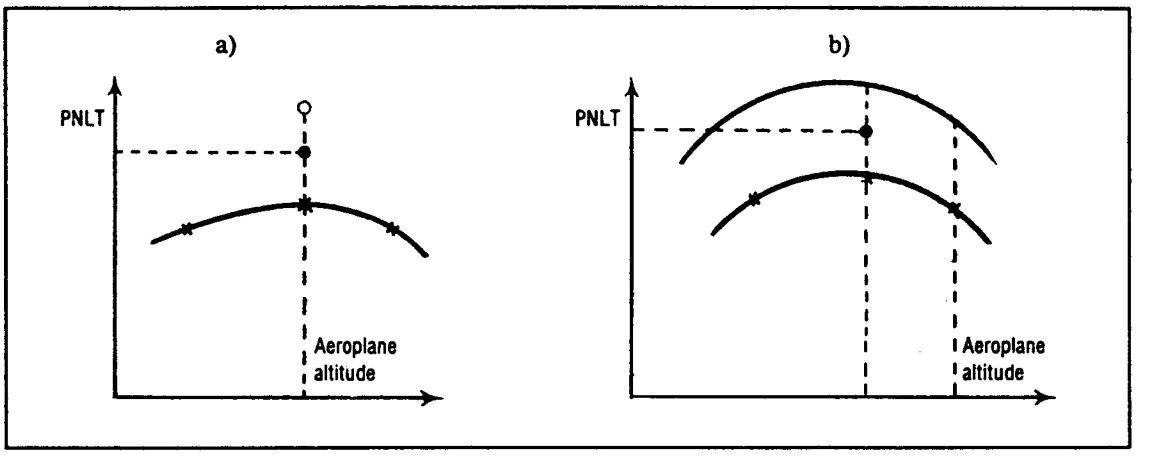


Figure 2-13. Symmetry correction

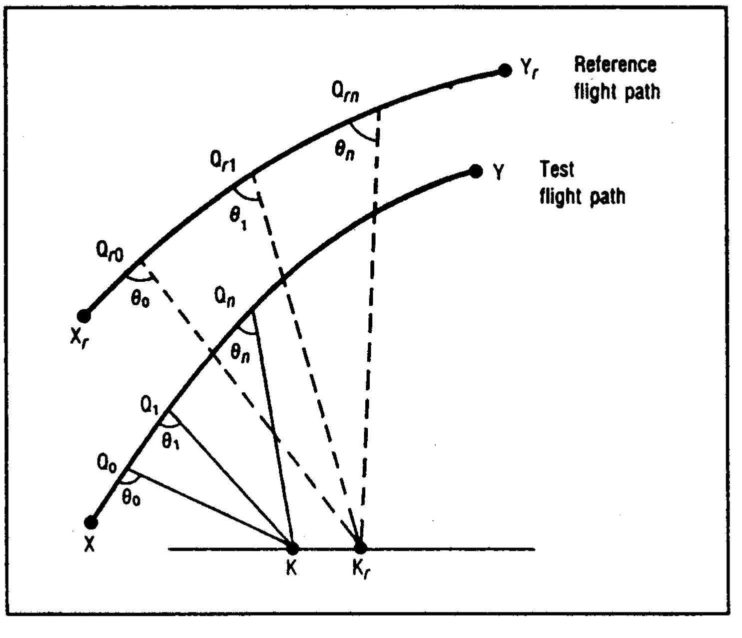


Figure 2-14. Correspondence between measured and reference flight paths for application of correction integrated methods

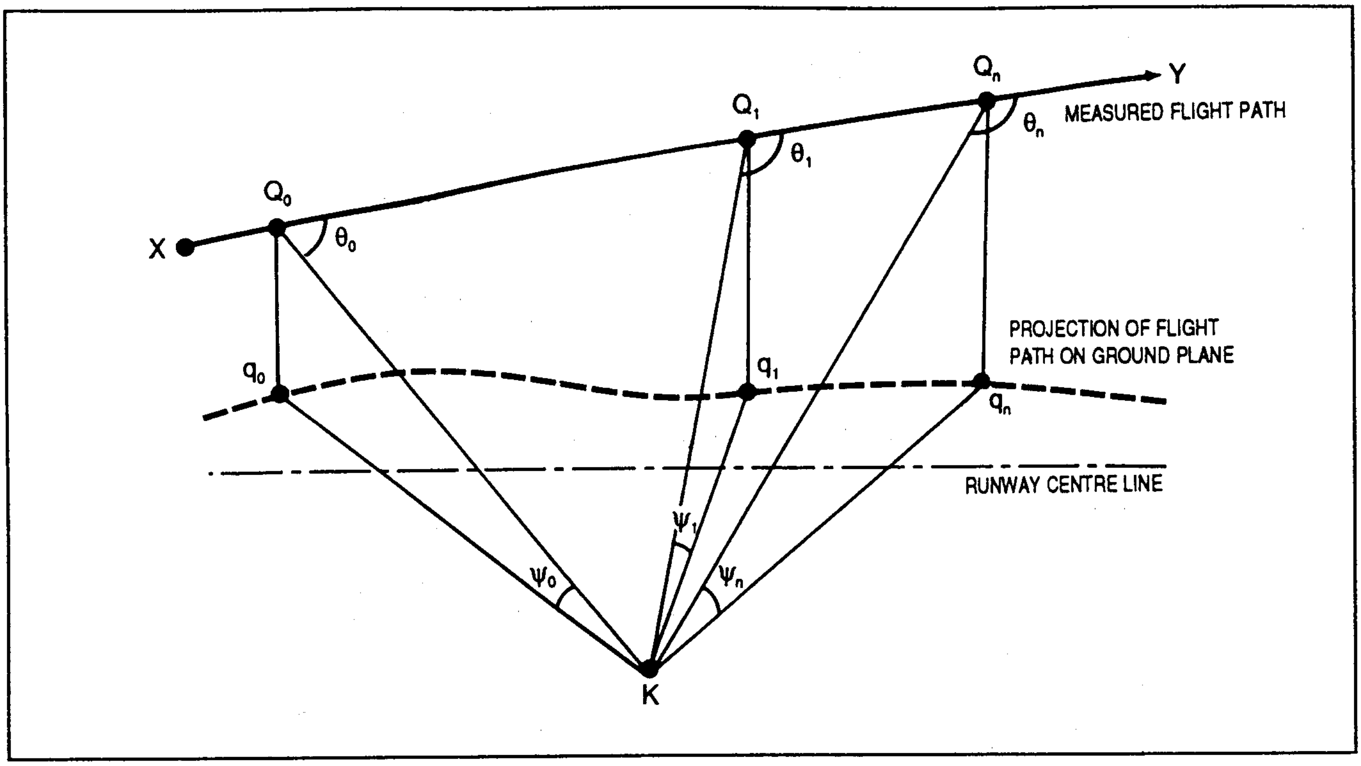


Figure 2-15 a). Measured flight path

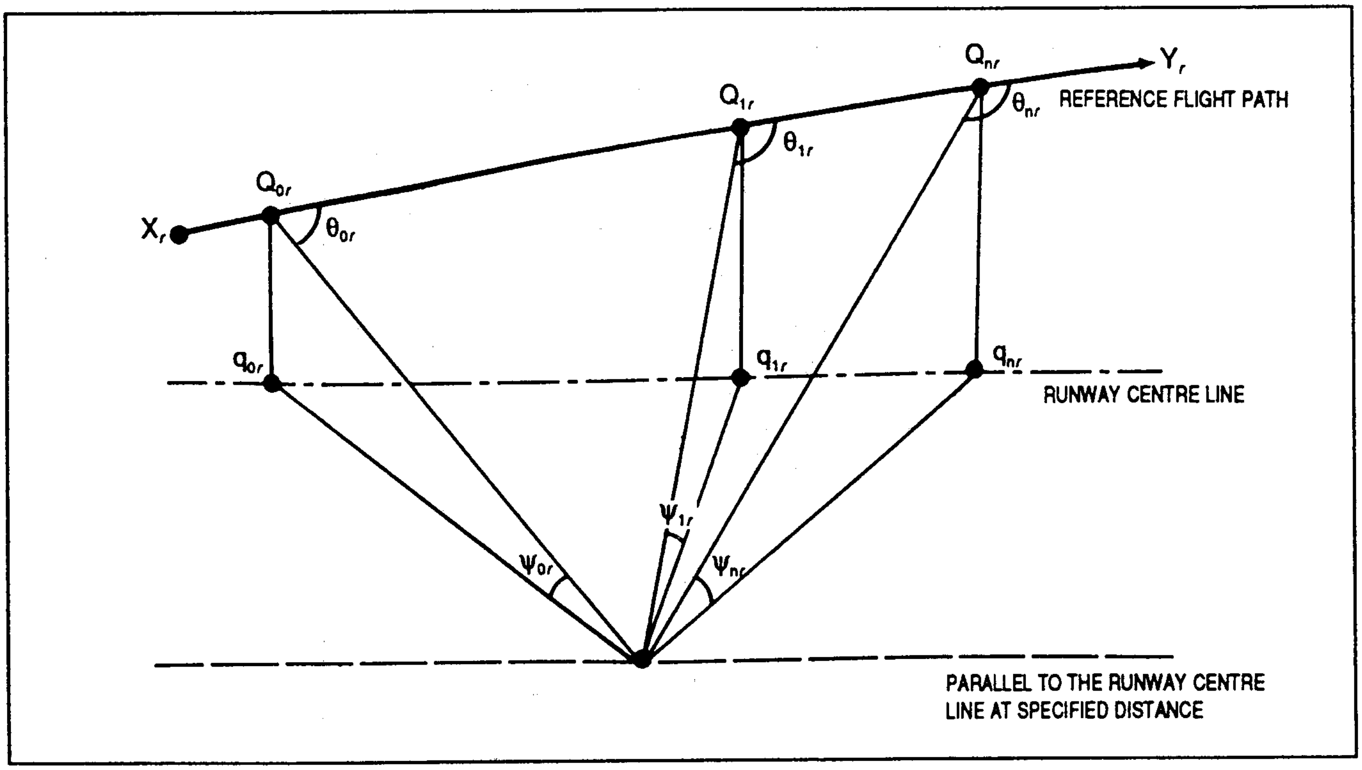


Figure 2-15 b). Reference flight path

b) The points Q_0, Q_1, Q_n *represent aeroplane positions on the measured flight path at time* t_0, t_1, *and* t_n *respectively. Consider the point* Q_1 *at which the noise was emitted and observed as one-third octave values* $SPL(i)_1$ *at the noise measuring station* K *at time* t_1. *The point* Q_{r1} *represents the corresponding position on the reference flight path for noise observed as* $SPL(i)_{r1}$ *at the measuring station* K_r *at time* t_{r1}. Q_1K *and* $Q_{r1}K_r$ *are respectively the measured and reference noise propagation paths.* Q_{r0} *and* Q_{rn} *are similarly the points on the reference flight path corresponding to* Q_0 *and* Q_n *on the measured flight path.* Q_0 *and* Q_n *are chosen so that between* Q_{r0} Q_{rn} *and all values of PNLT (computed and described below) within 10 dB of the peak value are included. In this case* K_r *is only specified as being on a particular lateral line. The position of* K_r *and* Q_{1r} *are found from the assumptions that:*

1) Q_1K *and* $Q_{1r}K_r$ *form the same angle* θ_1 *with their respective flight paths for all times* t_1; *and*

2) the differences between the angles ψ_1 *and* ψ_{1r} *are minimized over the relevant part of the time history by a method approved by the certificating authorities.*

Note 3.— In the particular case of lateral noise measurement, sound propagation is affected not only by "inverse square" and atmospheric attenuation, but also by ground absorption and reflection effects which depend mainly on the angle ψ. *For geometrical reasons it is generally not possible to choose* K_r *so that condition 1) above is fulfilled while at the same time* Ψ_1 *and* Ψ_{1r} *are kept equal at all times* t_1.

Note 4.— The time t_{r1} *is later (for* $Q_{r1}K_r > Q_1K$*) than* t_1 *by two separate amounts:*

1) the time taken for the aeroplane to travel the distance $Q_{r1}Q_{r0}$ *at a speed* V_r *less the time taken for it to travel* Q_1Q_0 *at* V;

2) the time taken for sound to travel the distance $Q_{r1}K_r - Q_1K$.

Note 5.— Where thrust or power cut-back is used there will be test and reference flight paths at full thrust or power and at cut-back thrust or power. Where the transient region between these affects the final result an interpolation must be made between them by an approved method such as that given in Section 2.2.1 of the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

9.4.2.1 The measured values of $SPL(i)_1$ etc. shall be adjusted to the reference values $SPL(i)_{r1}$ etc. for the differences between measured and reference noise path lengths and between measured and reference atmospheric conditions, by the methods of 9.3.2.1 of this appendix. Corresponding values of PNL_{r1} shall be computed.

9.4.2.2 For each value of PNL_{r1} a pure sound correction C_1 shall be determined by analysing the reference values $SPL(i)$, etc. by the methods of 4.3 of this appendix, and added to PNL_{r1} to give $PNLT_{r1}$.

9.4.3 Duration correction

9.4.3.1 The values of $PNLT_r$ corresponding to those of PNLT at each one-half second interval shall be plotted against time ($PNLT_{r1}$ at time t_{r1} etc.). The duration correction shall then be determined by the method of 4.5.1 of this appendix, to give $EPNL_r$.

9.4.4 Source noise adjustment

9.4.4.1 Finally, a source noise adjustment Δ_3 shall be determined by the methods by 9.3.4 of this appendix.

9.5 Flight path identification positions

Position	*Description*
A	Start of take-off roll.
B	Lift-off.
C	Start of first constant climb.
D	Start of thrust reduction.
E	Start of second constant climb.
F	End of noise certification take-off flight path.
G	Start of noise certification approach flight path.
H	Position on approach path directly above noise measuring station.
I	Start of level-off.
J	Touchdown.
K	Noise measurement point.
K_r	Reference measurement point.
K_1	Flyover noise measurement point.
K_2	Lateral noise measurement point.
K_3	Approach noise measurement point.
M	End of noise certification take-off flight track.
O	Threshold of approach end of runway.
P	Start of noise certification approach flight track.
Q	Position on measured take-off flight path corresponding to apparent PNLTM at station K. See 9.3.2.
Q_r	Position on corrected take-off flight path corresponding to PNLTM at station K. See 9.3.2.
V	Aeroplane test speed.
V_r	Aeroplane reference speed.

9.6 Flight path distances

Distance	*Unit*	*Meaning*
AB	metres	*Length of take-off roll.* The distance along the runway between the start of take-off roll and lift off.
AK	metres	*Take-off measurement distance.* The distance from the start of roll to the take-off noise measurement station along the extended centre line of the runway.
AM	metres	*Take-off flight track distance.* The distance from the start of roll to the take-off flight track position along the extended centre line of the runway for which the position of the aeroplane need no longer be recorded.
QK	metres	*Measured noise path.* The distance from the measured aeroplane position Q to station K.
Q_rK_r	metres	*Reference noise path.* The distance from the reference aeroplane position Q_r to station K_r.
K_3H	metres (feet)	*Aeroplane approach height.* The height of the aeroplane above the approach measuring station.
OK_3	metres	*Approach measurement distance.* The distance from the runway threshold to the approach measurement station along the extended centre line of the runway.
OP	metres	*Approach flight track distance.* The distance from the runway threshold to the approach flight track position along the extended centre line of the runway for which the position of the aeroplane need no longer be recorded.

11/11/93

APPENDIX 3. NOISE EVALUATION METHOD FOR NOISE CERTIFICATION OF PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 9 000 kg — APPLICATION FOR CERTIFICATE OF AIRWORTHINESS FOR THE PROTOTYPE ACCEPTED BEFORE 17 NOVEMBER 1988

Note.— See Part II, Chapter 6.

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

a) noise certification test and measurement conditions;

b) measurement of aeroplane noise received on the ground; and

c) reporting of data to the certificating authority and correction of measured data.

Note 2.— The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests, and to permit comparison between tests of various types of aeroplanes, conducted in various geographical locations. The method applies only to aeroplanes within the applicability clauses of Part II, Chapter 6.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification tests shall be conducted and the measurement procedures that shall be used to measure the noise made by the aeroplane for which the test is conducted.

2.2 General test conditions

2.2.1 Locations for measuring noise from an aeroplane in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted, or tall grass, shrubs, or wooded areas. No obstructions which significantly influence the sound field from the aeroplane shall exist within a conical space above the measurement position, the cone being defined by an axis normal to the ground and by a half-angle 75° from this axis.

2.2.2 The tests shall be carried out under the following atmospheric conditions:

a) no precipitation;

b) relative humidity not higher than 95 per cent and not lower than 20 per cent and ambient temperature not above 35°C and not below 2°C at 1.2 m (4 ft) above ground except that on a diagram of temperature plotted against relative humidity combinations of temperature and relative humidity which fall below a straight line between 2°C and 60 per cent and 35°C and 20 per cent shall be avoided;

c) reported wind not above 19 km/h (10 kt) at 1.2 m (4 ft) above ground and cross-wind component not above 9 km/h (5 kt) at 1.2 m (4 ft) above ground. Flights shall be made in equal numbers with tail and head wind components; and

d) no temperature inversions or anomalous wind conditions that would significantly affect the noise level of the aeroplane when the noise is recorded at the measuring points specified by the certificating authority.

2.3 Aeroplane testing procedures

2.3.1 The test procedures and noise measurement procedure shall be acceptable to the airworthiness and noise certificating authorities of the State issuing the certification.

2.3.2 The aeroplane height and lateral position relative to the microphone shall be determined by a method independent of normal flight instrumentation such as radar tracking, theodolite triangulation, photographic scaling techniques or other methods to be approved by the certificating authority.

3. MEASUREMENT OF AEROPLANE NOISE RECEIVED ON THE GROUND

3.1 General

3.1.1 All measuring equipment shall be approved by the certificating authority.

3.1.2 Sound pressure level data for noise evaluation purposes shall be obtained with acoustical equipment and measurement practices that conform to the specifications given hereunder in 3.2.

3.2 Measurement system

3.2.1 The acoustical measurement system shall consist of approved equipment equivalent to the following:

a) a microphone system with frequency response compatible with measurement and analysis system accuracy as stated in 3.3;

b) tripods or similar microphone mountings that minimize interference with the sound being measured;

c) recording and reproducing equipment characteristics, frequency response, and dynamic range compatible with the response and accuracy requirements of 3.3; and

d) acoustic calibrators using sine wave or broadband noise of known sound pressure level. If broadband noise is used, the signal shall be described in terms of its average and maximum root-mean-square (rms) value fon non-overload signal level.

3.3 Sensing, recording and reproducing equipment

3.3.1 When so specified by the certificating authority, the sound produced by the aeroplane shall be recorded in such a way that the complete information, including time history, is retained. A magnetic tape recorder is acceptable.

3.3.2 The characteristics of the complete system shall comply with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 179* with regard to the sections concerning microphone, amplifier and indicating instrument characteristics. The text and specifications of IEC Publication No. 179* entitled "Precision Sound Level Meters" are incorporated by reference into this section and are made a part hereof.

*Note.— When a tape recorder is used it forms part of the complete system complying with IEC Recommendation 561.**

3.3.3 The response of the complete system to a sensibly plane progressive sinusoidal wave of constant amplitude shall lie within the tolerance limits specified in Table IV and Table V for Type I instruments in IEC Publication No. 179,* for weighting curve "A" over the frequency range 45 to 11 200 Hz.

3.3.4 The recorded noise signal shall be read through an "A" filter as defined in IEC Publication No. 179,* and with dynamic characteristics designated "slow".

Note.— During tests with high flight speeds, the "fast" dynamic characteristics may be necessary to obtain the true level.

3.3.5 The equipment shall be acoustically calibrated using facilities for acoustic free field calibration. The over-all sensitivity of the measuring system shall be checked before and after the measurement of the noise level for a sequence of aeroplane operations, using an acoustic calibrator generating a known sound pressure level at a known frequency.

Note.— A pistonphone operating at a nominal 124 dB and 250 Hz is generally used for this purpose.

3.3.6 A wind screen shall be employed with the microphone during all measurements of aeroplane noise when the wind speed is in excess of 11 km/h (6 kt). Its characteristics shall be such that when it is used, the complete system including the wind screen will meet the specifications above. Its insertion loss at the frequency of the acoustic calibrator shall also be known and included in the provision of an acoustic reference level for the analysis of the measurements.

3.4 Noise measurement procedures

3.4.1 The microphones shall be oriented in a known direction so that the maximum sound received arrives as nearly as possible in the direction for which the microphones are calibrated. The microphones shall be placed so that their sensing elements are approximately 1.2 m (4 ft) above ground.

3.4.2 Immediately prior to and after each test, a recorded acoustic calibration of the system shall be made in the field with an acoustic calibrator for the two purposes of checking system sensitivity and providing an acoustic reference level for the analysis of the sound level data.

3.4.3 The ambient noise, including both acoustical background and electrical noise of the measurement systems, shall be recorded and determined in the test area with the system gain set at levels which will be used for aeroplane noise measurements. If aeroplane sound pressure levels do not exceed the background sound pressure levels by at least 10 dB(A), approved corrections for the contribution of background sound pressure level to the observed sound pressure level shall be applied.

* As amended. Available from the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

4. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND CORRECTION OF MEASURED DATA

4.1 Data reporting

4.1.1 Measured and corrected sound pressure levels obtained with equipment conforming to the specifications described in Section 3 of this appendix shall be reported.

4.1.2 The type of equipment used for measurement and analysis of all acoustic aeroplane performance and meteorological data shall be reported.

4.1.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

a) air temperature and relative humidity; and

b) maximum, minimum and average wind velocities.

4.1.4 Comments on local topography, ground cover, and events that might interfere with sound recordings shall be reported.

4.1.5 The following aeroplane information shall be reported:

a) type, model and serial numbers of aeroplane, engine(s) and propeller(s);

b) any modifications or non-standard equipment likely to affect the noise characteristics of the aeroplane;

c) maximum certificated take-off mass;

d) for each overflight, airspeed and air temperature at the flyover altitude determined by properly calibrated instruments;

e) for each overflight, engine performance as manifold pressure or power, propeller speed in revolutions per minute and other relevant parameters determined by properly calibrated instruments;

f) aeroplane height above ground (see 2.3.2);

g) corresponding manufacturer's data for the reference conditions relevant to d) and e) above.

4.2 Data correction

4.2.1 Correction of noise at source

4.2.1.1 When so specified by the certificating authority, corrections for differences between engine power achieved during the tests and the power that would be achieved at settings corresponding to the highest power in the normal operating range by an average engine of the type under reference conditions, shall be applied using approved methods.

4.2.1.2 At a propeller helical tip Mach number at or below 0.70 no correction is required if the test helical tip Mach number is within 0.014 of the reference helical tip Mach number. At a propeller helical tip Mach number above 0.70 and at or below 0.80 no correction is required if the test helical tip Mach number is within 0.007 of the reference helical tip Mach number. Above a helical tip Mach number of 0.80 no correction is required if the helical tip Mach number is within 0.005 of the reference helical tip Mach number. If the test power at any helical tip Mach number is within 10 per cent of the reference power, no correction for source noise variation with power is required. No corrections are to be made for power changes for fixed pitch propeller-driven aeroplanes. If test propeller helical tip Mach number and power variations from reference conditions are outside these constraints, corrections based on data developed using the actual test aeroplane or a similar configured aeroplane with the same engine and propeller operating as the aeroplane being certificated shall be used as described in Section 4.1 of the *Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft* (Doc 9501).

4.2.2 Correction of noise received on the ground

4.2.2.1 The noise measurements made at heights different from 300 m (985 ft) shall be adjusted to 300 m (985 ft) by the inverse square law.

4.2.3 Performance correction

Note.— The performance correction is intended to credit higher performance aeroplanes based on their ability to climb at a steeper angle and to fly the traffic pattern at a lower power setting. Also, this correction penalizes aeroplanes with limited performance capability which results in lower rates of climb and higher power settings in the traffic pattern.

4.2.3.1 A performance correction determined for sea level, 15°C conditions and limited to a maximum of 5 dB(A) shall be applied using the method described in 4.2.3.2 and added algebraically to the measured value.

4.2.3.2 The performance correction shall be calculated by using the following formula:

$$\Delta dB = 49.6 - 20 \log_{10}\left[(3\,500 - D_{15})\frac{R/C}{V_y} + 15\right]$$

where D_{15} = Take-off distance to 15 m at maximum certificated take-off mass and maximum take-off power (paved runway)

R/C = Best rate of climb at maximum certificated take-off mass and maximum take-off power

V_y = Climb speed corresponding to R/C at maximum take-off power and expressed in the same units.

Note.— When take-off distance is not certificated, the figure of 610 m for single-engined aeroplanes and 825 m for multi-engined aeroplanes is used.

4.3 Validity of results

4.3.1 The measuring point shall be overflown at least four times. The test results shall produce an average dB(A) value and its 90 per cent confidence limits, the noise level being the arithmetic average of the corrected acoustical measurements for all valid test runs over the measuring point.

4.3.2 The samples shall be large enough to establish statistically a 90 per cent confidence limit not exceeding ±1.5 dB(A). No test result shall be omitted from the averaging process, unless otherwise specified by the certificating authority.

Note.— Methods for calculating the 90 per cent confidence interval are given in Appendix 1 of the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

APPENDIX 4. EVALUATION METHOD FOR NOISE CERTIFICATION OF HELICOPTERS NOT EXCEEDING 2 730 kg MAXIMUM CERTIFICATED TAKE-OFF MASS

Note.— See Part II, Chapter 11.

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

a) noise certification test and measurement conditions;

b) definition of sound exposure level using measured noise data;

c) measurement of helicopter noise received on the ground;

d) adjustment of flight test results; and

e) reporting of data to the certificating authority.

Note 2.— The instructions and procedures given in the method are intended to ensure uniformity during compliance tests of various types of helicopters conducted in various geographical locations. The method applies only to helicopters meeting the applicability clauses of Part II, Chapter 11, of this volume of the Annex.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification shall be conducted and the meteorological and flight path measurement procedures that shall be used.

2.2 Test environment

2.2.1 The location for measuring noise from the helicopter in flight shall be surrounded by relatively flat terrain having no excessive ground absorption characteristics such as might be caused by thick, matted or tall grass, shrubs or wooded areas. No obstructions which significantly influence the sound field from the helicopter shall exist within a conical space above the test noise measurement position, the cone being defined by an axis normal to the ground and by a half-angle of 80° from this axis.

Note.— Those people carrying out the measurements could themselves constitute such obstructions.

2.2.2 The tests shall be carried out under the following atmospheric conditions:

a) no precipitation;

b) relative humidity not higher than 95 per cent or lower than 20 per cent and ambient temperature not above 35°C and not below 2°C at 10 m above ground (if the measurement site is within 2 000 m of an aerodrome thermometer, the aerodrome reported temperature may be used). Combinations of temperature and humidity which lead to an absorption coefficient in the 8 KHz one-third octave band of greater than 10 dB/100 m shall be avoided. Absorption coefficients as a function of temperature and relative humidity are given in Section 7 of Appendix 2 or SAE ARP 866 A;

c) reported wind speed not above 19 km/h (10 kt) and the wind speed component at right angles to the direction of flight not above 9 km/h (5 kt) at 1.2 m above ground; and

d) no other anomalous meteorological conditions that would significantly affect the noise level when recorded at the measuring points specified by the certificating authority.

2.3 Flight path measurement

2.3.1 The helicopter position relative to the flight path reference point shall be determined by a method independent of normal flight instrumentation, such as radar tracking, theodolite triangulation or photographic scaling techniques, approved by the certificating authority.

2.3.2 The helicopter noise shall be measured over a distance sufficient to ensure adequate data during the period that the noise is within 10 dB(A) of the maximum value of dB(A).

2.3.3 Position and performance data required to make the adjustments referred to in Section 5 of this appendix shall be recorded at an approved sampling rate. Measuring equipment shall be approved by the certificating authority.

3. NOISE UNIT DEFINITION

3.1 The value of sound exposure level L_{AE} is defined as the level, in decibels, of the time integral of squared A-weighted sound pressure (P_A) over a given time period or event, with reference to the square of the standard reference sound pressure (P_0) or 20 micropascals and a reference duration of one second.

3.2 This unit is defined by the expression:

$$L_{AE} = 10 \log \frac{1}{T_0} \int_{t1}^{t2} \left(\frac{P_A(t)}{P_0}\right)^2 dt$$

where T_0 is the reference integration time of one second and $(t2 - t1)$ is the integration time interval.

3.3 The above integral can also be expressed as:

$$L_{AE} = 10 \log \frac{1}{T_0} \int_{t1}^{t2} 10^{\frac{L_A(t)}{10}} dt$$

where $L_A(t)$ is the time varying A-weighted sound level.

3.4 The integration time $(t2 - t1)$ in practice shall not be less than the time interval during which $L_A(t)$ first rises to within 10 dB(A) of its maximum value (L_{AMAX}) and last falls below 10 dB(A) of its maximum value.

3.5 The SEL may be approximated by the following expression:

$$L_{AE} = L_{AMAX} + \Delta A$$

where ΔA is the duration allowance given by

$$\Delta A = 10 \log_{10} \tau$$

where $\tau = (t2 - t1)/2$.

L_{AMAX} is defined as the maximum level, in decibels, of the A-weighted sound pressure (slow response) with reference to the square of the standard reference sound pressure P_0.

4. MEASUREMENT OF HELICOPTER NOISE RECEIVED ON THE GROUND

4.1 General

4.1.1 All measuring equipment shall be approved by the certificating authority.

4.1.2 Sound pressure level data for noise evaluation purposes shall be obtained with acoustical equipment and measurement practices that conform to the specifications given in 4.2.

4.2 Measurement system

The acoustical measurement system shall consist of approved equipment equivalent to the following:

a) a microphone system with frequency response compatible with measurement and analysis system accuracy as stated in 4.3;

b) tripods or similar microphone mountings that minimize interference with the sound being measured;

c) recording and reproducing equipment characteristics, frequency response, and dynamic range compatible with the response and accuracy requirements of 4.3; and

d) acoustic calibrators using sine wave or broadband noise of known sound pressure level. If broadband noise is used, the signal shall be described in terms of its average and maximum root-mean-square (rms) value for non-overload signal level.

4.3 Sensing, recording and reproducing equipment

4.3.1 With the approval of the certificating authority the sound level produced by the helicopter may be stored on a magnetic tape recorder for later evaluation. Alternatively, the A-weighted sound level time history may be written onto a graphic level recorder set at "slow" response from which the SEL value may be determined or the SEL may be directly determined from an integrating sound level meter complying with the Standards of the International Electrotechnical Commission (IEC) Publication No. 804* for a Type 1 instrument set at "slow" response.

* Available from the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

4.3.2 The characteristics of the complete system shall comply with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 651* with regard to the sections concerning microphone, amplifier and indicating instrument characteristics. The text and specifications of IEC Publication No. 651, entitled "Sound Level Meters", are incorporated by reference into this section and are made a part hereof.

4.3.3 If a tape recording is required by the certificating authority, the tape recorder shall comply with the IEC Recommendation 561*.

4.3.4 The response of the complete system to a sensibly plane progressive sinusoidal wave of constant amplitude shall lie within the tolerance limits specified in Table IV and Table V for Type I instruments in IEC Publication No. 651, for weighting curve A over the frequency range 45 to 11 500 Hz.

4.3.5 The over-all sensitivity of the measuring system shall be checked before tests start and at intervals during testing using an acoustic calibrator generating a known sound pressure level at a known frequency.

Note.— A pistonphone operating at a nominal 124 dB and 250 Hz is generally used for this purpose.

4.3.6 A wind screen should be employed with the microphone during all measurements of helicopter noise. Its characteristics should be such that when it is used, the complete system including the wind screen will meet the specifications. Its insertion loss at the frequencies of the pistonphone should also be known and included in the acoustic reference level for analysis of the measurements.

4.4 Noise measurement procedures

4.4.1 The microphone shall be of the pressure-sensitive type designed for nearly uniform grazing incidence response.

4.4.2 The microphone shall be mounted with the centre of the sensing element 1.2 m above the local ground surface and shall be oriented for grazing incidence, i.e. with the sensing element substantially in the plane defined by the nominal flight path of the helicopter and the measuring station. The microphone mounting arrangement shall minimize the interference of the supports with the sound to be measured.

4.4.3 If the noise signal is tape-recorded, the frequency response of the electrical system shall be determined, during each test series, at a level within 10 dB of the full-scale reading used during the tests, utilizing random or pseudo-random pink noise. The output of the noise generator shall have been checked by an approved standards laboratory within six months of the test series, and tolerable changes in the relative output at each one-third octave band shall be not more than 0.2 dB. Sufficient determinations shall be made to ensure that the over-all calibration of the system is known for each test.

4.4.4 Where a magnetic tape recorder forms part of the measuring chain, each reel of magnetic tape shall carry 30 s of this electrical calibration signal at its beginning and end for this purpose. In addition, data obtained from tape-recorded signals shall be accepted as reliable only if the level difference in the 10 kHz one-third octave band filtered levels of the two signals is not more than 0.75 dB.

4.4.5 The ambient noise, including both acoustical background and electrical noise of the measurement systems, shall be determined in the test area with the system gain set at levels which will be used for helicopter noise measurements. If helicopter sound pressure levels do not exceed the background sound pressure levels by at least 15 dB(A), flyovers at an approved lower height may be used and the results adjusted to the reference measurement point by an approved method.

5. ADJUSTMENT TO TEST RESULTS

5.1 When certification test conditions differ from the reference conditions appropriate adjustments shall be made to the measured noise data by the methods of this section.

5.2 Corrections and adjustments

5.2.1 The adjustments may be limited to the effects of differences in spherical spreading between the helicopter test flight path and the reference flight path. No adjustment for the differences in atmospheric attenuation between the test and reference meteorological conditions and between the helicopter test and reference ground speeds need be applied.

5.2.2 The adjustments for spherical spreading may be approximated from:

$$\Delta = 12.5 \log_{10} (H/150) \text{ dB}$$

where H is the height, in metres, of the test helicopter when directly over the noise measurement point.

* Available from the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

6. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND VALIDITY OF RESULTS

6.1 Data reporting

6.1.1 Measured and corrected sound pressure levels obtained with equipment conforming to the specifications described in Section 4 of this appendix shall be reported.

6.1.2 The type of equipment used for measurement and analysis of all acoustic helicopter performance and meterological data shall be reported.

6.1.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation point prescribed in Section 2 of this appendix shall be reported:

a) air temperature and relative humidity;

b) wind speeds and wind directions; and

c) atmospheric pressure.

6.1.4 Comments on local topography, ground cover and events that might interfere with sound recording shall be reported.

6.1.5 The following helicopter information shall be reported:

a) type, model and serial numbers of helicopter, engine(s) and rotor(s);

b) any modifications or nonstandard equipment likely to affect the noise characteristics of the helicopter;

c) maximum certificated take-off and landing mass;

d) indicated airspeed in kilometres per hour (knots) and rotor speed in rpm during each demonstration;

e) engine performance parameters during each demonstration; and

f) helicopter height above the ground during each demonstration.

6.2 Reporting of noise certification reference conditions

Helicopter position and performance data and noise measurements shall be corrected to the noise certification reference conditions specified in Part II, Chapter 11, 11.5 of this volume. These conditions, including reference parameters, procedures and configurations shall be reported.

6.3 Validity of results

6.3.1 The measuring point shall be overflown at least six times. The test results shall produce an average SEL and its 90 per cent confidence limits, the noise level being the arithmetic average of the corrected acoustical measurements for all valid test runs over the measuring point for the reference procedure.

6.3.2 The sample shall be large enough to establish statistically a 90 per cent confidence limit not exceeding ±1.5 dB(A). No test results shall be omitted from the averaging process unless approved by the certificating authority.

Note.— Methods for calculating the 90 per cent confidence interval are given in Appendix 1 of the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft *(Doc 9501).*

APPENDIX 5. MONITORING AIRCRAFT NOISE ON AND IN THE VICINITY OF AERODROMES

Note.— See Part III.

1. INTRODUCTION

Note 1.— The introduction of jet aircraft operations, as well as the general increase in air traffic, has resulted in international concern over aircraft noise. To facilitate international collaboration on the solution of aircraft noise problems, it is desirable to recommend a procedure for monitoring aircraft noise on and in the vicinity of aerodromes.

Note 2.— In this appendix monitoring is understood to be the routine measurement of noise levels created by aircraft in the operation of an aerodrome. Monitoring usually involves a large number of measurements per day, from which an immediate indication of the noise level may be required.

Note 3.— This appendix specifies the measuring equipment to be used in order to measure noise levels created by aircraft in the operation of an aerodrome. The noise levels measured according to this appendix are approximations to perceived noise levels PNL, in PNdB, as calculated by the method described in Appendix 1, 4.2.

1.1 Monitoring aircraft noise should be carried out either with mobile equipment, often using only a sound level meter, or with permanently installed equipment incorporating one or more microphones with amplifiers located at different positions in the field with a data transmission system linking the microphones to a central recording installation. This appendix describes primarily the latter method, but specifications given in this appendix should also be followed, to the extent the specifications are relevant, when using mobile equipment.

2. DEFINITION

Monitoring of aircraft is defined as the routine measurement of noise levels created by aircraft on and in the vicinity of aerodromes for the purpose of monitoring compliance with and checking the effectiveness of noise abatement requirements.

3. MEASUREMENT EQUIPMENT

3.1 The measurement equipment should consist of either portable recording apparatus capable of direct reading, or apparatus located at one or more fixed positions in the field linked through a radio transmission — or cable system (e.g. telephone line, etc.) to a centrally located recording device.

3.2 The characteristics of the field equipment, including the transmission system, should comply with IEC Publication 179*, "Precision Sound Level Meters", except that frequency weighting equal to the inverse of the 40 noy contour (see Figure 5-1) should apply. An approximation, to the nearest decibel, of the inverse of the 40 noy contour relative to the value at 1 000 Hz, is given in Table 5-1. The relative frequency response of the weighting element of the equipment should be maintained within a tolerance of ±0.5 dB. When such a weighting network is incorporated in a direct reading instrument, the relation between the acoustical input to the microphone and the meter reading should follow the inverse of the 40 noy contour with the same tolerances as those specified for weighting curve C in IEC Publication 179*. Measurements obtained by means of the instrumentation described above provide, after adding 7 dB, values which are approximations to the perceived noise levels in PNdB.

3.3 An alternative method of determining approximations to the perceived noise levels can be obtained from measuring the noise using a sound-level meter incorporating the A-weighting network** and adding a correction K normally between 9 and 14 dB dependent on the frequency spectrum of the noise. The value of K and the method used by the measuring authorities for determination of that value should be specified when reporting results.

3.4 The field installation of microphones for aircraft noise monitoring purposes should provide for suitable protection of the microphones from rain, snow and other adverse weather conditions. Adequate correction for any insertion loss, as a function of frequency and weather conditions, produced by wind screens or other protective enclosures should be applied to the measured data.

* This publication was first issued in 1965 by the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

** The A-weighting network is described in IEC Publication 179.

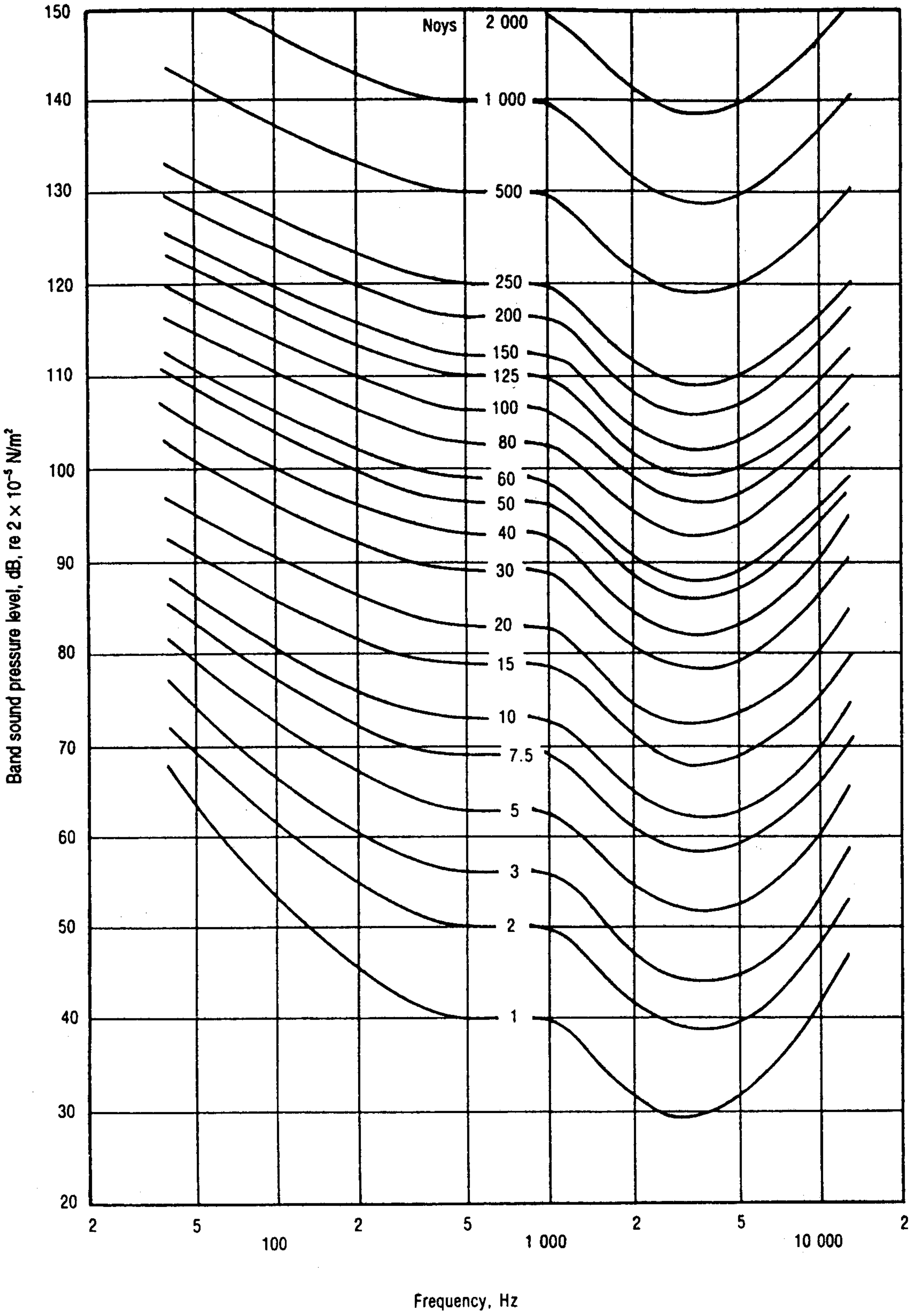


Figure 5-1. Contours of perceived noisiness

Table 5-1. Approximation to the nearest decibel of the inverse of the 40 noy contour relative to the value at 1 000 Hz

Hz	40	50	63	80	100	125	160
dB	−14	−12	−11	−9	−7	−6	−5
Hz	200	250	315	400	500	630	800
dB	−3	−2	−1	0	0	0	0
Hz	1 000	1 250	1 600	2 000	2 500	3 150	4 000
dB	0	+2	+6	+8	+10	+11	+11
Hz	5 000	6 300	8 000	10 000	12 500		
dB	+10	+9	+6	+3	0		

Note.— Where a record of the noise as a function of time is required this can be obtained by recording the noise signal on a magnetic tape, a graphic level recorder or other suitable equipment.

3.5 The recording and indicating equipment should comply with IEC Publication 179* regarding the dynamic characteristics of the indicating instrument designated as "slow".

Note.— If the anticipated duration of the noise signal is less than 5 s, the dynamic characteristics designated as "fast" may be used.

For the purpose of this note, the duration is described as the length of the significant time history during which the recorded signal, passed through a weighting network having an amplitude characteristic equal to the inverse 40 noy contour, remains within 10 dB of its maximum value.

3.6 The microphone system should have been originally calibrated at a laboratory equipped for free-field calibration and its calibration should be rechecked at least every six months.

3.7 The complete measurement system prior to field installation and at periodic intervals thereafter should be calibrated in a laboratory to ensure that the frequency response and dynamic range requirements of the system comply with the specifications described in this document.

Note.— Direct reading measuring systems that yield approximate values of perceived noise levels other than those defined above are not meant to be excluded from use in monitoring.

4. FIELD EQUIPMENT INSTALLATION

4.1 Microphones used for monitoring noise levels from aircraft operations should be installed at appropriate locations with the axis of maximum sensitivity of each microphone oriented in a direction such that the highest sensitivity to sound waves is achieved. The microphone position should be selected so that no obstruction which influences the sound field produced by an aircraft exists above a horizontal plane passing through the active centre of the microphone.

Note 1.— Monitoring microphones may need to be placed in locations having substantial background noise levels caused by motor vehicle traffic, children playing, etc. In these instances it is often expedient to locate the microphone on a roof-top, telephone pole or other structure rising above the ground. Consequently, it is necessary to determine the background noise level and to carry out a field check, at one or more frequencies, of the over-all sensitivity of the measuring system after or before the measurement of the noise level for a sequence of aircraft operations.

Note 2.— If, due to the microphone being placed in a structure above the ground, it is impracticable for operating personnel to calibrate it directly because of its inaccessibility, it can be useful to provide a calibrated sound source at the microphone location. This sound source can be a small loudspeaker, an electrostatic actuator, or similar device.

4.2 Monitoring concerns the noise produced by a single aircraft flight, by a series of flights or by a specified type of aircraft, or by a large number of operations of different aircraft. Such noise levels vary, for a specific monitoring location, with variations in flight procedures or meteorological conditions. In interpretation of the results of a monitoring procedure, consideration should therefore be given to the statistical distribution of the measured noise levels. In describing the results of a monitoring procedure an appropriate description of the distribution of the observed noise levels should be provided.

* This publication was first issued in 1965 by the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

APPENDIX 6. NOISE EVALUATION METHOD FOR NOISE CERTIFICATION OF PROPELLER-DRIVEN AEROPLANES NOT EXCEEDING 9 000 kg — APPLICATION FOR CERTIFICATE OF AIRWORTHINESS FOR THE PROTOTYPE ACCEPTED ON OR AFTER 17 NOVEMBER 1988

Note.— See Part II, Chapter 10.

1. INTRODUCTION

Note 1.— This noise evaluation method includes:

a) noise certification test and measurement conditions;

b) noise unit;

c) measurement of aeroplane noise received on the ground;

d) adjustments to test data; and

e) reporting of data to the certificating authority and validity of results.

Note 2.— The instructions and procedures given in the method are clearly delineated to ensure uniformity during compliance tests and to permit comparison between tests of various types of aeroplanes, conducted in various geographical locations. The method applies only to aeroplanes within the applicability clauses of Part II, Chapter 10.

2. NOISE CERTIFICATION TEST AND MEASUREMENT CONDITIONS

2.1 General

This section prescribes the conditions under which noise certification tests shall be conducted and the measurement procedures that shall be used to measure the noise made by the aeroplane for which the test is conducted.

2.2 General test conditions

2.2.1 Locations for measuring noise from an aeroplane in flight shall be surrounded by relatively flat terrain having no excessive sound absorption characteristics such as might be caused by thick, matted, or tall grass, shrubs, or wooded areas. No obstructions which significantly influence the sound field from the aeroplane shall exist within a conical space above the measurement position, the cone being defined by an axis normal to the ground and by a half-angle 75° from this axis.

2.2.2 The tests shall be carried out under the following atmospheric conditions:

a) no precipitation;

b) relative humidity not higher than 95 per cent and not lower than 20 per cent and ambient temperature not above 35°C and not below 2°C at 1.2 m;

c) reported wind not above 19 km/h (10 kt) and cross wind not above 9 km/h (5 kt) at 1.2 m, using a 30 s average;

d) no other anomalous meteorological conditions that would significantly affect the noise level of the aeroplane when the noise is recorded at the measuring points specified by the certificating authority.

2.3 Aeroplane testing procedures

2.3.1 The test procedures and noise measurement procedure shall be acceptable to the airworthiness and noise certificating authorities of the State issuing the certification.

2.3.2 The flight test programme shall be initiated at the maximum take-off mass for the aeroplane, and the mass shall be adjusted to maximum take-off mass after each hour of flight time.

2.3.3 The flight test shall be conducted at V_y ±9 km/h (5 kt) indicated airspeed.

2.3.4 The aeroplane position relative to the flight path reference point shall be determined by a method independent of normal flight instrumentation, such as radar tracking, theodolite triangulation or photographic scaling techniques, approved by the certificating authorities.

2.3.5 The aeroplane height when directly over the microphone shall be measured by an approved technique. The aeroplane shall pass over the microphone within ±10° from the vertical and within ±20 per cent of the reference height (see Figure 6-1).

2.3.6 Aeroplane speed, position and performance data required to make the adjustments referred to in Section 5 of this appendix shall be recorded when the aeroplane is directly over the measurement site. Measuring equipment shall be approved by the certificating authority.

2.3.7 An independent device accurate to within ±1 per cent shall be used for the measurement of propeller rotational speed to avoid orientation and installation errors when the test aeroplane is equipped with mechanical tachometers.

3. NOISE UNIT DEFINITION

The L_{Amax} is defined as the maximum level, in decibels, of the A-weighted sound pressure (slow response) with reference to the square of the standard reference sound pressure (P_0) of 20 micropascals (μPa).

4. MEASUREMENT OF AEROPLANE NOISE RECEIVED ON THE GROUND

4.1 General

4.1.1 All measuring equipment shall be approved by the certificating authority.

4.1.2 Sound pressure level data for noise evaluation purposes shall be obtained with acoustical equipment and measurement practices that conform to the specifications given hereunder in 4.2.

4.2 Measurement system

The acoustical measurement system shall consist of approved equipment equivalent to the following:

a) a microphone system with frequency response compatible with measurement and analysis system accuracy as stated in 4.3;

b) tripods or similar microphone mountings that minimize interference with the sound being measured;

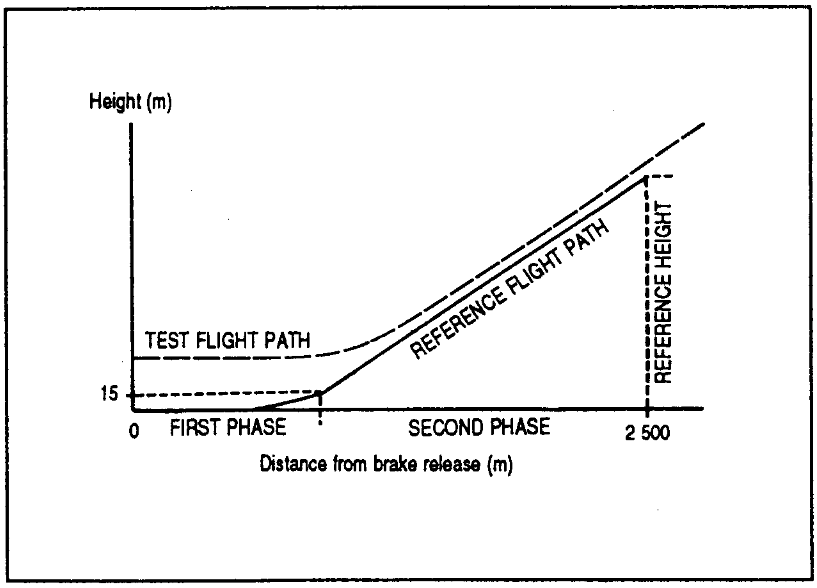


Figure 6-1. Typical test and reference profiles

c) recording and reproducing equipment characteristics, frequency response, and dynamic range compatible with the response and accuracy requirements of 4.3; and

d) acoustic calibrators using sine wave or broadband noise of known sound pressure level. If broadband noise is used, the signal shall be described in terms of its average and maximum root-mean-square (rms) value for non-overload signal level.

4.3 Sensing, recording and reproducing equipment

4.3.1 The sound level produced by the aeroplane shall be recorded. A magnetic tape recorder, graphic level recorder or sound level meter is acceptable at the option of the certificating authority.

4.3.2 The characteristics of the complete system shall comply with the recommendations given in International Electrotechnical Commission (IEC) Publication No. 651* with regard to the sections concerning microphone, amplifier and indicating instrument characteristics. The text and specifications of IEC Publication No. 651 entitled "Sound Level Meters" are incorporated by reference into this section and are made a part hereof.

Note.— If a tape recording is required by the certificating authority, the tape recorder shall comply with IEC Recommendation 561.

4.3.3 The response of the complete system to a sensibly plane progressive sinusoidal wave of constant amplitude shall lie within the tolerance limits specified in Table IV and Table V for Type I instruments in IEC Publication No. 651, for weighting curve "A" over the frequency range 45 to 11 500 Hz.

4.3.4 The noise signal shall be passed through an "A" filter as defined in IEC Publication No. 651.

4.3.5 The over-all sensitivity of the measuring system shall be checked before tests start and at intervals during testing using an acoustic calibrator generating a known sound pressure level at a known frequency.

Note.— A pistonphone operating at a nominal 124 dB and 250 Hz is generally used for this purpose.

4.3.6 When a tape recording is used, the maximum A-weighted noise level L_{Amax} may be determined using a graphic level recorder or digital equivalent.

Note.— The maximum noise level L_{Amax} could also be determined using an approved sound level meter.

4.4 Noise measurement procedures

4.4.1 The microphone shall be a 12.7 mm diameter pressure type, with its protective grid, mounted in an inverted position such that the microphone diaphragm is 7 mm above and parallel to a circular metal plate. This white-painted metal plate shall be 40 cm in diameter and at least 2.5 mm thick, and shall be placed horizontally and flush with the surrounding ground surface with no cavities below the plate. The microphone shall be located three-quarters of the distance from the centre to the edge along a radius normal to the line of flight of the test aeroplane.

4.4.2 If the noise signal is tape-recorded, the frequency response of the electrical system shall be determined, during each test series, at a level within 10 dB of the full-scale reading used during the tests, utilizing random or pseudorandom pink noise. The output of the noise generator shall have been checked by an approved Standards laboratory within six months of the test series, and tolerable changes in the relative output at each one-third octave band shall be not more than 0.2 dB. Sufficient determinations shall be made to ensure that the over-all calibration of the system is known for each test.

4.4.3 Where a magnetic tape recorder forms part of the measuring chain, each reel of magnetic tape shall carry 30 s of this electrical calibration signal at its beginning and end for this purpose. In addition, data obtained from tape-recorded signals shall be accepted as reliable only if the level difference in the 10 kHz one-third octave band filtered levels of the two signals is not more than 0.75 dB.

4.4.4 The ambient noise, including both acoustical background and electrical noise of the measurement systems, shall be determined in the test area with the system gain set at levels which will be used for aeroplane noise measurements. If aeroplane peak sound pressure levels do not exceed the background sound pressure levels by at least 10 dB(A), a take-off measurement point nearer to the start of roll shall be used and the results adjusted to the reference measurement point by an approved method.

5. ADJUSTMENT TO TEST RESULTS

When certification test conditions differ from the reference conditions appropriate adjustments shall be made to the measured noise data by the methods of this section.

* Available from the Bureau central de la Commission électrotechnique internationale, 1 rue de Varembé, Geneva, Switzerland.

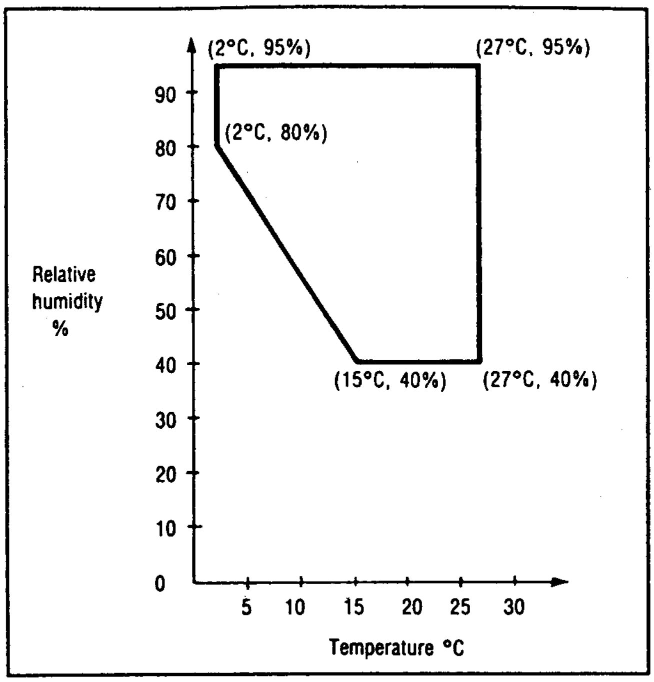


Figure 6-2. Measurement window for no absorption correction

5.2 Corrections and adjustments

5.2.1 The adjustments take account of the effects of:

a) differences in atmospheric absorption between meteorological test conditions and reference conditions;

b) differences in the noise path length between the actual aeroplane flight path and the reference flight path;

c) the change in the helical tip Mach number between test and reference conditions; and

d) the change in engine power between test and reference conditions.

5.2.2 The noise level under reference conditions (L_{Amax}) REF is obtained by adding increments for each of the above effects to the test day noise level (L_{Amax}) TEST.

$$(L_{Amax})\ REF = (L_{Amax})\ TEST + \Delta(M) + \Delta_1 + \Delta_2 + \Delta_3$$

where

$\Delta(M)$ is the adjustment for the change in atmospheric absorption between test and reference conditions;
Δ_1 is the adjustment for noise path lengths;
Δ_2 is the adjustment for helical tip Mach number; and
Δ_3 is the adjustment for engine power.

a) When the test conditions are within those specified in Figure 6-2, no adjustments for differences in atmospheric absorption need be applied, i.e. $\Delta(M) = 0$. If conditions are outside those specified in Figure 6-2 then adjustments must be applied by an approved procedure or by adding an increment $\Delta(M)$ to the test day noise levels where,

$$\Delta(M) = 0.01\ (H_T\alpha - 0.2\ H_R)$$

and where H_T is the height in metres of the test aeroplane when directly over the noise measurement point, H_R is the reference height of the aeroplane above the noise measurement point, and α is the rate of absorption at 500 Hz specified in Tables 1-5 to 1-16 of Appendix 1.

b) Measured noise levels should be adjusted to the height of the aeroplane over the noise measuring point on a reference day by algebraically adding an increment equal to Δ_1. When test day conditions are within those specified in Figure 6-2:

$$\Delta_1 = 22\log(H_T/H_R)$$

When test day conditions are outside those specified in Figure 6-2:

$$\Delta_1 = 20\log(H_T/H_R)$$

where H_T is the height of the aeroplane when directly over the noise measurement point and H_R is the reference height of the aeroplane over the measurement point.

c) No adjustments for helical tip Mach number variations need be made if the propeller helical tip Mach number is:

1) at or below 0.70 and the test helical tip Mach number is within 0.014 of the reference helical tip Mach number;

2) above 0.70 and at or below 0.80 and the test helical tip Mach number is within 0.007 of the reference helical tip Mach number;

3) above 0.80 and the test helical tip Mach number is within 0.005 of the reference helical tip Mach number. For mechanical tachometers, if the helical tip Mach number is above 0.8 and the test helical tip Mach number is within 0.008 of the reference helical tip Mach number.

Outside these limits measured noise levels shall be adjusted for helical tip Mach number by an increment equal to:

$$\Delta_2 = K_2 \log (M_R/M_T)$$

which shall be added algebraically to the measured noise level, where M_T and M_R are the test and reference helical tip Mach numbers respectively. The value of K_2 shall be determined from approved data from the test aeroplane. In the absence of flight test data and at the discretion of the certificating authority a value of K_2 = 150 may be used for M_T less than M_R; however, for M_T greater than or equal to M_R no correction is applied.

Note.— The reference helical tip Mach number M_R *is the one corresponding to the reference conditions above the measurement point:*

where

$$M_R = \frac{\left|\left[\frac{D\pi N}{60}\right]^2 + V_{T^2}\right|^{1/2}}{a}$$

where D *is the propeller diameter in metres*

V_T *is the true airspeed of the aeroplane in reference conditions in metres per second*

N *is the propeller speed in reference conditions in rpm*

a *is the reference day speed of sound at the altitude of the aeroplane in metres per second.*

d) Measured sound levels shall be adjusted for engine power by algebraically adding an increment equal to:

$$\Delta_3 = K_3 \log (P_R/P_T)$$

where P_T and P_R are the test and reference engine powers respectively obtained from the manifold pressure/torque gauges and engine rpm. The value of K_3 shall be determined from approved data from the test aeroplane. In the absence of flight test data and at the discretion of the certificating authority a value of K_3 = 17 may be used.

6. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY AND VALIDITY OF RESULTS

6.1 Data reporting

6.1.1 Measured and corrected sound pressure levels obtained with equipment conforming to the specifications described in Section 4 of this appendix shall be reported.

6.1.2 The type of equipment used for measurement and analysis of all acoustic aeroplane performance and meteorological data shall be reported.

6.1.3 The following atmospheric environmental data, measured immediately before, after, or during each test at the observation points prescribed in Section 2 of this appendix shall be reported:

a) air temperature and relative humidity;

b) wind speeds and wind directions; and

c) atmospheric pressure.

6.1.4 Comments on local topography, ground cover and events that might interfere with sound recordings shall be reported.

6.1.5 The following aeroplane information shall be reported:

a) type, model and serial numbers of aeroplane, engine(s) and propeller(s);

b) any modifications or nonstandard equipment likely to affect the noise characteristics of the aeroplane;

c) maximum certificated take-off mass;

d) for each overflight, airspeed and air temperature at the flyover altitude determined by properly calibrated instruments;

e) for each overflight, engine performance as manifold pressure or power, propeller speed in revolutions per minute and other relevant parameters determined by properly calibrated instruments;

f) aeroplane height above the measurement point; and

g) corresponding manufacturer's data for the reference conditions relevant to d), e) and f) above.

6.2 Validity of results

6.2.1 The measuring point shall be overflown at least six times. The test results shall produce an average noise level (L_{Amax}) value and its 90 per cent confidence limits, the noise level being the arithmetic average of the corrected acoustical measurements for all valid test runs over the measuring point.

6.2.2 The samples shall be large enough to establish statistically a 90 per cent confidence limit not exceeding ±1.5 dB(A). No test results shall be omitted from the averaging process, unless otherwise specified by the certificating authority.

ATTACHMENTS TO ANNEX 16, VOLUME I

ATTACHMENT A. EQUATIONS FOR THE CALCULATION OF NOISE LEVELS AS A FUNCTION OF TAKE-OFF MASS

Note.— See Part II, 2.4.1, 2.4.2, 3.4.1, 5.4.1 and 8.4.1.

1. CONDITIONS DESCRIBED IN CHAPTER 2, 2.4.1

M = Maximum take-off mass in 1 000 kg	0	34	272
Lateral noise level (EPNdB)	102	91.83 + 6.64 log M	108
Approach noise level (EPNdB)	102	91.83 + 6.64 log M	108
Flyover noise level (EPNdB)	93	67.56 + 16.61 log M	108

2. CONDITIONS DESCRIBED IN CHAPTER 2, 2.4.2

<table>
<tr><th colspan="2">M = Maximum take-off mass in 1 000 kg</th><th>0</th><th>34</th><th>35</th><th>48.3</th><th>66.72</th><th>133.45</th><th>280</th><th>325</th><th>400</th></tr>
<tr><td colspan="2">Lateral noise level (EPNdB) All aeroplanes</td><td colspan="2">97</td><td colspan="7">83.87 + 8.51 log M</td><td>106</td></tr>
<tr><td colspan="2">Approach noise level (EPNdB) All aeroplanes</td><td colspan="2">101</td><td colspan="5">89.03 + 7.75 log M</td><td colspan="2">108</td></tr>
<tr><td rowspan="3">Flyover noise levels (EPNdB)</td><td>2 engines</td><td colspan="3">93</td><td colspan="5">70.62 + 13.29 log M</td><td>104</td></tr>
<tr><td>3 engines</td><td>93</td><td colspan="3">67.56 + 16.61 log M</td><td colspan="4">73.62 + 13.29 log M</td><td>107</td></tr>
<tr><td>4 engines</td><td>93</td><td colspan="4">67.56 + 16.61 log M</td><td colspan="3">74.62 + 13.29 log M</td><td>108</td></tr>
</table>

3. CONDITIONS DESCRIBED IN CHAPTER 3, 3.4.1

<table>
<tr><th colspan="2">M = Maximum take-off mass in 1 000 kg</th><th>0</th><th>20.2</th><th>28.6</th><th>35</th><th>48.1</th><th>280</th><th>385</th><th>400</th></tr>
<tr><td colspan="2">Lateral noise level (EPNdB) All aeroplanes</td><td colspan="3">94</td><td colspan="4">80.87 + 8.51 log M</td><td>103</td></tr>
<tr><td colspan="2">Approach noise level (EPNdB) All aeroplanes</td><td colspan="3">98</td><td colspan="2">86.03 + 7.75 log M</td><td colspan="3">105</td></tr>
<tr><td rowspan="3">Flyover noise levels (EPNdB)</td><td>2 engines or less</td><td colspan="4">89</td><td colspan="2">66.65 + 13.29 log M</td><td colspan="2">101</td></tr>
<tr><td>3 engines</td><td colspan="2">89</td><td colspan="4">69.65 + 13.29 log M</td><td colspan="2">104</td></tr>
<tr><td>4 engines or more</td><td>89</td><td colspan="5">71.65 + 13.29 log M</td><td colspan="2">106</td></tr>
</table>

4. CONDITIONS DESCRIBED IN CHAPTER 5, 5.4.1

<table>
<tr><th>M = Maximum take-off mass in 1 000 kg</th><th>0</th><th>34.0</th><th>358.9</th><th>384.7</th></tr>
<tr><td>Lateral noise level (EPNdB)</td><td>96</td><td colspan="2">85.83 + 6.64 log M</td><td>103</td></tr>
<tr><td>Approach noise level (EPNdB)</td><td>98</td><td colspan="2">87.83 + 6.64 log M</td><td>105</td></tr>
<tr><td>Flyover noise level (EPNdB)</td><td>89</td><td>63.56 + 16.61 log M</td><td colspan="2">106</td></tr>
</table>

5. CONDITIONS DESCRIBED IN CHAPTER 8, 8.4.1

M = Maximum take-off mass in 1 000 kg	0	0.788	80
Take-off noise level (EPNdB)	89	90.03 + 9.97 log M	109
Approach noise level (EPNdB)	90	91.03 + 9.97 log M	110
Overflight noise level (EPNdB)	88	89.03 + 9.97 log M	108

6. CONDITIONS DESCRIBED IN CHAPTER 10, 10.4

M = Maximum take-off mass in 1 000 kg	0	0.6	1.4
Noise level in dB(A)	76	83.23 + 32.67 log M	88

11/11/93

ATTACHMENT B. GUIDELINES FOR NOISE CERTIFICATION OF PROPELLER-DRIVEN STOL AEROPLANES

Note.— See Part II, Chapter 7.

Note 1.— For the purpose of these guidelines, STOL aeroplanes are those which, when operating in the short take-off and landing mode, consistent with the relevant airworthiness requirements, require a runway length (with no stopway or clearway) of not more than 610 m at maximum certificated mass for airworthiness.

Note 2.— These guidelines are not applicable to aircraft with vertical take-off and landing capabilities.

1. APPLICABILITY

The following guidelines should be applied to all propeller-driven aeroplanes of over 5 700 kg maximum certificated take-off mass intended for operation in the short take-off and landing (STOL) mode, requiring a runway* length, compatible with the relevant take-off and landing distance requirements, of less than 610 m at maximum certificated mass for airworthiness, and for which a certificate of airworthiness for the individual aeroplane was first issued on or after 1 January 1976.

2. NOISE EVALUATION MEASURE

The noise evaluation measure should be the effective perceived noise level in EPNdB as described in Appendix 2 to this volume of the Annex.

3. NOISE MEASUREMENT REFERENCE POINTS

The aeroplane, when tested in accordance with the flight test procedure of Section 6, should not exceed the noise levels specified in Section 4 at the following reference points:

a) *lateral noise reference point:* the point on a line parallel to, and 300 m from the runway centre line, or extended runway centre line, where the noise level is a maximum during take-off or landing, with the aeroplane operating in the STOL mode;

b) *flyover noise reference point:* the point on the extended centre line of the runway 1 500 m from the start of the take-off roll; and

c) *approach noise reference* point:* the point on the extended centre line of the runway 900 m from the runway threshold.

4. MAXIMUM NOISE LEVELS

The maximum noise level at any of the reference points, when determined in accordance with the noise evaluation method of Appendix 2, should not exceed 96 EPNdB in the case of aeroplanes with maximum certificated mass of 17 000 kg or less, this limit increasing linearly with the logarithm of mass at a rate of 2 EPNdB per doubling of mass in the case of aeroplanes having maximum certificated mass in excess of 17 000 kg.

5. TRADE-OFFS

If the maximum noise levels are exceeded at one or two measurement points:

a) the sum of any excesses should not be greater than 4 EPNdB;

b) any excess at any single point should not be greater than 3 EPNdB; and

c) any excesses should be offset by a corresponding reduction at the other point or points.

6. TEST PROCEDURES

6.1 The take-off reference procedure should be as follows:

* With no stopway or clearway.

a) the aeroplane should be at the maximum take-off mass for which noise certification is requested;

b) the propeller and/or engine speed (rpm) and engine power setting scheduled for STOL take-off should be used; and

c) throughout the take-off noise certification demonstration test, the airspeed, climb gradient, aeroplane attitude and aeroplane configuration should be those specified in the flight manual for take-off in the STOL mode.

6.2 The approach reference procedure should be as follows:

a) the aeroplane should be at the maximum landing mass for which the noise certification is requested;

b) throughout the approach noise certification demonstration test, the propeller and/or engine speed (rpm), engine power setting, airspeed, descent gradient, aeroplane attitude and aeroplane configuration should be those specified in the flight manual for STOL landing; and

c) the use of reverse thrust after landing should be the maximum specified in the flight manual.

7. ADDITIONAL NOISE DATA

Where so specified by the certificating authority, data permitting measured noise levels to be evaluated in terms of the A-weighted over-all sound pressure level (dB(A)) should be provided.

ATTACHMENT C. GUIDELINES FOR NOISE CERTIFICATION OF INSTALLED AUXILIARY POWER UNITS (APU) AND ASSOCIATED AIRCRAFT SYSTEMS DURING GROUND OPERATION

Note.— See Part II, Chapter 9.

1. INTRODUCTION

1.1 The following guidance material has been prepared for the information of States establishing noise certification requirements for installed auxiliary power units (APU) and associated aircraft systems used during normal ground operation.

1.2 It should apply to installed APU and associated aircraft systems in all aircraft for which application for a certificate of airworthiness for the prototype, or another equivalent prescribed procedure, is made on or after 26 November 1981.

1.3 For aircraft of existing type design, for which application for a change of type design involving the basic APU installation, or another equivalent prescribed procedure, is made on or after 26 November 1981, the noise levels produced by installed APU and associated aircraft systems should not exceed those existing prior to the change, when determined in accordance with the following guidelines.

2. NOISE EVALUATION PROCEDURE

The noise evaluation procedure should be according to the methods specified in Section 4.

3. MAXIMUM NOISE LEVELS

The maximum noise levels, when determined in accordance with the noise evaluation procedure specified in Section 4, should not exceed the following:

a) 85 dB(A) at the points specified in 4.4.2.2 a), b) and c);

b) 90 dB(A) at any point on the perimeter of the rectangle shown in Figure C-2.

4. NOISE EVALUATION PROCEDURES

4.1 General

4.1.1 Test procedures are described for measuring noise at specific locations (passenger and cargo doors, and servicing positions) and for conducting general noise surveys around aircraft.

4.1.2 Requirements are identified with respect to instrumentation, acoustic and atmospheric environment data acquisition, reduction and presentation, and such other information as is needed for reporting the results.

4.1.3 Procedures involve recording data on magnetic tape for subsequent processing. The use of tape-recorder time-integrating analyser systems avoids the need to average by eye the variations associated with manual readings from sound level meters and octave band analysers and therefore yields more accurate results.

4.1.4 No provision is made for predicting APU noise from basic engine characteristics, nor for measuring noise of more than one aircraft operating at the same time.

4.2 General test conditions

4.2.1 Meteorological conditions

Wind: not more than 19 km/h (10 kt).

Temperature: not less than 2°C nor more than 35°C.

Humidity: relative humidity not less than 30 per cent nor more than 90 per cent.

Precipitation: none.

Barometric pressure: not less than 800 hPa nor more than 1 100 hPa.

4.2.2 Test site

The ground between microphone and aircraft should be a smooth, hard surface. No obstructions should be present between aircraft and measurement positions and no reflecting surfaces (except the ground and aircraft) should be near enough to sound paths to significantly influence results. Surface of the ground surrounding the aircraft should be sensibly flat and level at least over an area formed by boundaries parallel to and 60 m beyond the outermost microphone array identified in 4.4.2.2 d).

4.2.3 Ambient noise

Ambient noise of the measurement system and test area (that is, composite of the noise due to environmental background and the electrical noise of the acoustic instrumentation) should be determined.

4.2.4 APU installation

Pertinent APU and associated aircraft systems should be tested for each aircraft model for which acoustic data are required.

4.2.5 Aircraft ground configuration

Aircraft flight control surfaces should be in the "neutral" or "clean" configuration, with gust locks on, or as stated in the aircraft's approved operating manual for aircraft undergoing servicing.

4.3 Instrumentation

4.3.1 Aircraft

Operation data identified in 4.5.3 should be determined from normal aircraft instruments and controls.

4.3.2 Acoustical

4.3.2.1 *General*

Instrumentation and measurement procedures should be consistent with requirements of latest applicable issues of appropriate standards listed in the references (see 4.6). All data samples should be at least 2.5 times the data reduction integration period which in no case should be less than 8 s. All sound pressure levels should be in decibels to a reference pressure of 20 μPa.

4.3.2.2 *Data acquisition systems*

Instrumentation systems for recording and analysis of noise, shown in the block diagram of Figure C-1, should meet the following specifications:

4.3.2.2.1 *Microphone system*

a) Over a frequency range of at least 45 Hz to 11 200 Hz the system should meet the requirements as outlined under microphone system specifications in the latest issue of reference 10 (see 4.6).

b) Microphones should be omnidirectional, vented for pressure equalization if of condenser type, and should have known ambient pressure and temperature coefficients. Microphone amplifier specifications should be compatible with those of the microphone and tape recorder.

c) Microphone wind screens should be employed when wind speed is in excess of 11 km/h (6 kt). Corrections as a function of frequency should be applied to measured data to account for the presence of microphone wind screens.

4.3.2.2.2 *Tape recorder*

The tape recorder may be direct record or FM and should have the following characteristics:

dynamic range of 50 dB minimum in the octave or one-third octave bands;

tape speed accuracy within ±0.2 per cent of rated speed;

wow and flutter (peak to peak) less than 0.5 per cent of tape speed;

maximum third harmonic distortion less than 2 per cent.

4.3.2.3 *Calibration*

4.3.2.3.1 *Microphone*

Frequency response calibration should be performed prior to the test series and a subsequent post-calibration should be performed within one month of the pre-calibration, with additional calibrations made when shock or damage is suspected. Response calibration should cover the range of at least 45 Hz to 11 200 Hz. Pressure response characteristics of the microphone should be corrected to obtain random incidence calibration.

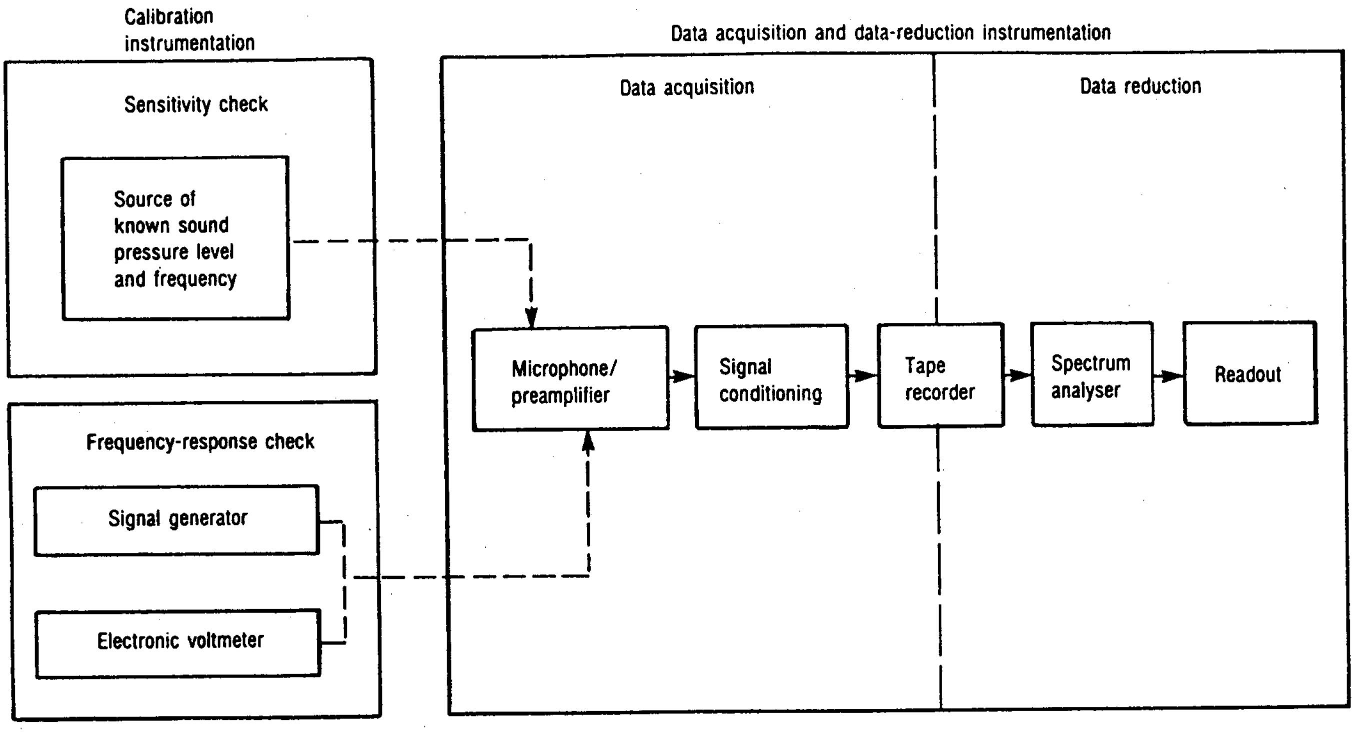


Figure C-1. Noise measurement systems

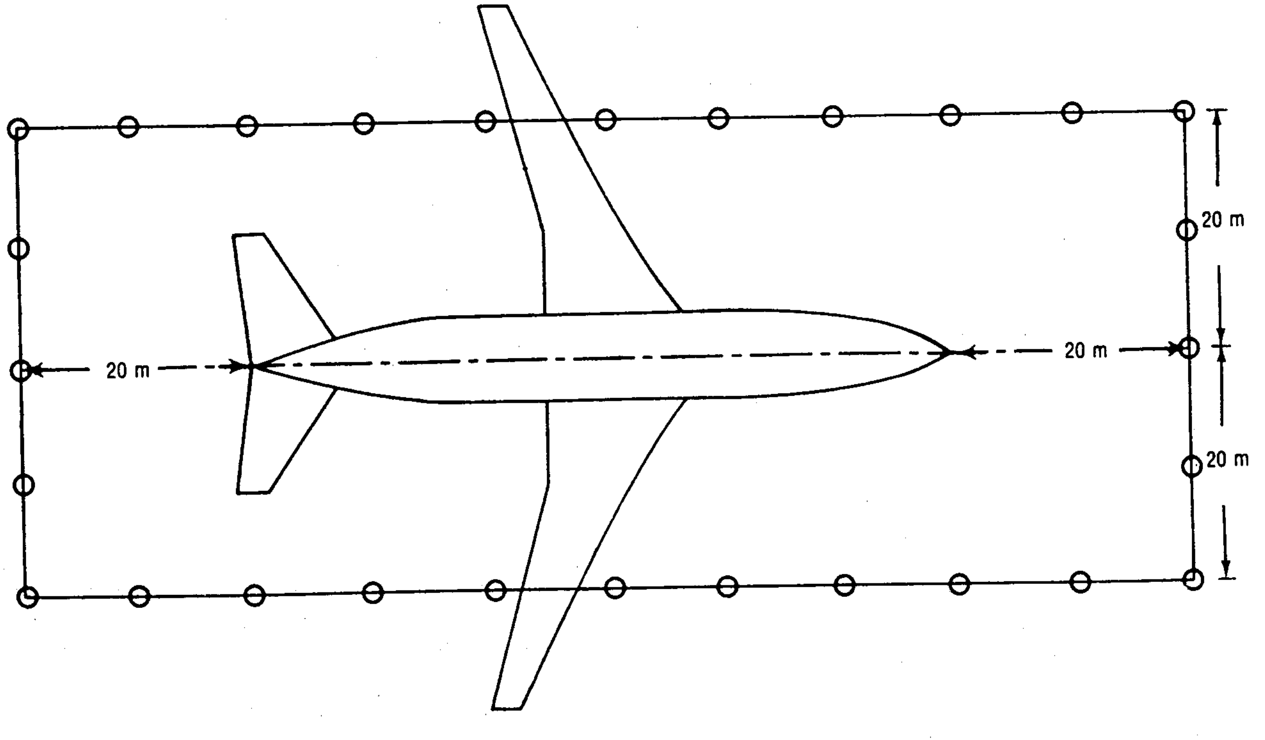


Figure C-2. Rectangle of noise survey measurement positions

4.3.2.3.2 *Recording system*

a) A calibration tape, a recording of broadband noise or a sweep of sinusoidal signals over a minimum frequency range of 45 Hz to 11 200 Hz should be recorded in the field or in the laboratory at the beginning and end of each test. The tape should also include signals at the frequencies employed during sound pressure sensitivity checks as defined below.

b) This calibration signal, an insert voltage, should be applied to the input and should include all signal conditioning preamplifiers, networks and recorder electronics used to record acoustic data. In addition, a "shorted input" (i.e. microphone pressure sensitive element replaced with equivalent electrical impedance) recording of at least 20 s should be made as a check on system dynamic range and noise floor.

c) Sound pressure sensitivity calibrations with the arrangements shown in Figure C-1 should be made in the field for each microphone prior to beginning and after completion of measurements each day. These calibrations should be made using a calibrator producing a known and constant-amplitude sound pressure level at one or more one-third octave band centre frequencies, specified in reference 11 in the frequency range from 45 Hz to 11 200 Hz. A barometric correction should be applied as required. Calibrators employed should be precise at least to within ±0.5 dB and should have a calibration obtained according to references 6 to 9 (see 4.6).

d) Each reel of tape should have comparable response and background noise to the calibration tape. A constant amplitude sine wave should be recorded at the start of each reel of tape, for reel-to-reel sound pressure sensitivity comparisons. The frequency of this sine wave should be within the same frequency range as used for sound pressure sensitivity checks. A separate voltage insert device or an acoustic calibrator may be used for this purpose. If an acoustic calibrator is used, it should be carefully "seated" and corrections for ambient pressure should be made so that effects of pressure on calibrator and microphone response are eliminated.

e) Battery-driven tape recorders should be checked at frequent intervals during a test to ensure good battery condition. Tape recorders should not be moved while recording is in progress unless it has been established that such movements will not change tape recorder characteristics.

4.3.2.3.3 *Data reduction equipment*

Data reduction equipment should be calibrated with electrical signals of known amplitude either at a series of discrete frequencies or with broadband signals covering the frequency range of 45 Hz to 11 200 Hz.

4.3.2.4 *Data reduction*

4.3.2.4.1 The data reduction system of Figure C-1 should provide one-third or one octave band sound pressure levels. Analyser filters should comply with requirements of reference 12 (Class II for octave band filters and Class III for one-third octave-band filters). Analyser amplitude resolution should be no worse than 0.5 dB; dynamic range should be a minimum of 50 dB between full scale and the root-mean-square (rms) value of the analyser noise floor in the octave band with the highest noise floor; and amplitude response over the upper 40 dB range should be linear to within ±0.5 dB.

4.3.2.4.2 Mean square sound pressures should be time averaged by integration of the squared output of frequency band filters over an integration interval that should be no less than 8 s. All data should be processed within the frequency range from 45 Hz to 11 200 Hz. Data should be corrected for all known or predictable errors, such as deviations of system frequency response from a flat response.

4.3.2.5 *Total system*

4.3.2.5.1 In addition to specifications for component systems, frequency response of the combined data acquisition and reduction system should be flat within ±3 dB over the frequency range from 45 Hz to 11 200 Hz. Frequency response gradient anywhere within this range should not exceed 5 dB per octave.

4.3.2.5.2 Amplitude resolution should be at least 1.0 dB. Dynamic range should be a minimum of 45 dB between full scale and the rms value of the system noise floor in the frequency band with the highest noise floor. Amplitude response should be linear within ±0.5 dB over the upper 35 dB in each frequency band.

4.3.3 Meteorological

The wind speed should be measured with a device having a range of at least 0 to 28 km/h (0-15 kt) with an accuracy of at least ±2 km/h (±1 kt). Temperature measurements should be made with a device having a range of at least 0°C to 40°C with an accuracy of at least ±0.5°C. Relative humidity should be measured with a device having a range of 0 to 100 per cent with an accuracy of at least ±5 percentage points. Atmospheric pressure should be measured with a device having a range of at least 800 to 1 100 hPa with an accuracy of at least ±3 hPa.

4.4 Test procedure

4.4.1 Test conditions

4.4.1.1 Ambient noise measurements should be made in sufficient number to be representative for all acoustic measurement stations, providing correction data to apply to measured APU noise where necessary (see 4.4.4).

4.4.1.2 The installed APU should meet the noise levels specified in 3.1 at the points specified under typical loads, up to and including those imposed by the electric power generator and air-conditioning units and any other associated systems at their normal maximum continuous ground operation power requirements.

Note.— A measurement of noise from a particular model of auxiliary power unit installed in a specific aircraft type should not be deemed typical of the same equipment installed in other aircraft types nor of other models of APU installed in the same aircraft type.

4.4.2 Acoustical measurement locations

4.4.2.1 Except where specified otherwise, noise measurements should be made with microphones at 1.6 m ±0.025 m (5.25 ft ±1.0 in) above the ground or surface where passengers or servicing personnel may stand, with the microphone diaphragm parallel to the ground and facing upwards.

4.4.2.2 Locations for measuring noise should be as follows:

a) *cargo door locations:* measurements should be made at each cargo door location, with the door open, while the aircraft is in a typical ground handling configuration. These measurements should be taken at the centre of the opening, in the plane of the fuselage skin;

b) *passenger door locations:* measurements should be made at each passenger entry door, with the door open, on the vertical centre line of the opening, in the plane of the fuselage skin;

c) *servicing locations:* measurements should be made at all servicing positions where persons are normally working during aircraft ground handling operations, these positions to be determined by reference to the approved aircraft operating and service manuals;

d) *survey locations:* appropriate measurement positions should be chosen along the sides of a rectangle centred on the test aircraft as illustrated in Figure C-2. The distance between measurement positions should not be greater than 10 m for large aircraft. This distance may be reduced to accommodate small aeroplanes or to fulfil special requirements.

4.4.3 Meteorological measurement locations

Meteorological data should be measured at a location at the test site within the microphone array of Figure C-2, but upwind of the aircraft and at a height of 1.6 m (5.25 ft) above ground level.

4.4.4 Data presentation

4.4.4.1 A-weighted sound levels should be calculated by applying frequency weighting corrections derived from the standards for precision sound level meters (reference 10) to one-third or one octave band sound pressure levels. The one octave band sound pressure levels may be determined from a summation of mean-square sound pressures in appropriate one-third octave bands. Over-all sound pressure levels should be determined from a summation of mean-square sound pressures in the 24 one-third octave, or 8 one octave, frequency bands included in the frequency range from 45 Hz to 11 200 Hz.

4.4.4.2 Over-all sound pressure levels, A-weighted sound levels and one-third or one octave band data should be presented to the nearest decibel (dB) in tabular form, with supplementary graphical presentations as appropriate. Sound pressure levels should be corrected, if necessary, for the presence of high ambient noise. No corrections are needed if a sound pressure level is 10 dB or more above ambient noise. For sound pressure levels between 3 and 10 dB above ambient noise, measured values should be corrected for ambient noise by logarithmic subtraction of levels. If sound pressure levels do not exceed ambient noise by as much as 3 dB, the measured values may be adjusted by means of a method agreed to by the certificating authority.

4.4.4.3 Acoustical data need not be normalized for atmospheric absorption losses. Test results should be reported under the actual test-day meteorological conditions.

4.5 Data reporting

4.5.1 Identification information

a) Test location, date and time of test.

b) Manufacturer and model of the APU and pertinent associated equipment.

c) Aircraft type, manufacturer, model and air registry number.

d) Plan and elevation views, as appropriate, of the aircraft outline showing location of the APU (including inlet and exhaust ports), all associated equipment, and all acoustical measurement stations.

4.5.2 Test site description

a) Type and location of ground surfaces.

b) Location and extent of any above-ground-level reflective surfaces, such as buildings or other aircraft, that might have been present in spite of the precautions noted in 4.2.2.

4.5.3 Meteorological data *(for each test condition)*

a) Wind speed, km/h (kt) and direction, degrees, relative to aircraft centre line (forward 0°).

b) Ambient temperature °C.

c) Relative humidity, per cent.

d) Barometric pressure, hPa.

4.5.4 Operational data *(for each test condition)*

a) Number of air conditioning packs operated and their locations.

b) APU shaft speed(s), rpm or percentage of normal rated.

c) APU normal rated shaft speed, rpm.

d) APU shaft load (kW), horse-power and/or electric power output, kVA.

e) Pneumatic load, kg/min delivered by APU to all pneumatically operated aircraft systems during the test (calculated as required).

f) Temperature of APU exhaust gas at location specified in aircraft's approved operations manual, °C.

g) Operating mode of environmental control system, cooling or heating.

h) Air conditioning distribution system supply duct temperature, °C.

i) Events occurring during the test which may have influenced the measurements.

4.5.5 Instrumentation

a) A brief description (including manufacturer and type or model numbers) of the acoustical and meteorological measuring instruments.

b) A brief description (including manufacturer and type or model numbers) of the data acquisition and data processing systems.

4.5.6 Acoustical data

a) Ambient noise.

b) Acoustical data specified in 4.4.4 with a description of corresponding microphone locations.

c) List of standards used and description and reason for any deviations.

4.6 References

Related standard for instruments and measurement procedures

1. *International Electrotechnical Vocabulary,* 2nd Edition, IEC-50(08) (1960).
2. *Acoustic Standard Tuning Frequency,* ISO-16.
3. *Expression of the Physical and Subjective Magnitudes of Sound or Noise,* ISO-131 (1959).
4. *Acoustics — Preferred Reference Quantities for Acoustic Levels,* ISO DIS 1638.2.
5. *Guide to the Measurement of Acoustical Noise and Evaluation of its Effects on Man,* ISO-2204 (1973).
6. *Precision Method for Pressure Calibration of One-inch Standard Condenser Microphone by the Reciprocity Technique,* IEC-327 (1971).
7. *Precision Method for Free Field Calibration of One-inch Standard Condenser Microphone by the Reciprocity Technique,* IEC-486 (1974).
8. *Values for the Difference between Free Field and Pressure Sensitivity Levels for One-inch Standard Condenser Microphone,* IEC-655 (1979).
9. *Simplified Method for Pressure Calibration of One-inch Standard Condenser Microphone by the Reciprocity Technique,* IEC-402 (1972).
10. *IEC Recommendations for Sound Level Meters,* International Electrotechnical Commission, IEC 651 (1979).
11. *ISO Recommendations for Preferred Frequencies for Acoustical Measurements,* International Organization for Standardization, ISO/R266-1962(E).
12. *IEC Recommendations for Octave, Half-Octave and Third-Octave Band Filters Intended for the Analysis of Sounds and Vibrations,* International Electrotechnical Commission, IEC 225 (1966).

Note.— The texts and specifications of these publications, as amended, are incorporated by reference into this attachment.

IEC publications may be obtained from:

Bureau central de la Commission
électrotechnique internationale
1 rue de Varembé
Geneva, Switzerland

ISO publications may be obtained from:

International Organization for Standardization
1 rue de Varembé
Geneva, Switzerland

or from State ISO member bodies.

11/11/93

ATTACHMENT D. GUIDELINES FOR EVALUATING AN ALTERNATIVE METHOD OF MEASURING HELICOPTER NOISE DURING APPROACH

Note.— The approach reference procedure of 8.6.4.1 specifies a single approach path angle. This can coincide with the impulsive noise regime for some helicopters and not for others. In order that alternative methods of establishing compliance may be evaluated, States are encouraged to undertake additional measurements as described below.

1. INTRODUCTION

The following guidance material has been prepared for the use of States when obtaining additional information on which a future revision of the approach test procedures of Chapter 8 may be based.

2. APPROACH NOISE EVALUATION PROCEDURE

When conducting such tests the provisions of Chapter 8 shall be observed except as follows.

2.1 Approach reference noise measurement points

A flight path reference point located on the ground 120 m (395 ft) vertically below the flight paths defined in the approach reference procedure. On level ground this corresponds to the following positions:

2 290 m from the intersection of the 3° approach path with the ground plane

1 140 m from the intersection of the 6° approach path with the ground plane

760 m from the intersection of the 9° approach path with the ground plane.

2.2 Maximum noise levels

At the approach flight path reference point: the noise level to be calculated by taking the arithmetical average of the corrected levels for 3°, 6°, and 9° approaches.

2.3 Approach reference procedure

The approach reference procedure shall be established as follows:

a) the helicopter shall be stabilized and following approach paths of 3°, 6°, and 9°;

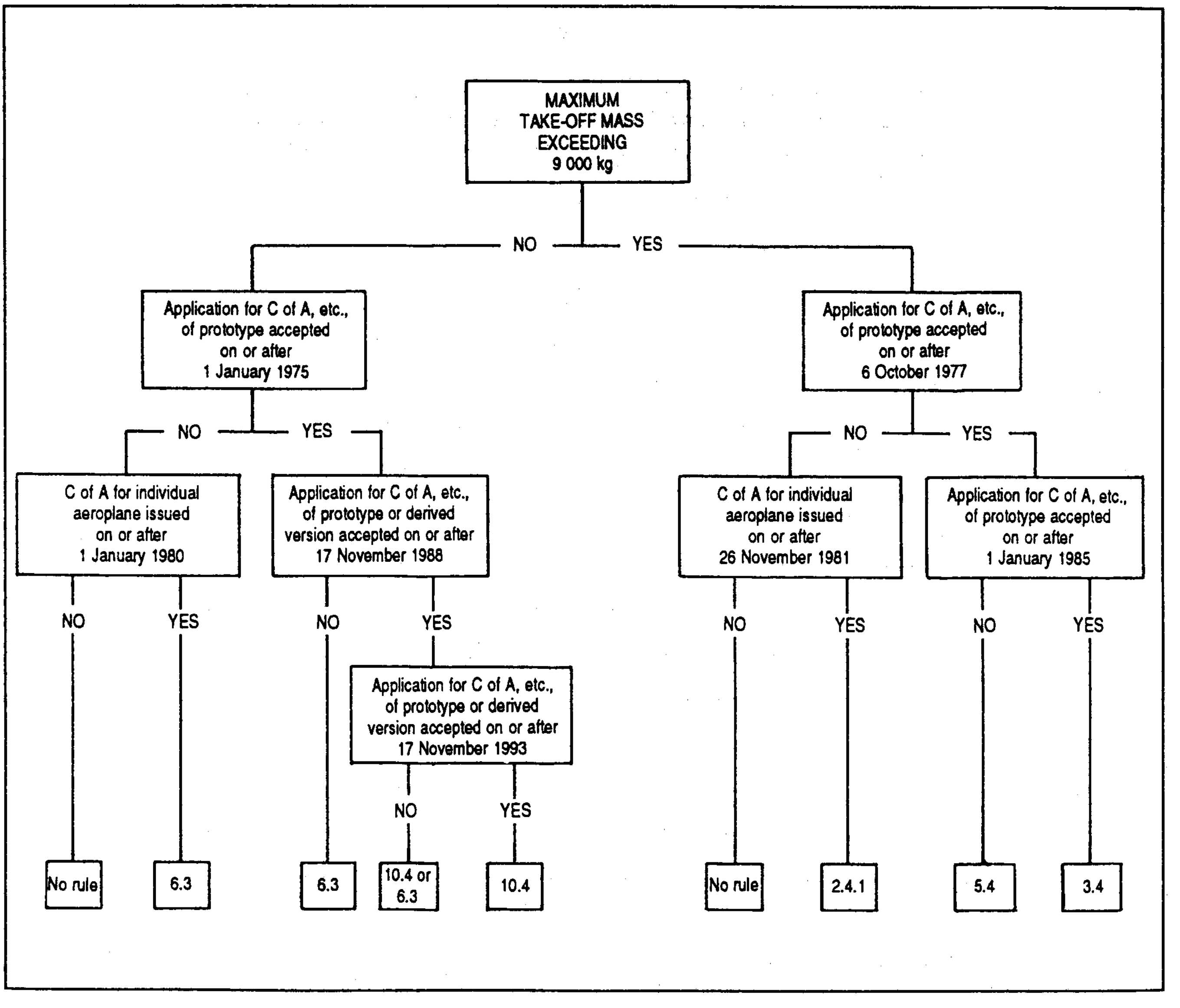
b) the approach shall be made at a stabilized airspeed equal to the best rate of climb speed V_y, or the lowest approved speed for the approach, whichever is the greater, with power stabilized during the approach and over the flight path reference point, and continued to a normal touchdown;

c) the approach shall be made with the rotor speed stabilized at the maximum normal operating rpm certificated for approach;

d) the constant approach configuration used in airworthiness certification tests, with the landing gear extended, shall be maintained throughout the approach reference procedure; and

e) the mass of the helicopter at touchdown shall be the maximum landing mass at which noise certification is requested.

ATTACHMENT E. APPLICABILITY OF ICAO ANNEX 16 NOISE CERTIFICATION STANDARDS FOR PROPELLER-DRIVEN AEROPLANES*



* These standards do not apply to aeroplanes specifically designed for aerobatic purposes or agricultural or fire fighting uses or to self-sustaining powered sailplanes.

— END —

SUPPLEMENT TO ANNEX 16 — ENVIRONMENTAL PROTECTION

Volume I — Aircraft Noise

Third Edition

Differences between the national regulations and practices of Contracting States and the corresponding International Standards and Recommended Practices contained in Annex 16, Volume I as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

DECEMBER 1994

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT

No.	*Date*	*Entered by*	*No.*	*Date*	*Entered by*

AMENDMENTS TO ANNEX 16, VOLUME I ADOPTED OR APPROVED BY THE COUNCIL SUBSEQUENT TO THE THIRD EDITION ISSUED JULY 1993

No.	*Date of adoption or approval*	*Date applicable*	*No.*	*Date of adoption or approval*	*Date applicable*

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards of Annex 16, Volume I, Third Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
Canada	13/7/93	1	31/12/94
France	18/11/93	1	31/12/94
Germany	21/2/94	1	31/12/94
Netherlands, Kingdom of the	25/10/93	1	31/12/94
New Zealand	19/10/93	1	31/12/94
Russian Federation	30/9/93	1	31/12/94
Saudi Arabia	25/7/93	1	31/12/94
United States	26/7/93	5	31/12/94
Vanuatu	2/8/93	1	31/12/94

2. Contracting States which have notified ICAO that no differences exist

State	*Date of notification*	*State*	*Date of notification*
Argentina	2/9/93	Jordan	17/10/93
Australia	2/8/93	Namibia	27/7/93
Barbados	25/5/93	Norway	12/10/93
Chile	26/10/93	Portugal	12/1/94
Cyprus	5/10/93	Qatar	22/6/93
Denmark	12/10/93	Singapore	16/9/93
Egypt	25/7/93	Turkey	24/6/93
Finland	28/4/93	Ukraine	22/7/93
Iceland	31/10/94	Uruguay	19/10/93
Ireland	10/10/93		

3. Contracting States from which no information has been received

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Armenia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Colombia
Comoros
Congo
Cook Islands
Costa Rica
Côte d'Ivoire
Croatia
Cuba
Czech Republic
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Ecuador
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Fiji
Gabon
Gambia
Georgia
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
India
Indonesia
Iran, Islamic Republic of
Iraq
Israel
Italy
Jamaica
Japan
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Lithuania
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Micronesia, Federated States of
Monaco
Mongolia
Morocco
Mozambique
Myanmar
Nauru
Nepal
Nicaragua
Niger
Nigeria
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Poland
Republic of Korea
Republic of Moldova
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
Slovakia
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syrian Arab Republic
Tajikistan
Thailand
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkmenistan
Uganda
United Arab Emirates
United Kingdom
United Republic of Tanzania
Uzbekistan
Venezuela
Viet Nam
Yemen
Zaire
Zambia
Zimbabwe

31/12/94

4. **Paragraphs with respect to which differences have been notified**

Paragraph	*Differences notified by*
General	Canada
	France
	Germany
	United States
	United States
	Russian Federation
	Saudi Arabia
	Vanuatu
PART II	
Chapter 1	
General	Netherlands, Kingdom of the
1.2	New Zealand
1.3	Germany
1.5	New Zealand
1.6	New Zealand
1.7	Germany
Chapter 2	
2.1.1	United States
2.3.1	United States
2.4.2	United States
2.4.2.2	United States
2.5.1	United States
2.6.1.1	United States
Chapter 3	
3.1.1	Canada
	United States
3.3.2.2	United States
3.6.2.1	United States
3.7.4	United States
Chapter 4	
General	Canada
	Netherlands, Kingdom of the
Chapter 5	
5.1.1	United States
Chapter 6	
6.1.1	Canada
	Germany
	United States
6.3.1	Canada
	Germany
6.5.3	Germany
Chapter 7	
General	Canada
Chapter 8	
8.1.1	United States
8.6.3.1	United States
8.6.4	United States
8.7.4	United States
8.7.5	United States
8.7.6	United States
8.7.8	United States

Paragraph	*Differences notified by*
Chapter 9	
General	Canada
Chapter 10	
General	Canada
	Netherlands, Kingdom of the
	United States
10.1.1	Germany
	United States
10.4	Germany
	United States
10.5.2	Germany
Chapter 11	
General	Netherlands, Kingdom of the
11.1	United States
11.6	United States
PART V	
General	United States
Appendix 1	
General	Netherlands, Kingdom of the
	United States
2.2.1	United States
2.2.2	United States
2.2.3	United States
2.3.4	United States
2.3.5	United States
Appendix 2	
General	Canada
	Netherlands, Kingdom of the
2.2.1	United States
2.2.2	United States
3.2.6	United States
3.4.5	United States
3.5.2	United States
9.1.2	United States
9.1.3	United States
Appendix 3	
General	Canada
	Netherlands, Kingdom of the
4.2.1.1	Germany
4.3.1	Germany
Appendix 4	
General	Netherlands, Kingdom of the
5.2	United States
Appendix 5	
General	Netherlands, Kingdom of the
Appendix 6	
General	Canada
General	Netherlands, Kingdom of the
4.4.1	United States

General The applicable noise emission Standards of Annex 16, Chapters 2, 3, 5, 6, 8 and 10 apply:

1) in respect of issuance of new or amended type approvals (type certifications) for aeroplanes after 31 December 1985 and in respect of application for new or amended type approvals for helicopters after 31 December 1988; or

2) for aircraft that were first registered on the Canadian Register, for aeroplanes after 31 December 1985 and for helicopters after 31 December 1988 and are type designs that had previously been noise tested and found in compliance.

PART II

Chapter 3

3.1.1 c) Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

Chapter 4 Not adopted.

Chapter 6

6.1.1 Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

6.3.1 Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

Chapter 7 Not adopted.

Chapter 9 Not adopted.

Chapter 10

10.1.1 Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

10.4 Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

Appendix 2 Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

Appendix 3 Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

Appendix 6 Maximum certificated take-off mass for propeller-driven aeroplanes is reduced from 9 000 kg to 8 618 kg (19 000 lb).

FRANCE

General France has drawn up the following timetable for the implementation of the provisions introduced by Amendment 4:

Part II, Chapters 3, 5, 6 and 8 and Appendix 2: first half of 1994
Part II, Chapters 10 and 11: second half of 1994.

At the conclusion of this timetable, the rules and procedures in France will be in conformity with Annex 16, Volume I, including Amendment 4.

31/12/94

GERMANY

General In addition to the following differences, minor deviations may be introduced into the German Regulations. However, these deviations will be less significant than those listed below.

PART II

Chapter 1

1.3 The document contains additional information such as muffler type, noise requirements, 90 per cent confidence level(s), noise limit(s).

1.7 The applicability of noise standards is determined by the date of application for registration.

Chapter 6

6.1.1 Applicable also to powered sailplanes.

6.3.1 The maximum noise level when determined in accordance with the noise evaluation method of Appendix 3 shall not exceed the following:

a 64 dB(A) constant limit up to an aeroplane mass of 600 kg, varying linearly with mass from that point to 1 500 kg, after which the limit is constant at 76 dB(A) up to 9 000 kg.

6.5.3 "Highest power in the normal operating range" has been replaced by "maximum continuous power".

Chapter 10

10.1.1 Applicable also to powered sailplanes.

10.4 The maximum noise level determined in accordance with the noise evaluation method of Appendix 6 shall not exceed the following:

a 68 dB(A) constant limit up to an aeroplane mass of 500 kg, varying linearly with mass from that point to 1 500 kg, after which the limit is constant at 85 dB(A) up to 9 000 kg.

10.5.2 If the reference height of the aeroplane over the microphone exceeds 450 m, the distance between the reference noise measurement point and the start of take-off roll has to be reduced.

Appendix 3

4.2.1.1 "Highest power in the normal operating range" has been replaced by "maximum continuous power". See also 6.5.3.

4.3.1 The measuring point shall be overflown at least six times.

31/12/94

NETHERLANDS, KINGDOM OF THE

PART II *General Note.— The Kingdom of the Netherlands will have complied with the provisions of Chapters 3, 6, 8, 10 and 11 and Appendices 2, 3, 4 and 6 by late 1994 or early 1995.*

Chapter 1 No noise certificate is issued.

Chapter 4 Not applied.

Chapter 10 Not applied.

Chapter 11 Not applied.

Appendix 1 Not applied.

Appendix 2 Not applied.

Appendix 3 Not applied.

Appendix 4 Not applied.

Appendix 5 Not applied.

Appendix 6 Not applied.

31/12/94

NEW ZEALAND

PART II

Chapter 1

1.2, 1.5, 1.6 New Zealand has Civil Aviation Regulations providing for the issue of requirements for noise certification of aircraft. However, as yet the actual requirements for the granting or validation of noise certification have not been issued.

31/12/94

RUSSIAN FEDERATION

General Work is presently under way in the Russian Federation on the preparation of new national standards (aviation regulations) for local aircraft noise which take into account the provisions of Annex 16, Volume I, including Amendment 4. It is intended to put these regulations into effect within the next six months, after which the Russian Federation will submit the required notification of differences.

31/12/94

SAUDI ARABIA

General The provisions of Annex 16, Volume I have not been incorporated in the national regulations because aircraft noise is not considered a significant problem in the Kingdom of Saudi Arabia. Adoption of noise emission standards in the national regulations will be considered if the need arises.

31/12/94

General In addition to the differences detailed below, minor deviations may be identified with respect to incorporated references, nomenclature and tolerances. These minor deviations are considered to be acceptable in the context of approved equivalent procedures and are less significant than the table differences.

PART II

Chapter 2

2.1.1 For type design change applications made after 14 August 1989, if an aeroplane is a Stage 3 aeroplane prior to a change in type design, it must remain a Stage 3 aeroplane after the change in type design regardless of whether Stage 3 compliance was required before the change in type design.

2.3.1 a) Sideline noise is measured along a line 450 m from and parallel to the extended runway centre line for two- and three-engine aircraft; for four-engine aircraft, the sideline distance is 0.35 NM.

2.4.2 Noise level limits for Stage 2 derivative aircraft depend upon whether the engine by-pass ratio is less than two. If it is, the Stage 2 limits apply. Otherwise, the limits are the Stage 3 limits plus 3 dB or the Stage 2 value, whichever is lower.

2.4.2.2 b) Take-off noise limits for three-engine, Stage 2 derivative aeroplanes with a by-pass ratio equal to or greater than 2 are 107 EPNdB for maximum weights of 385 000 kg (850 000 lb) or more, reduced by 4 dB per halving of the weight down to 92 EPNdB for maximum weights of 28 700 kg (63 177 lb) or less. Aircraft with a by-pass ratio less than 2 only need meet the Stage 2 limits.

2.5.1 Trade-off sum of excesses not greater than 3 EPNdB and no excess greater than 2 EPNdB.

2.6.1.1 For aeroplanes that do not have turbo-jet engines with a by-pass ratio of 2 or more, the following apply:

a) four-engine aeroplanes — 214 m (700 ft);

b) all other aeroplanes — 305 m (1 000 ft).

For all aeroplanes that have turbo-jet engines with a by-pass ratio of two or more, the following apply:

a) four-engine aeroplanes — 210 m (689 ft);

b) three-engine aeroplanes — 260 m (853 ft);

c) aeroplanes with fewer than three engines — 305 m (1 000 ft).

The power may not be reduced below that which will provide level flight for an engine inoperative or that will maintain a climb gradient of at least 4 per cent, whichever is greater.

Chapter 3

3.1.1 For type design change applications made after 14 August 1989, if an aeroplane is a Stage 3 aeroplane prior to a change in type design, it must remain a Stage 3 aeroplane after the change in type design regardless of whether Stage 3 compliance was required before the change in type design.

3.3.2.2 A minimum of two microphones symmetrically positioned about the test flight track must be used to define the maximum sideline noise. This maximum noise may be assumed to occur where the aircraft reaches 305 m (1 000 ft).

3.6.2.1 c) The test day speed and the reference speed must be the minimum approved value of V_2 + 10 kt. Test speeds shall be within ±3 kt of that value.

3.7.4 If a take-off test series is conducted at weights other than the maximum take-off weight for which noise certification is requested:

a) at least one take-off test must be at or above that maximum weight;

b) each take-off test weight must be within +5 or −10 per cent of the maximum weight.

If an approach test series is conducted at weights other than the maximum landing weight for which certification is requested:

a) at least one approach test must be conducted at or above that maximum weight;

b) each test weight must exceed 90 per cent of the maximum landing weight.

Total EPNL adjustment for variations in approach flight path from the reference flight path and for any difference between test engine thrust or power and reference engine thrust or power must not exceed 2 EPNdB.

Chapter 5

5.1.1 Applies to all large transport category aircraft (as they do to all subsonic turbo-jet aircraft regardless of category). Commuter category aircraft, propeller-driven aeroplanes below 8 640 kg (19 000 lb) are subject to FAR Part 36, Appendix F or to Appendix G, depending upon the date of completion of the noise certification tests.

Chapter 6

6.1.1 Applies to new, all propeller-driven aeroplane types below 19 000 lb (8 640 kg) in the normal, commuter, utility, acrobatic, transport or restricted categories for which the noise certification tests are completed before 22 December 1988.

Chapter 8

General FAR 36.1(g) defines Stage 1 and Stage 2 noise levels and Stage 1 and Stage 2 helicopters. These definitions parallel those used in FAR Part 36 for turbo-jets and are used primarily to simplify the acoustical change provisions in 36.11.

FAR 36.805(c) provides for certain derived versions of helicopters for which there are no civil prototypes to be certificated above the noise level limits.

8.1.1 a) Applicable to new helicopter types for which application for an original type certificate was made on or after 6 March 1988.

8.1.1 b) Applicable only to "acoustical changes" for which application for an amended or supplemental type certificate was made on or after 6 March 1988.

8.6.3.1 b) Does not include the V_{NE} speeds.

8.6.3.1, Note No equivalent provision.

8.6.4 The helicopter reference approach path shall follow a 6° ± 0.5° descent angle.

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8.7.4 No equivalent requirement.

8.7.5 EPNL correction must be less than 2.0 EPNdB for any combination of lateral deviation, height, approach angle and, in the case of flyover, thrust or power.

Corrections to the measured data are required if the tests were conducted below the reference weight.

Corrections to the measured data are required if the tests were conducted at other than reference engine power.

8.7.6 The rotor speed must be maintained within one per cent of the normal operating RPM.

8.7.8 The helicopter shall fly within ±10° from the zenith for approach and take-off, but within ±5° from the zenith for horizontal flyover.

Chapter 10

General Exception from acoustical change rule given for aircraft with flight time prior to 1 January 1955 and land configured aircraft reconfigured with floats or skis.

10.1.1 Applies to new, amended or supplemental type certificates for propeller-driven aeroplanes not exceeding 8 640 kg (19 000 lb) for which noise certification tests have not been completed before 22 December 1988.

10.4 The maximum noise level is a constant 73 dBA up to 600 kg (1 320 lb). Above that weight, the limit increases at the rate of 1 dBA/75 kg (1 dBA/165 lb) up to 85 dBA at 1 500 kg (3 300 lb) after which it is constant up to and including 8 640 kg (19 000 lb).

Chapter 11

11.1 FAR Appendix J was effective 11 September 1992 and applies to those helicopters for which application for a type certificate was made on or after 6 March 1986.

11.6 FAR J36.105(c) requires an adjustment to the reference airspeed prescribed in 11.5.2 such that each flyover test is conducted at the same advancing blade tip Mach number as associated with reference conditions. Chapter 11 does not contain a similar provision.

FAR J36.105(b)(2) prescribes a ±15 metre limitation on the allowed vertical deviation about the reference flight path during the flyover test procedure. Chapter 11 does not have a similar requirement.

PART V

General No comparable provision exists in United States Federal Regulations. Any local airport proprietor may propose noise abatement operating procedures to the FAA which reviews them for safety and appropriateness.

Appendix 1

General Sections 3, 8 and 9 of Appendix 1 which contain the technical specifications for equipment, measurement and analysis and data correction for Chapter 2 aircraft and their derivatives differ in many important aspects from the corresponding requirements in Appendix 2 which has been updated several times. Part 36 updates have generally paralleled those of Appendix 2 of Annex 16. These updated requirements are applicable in the United States to both Stage 2 and Stage 3 aircraft and their derivatives.

2.2.1 A minimum of two microphones symmetrically positioned about the test flight track must be used to define the maximum sideline noise. This maximum noise may be assumed to occur where the aircraft reaches 305 m (1 000 ft), except for four-engine, Stage 2 aircraft for which 439 m (1 440 ft) may be used.

2.2.2 No obstructions in the cone defined by the axis normal to the ground and the half-angle 80° from the axis.

2.2.3 c) Relative humidity and ambient temperature over the sound path between the aircraft and 10 m above the ground at the noise measuring site is such that the sound attenuation in the 8 kHz one-third octave band is not greater than 12 dB/100 m and the relative humidity is between 20 and 95 per cent. However, if the dew point and dry bulb temperature used for obtaining relative humidity are measured with a device which is accurate to within one-half a degree Celsius, the sound attenuation rate shall not exceed 14 dB/100 m in the 8 kHz one-third octave band.

2.2.3 d) Test site average wind not above 12 kt and average cross-wind component not above 7 kt.

2.3.4 The aircraft position along the flight path is related to the recorded noise 10 dB downpoints.

2.3.5 At least one take-off test must be a maximum take-off weight and the test weight must be within +5 or −10 per cent of maximum certificated take-off weight.

Appendix 2

2.2.1 A minimum of two symmetrically placed microphones must be used to define the maximum sideline noise at the point where the aircraft reaches 305 m.

2.2.2 When a multiple layering calculation is required, the atmosphere between the aeroplane and the ground shall be divided into layers. These layers are not required to be of equal depth and the maximum layer depth must be 100 m.

2.2.2 c) Part 36 imposes a limit of 14 dB/100 m in the 8 kHz one-third octave band when the temperature and dew point are measured with a device which is accurate to within one-half a degree Celsius.

3.2.6 No equivalent requirement.

3.4.5 For each detector/integrator the response to a sudden onset or interruption of a constant sinusoidal signal at the respective one-third octave band centre frequency must be measured at sampling times 0.5, 1.0, 1.5 and 2.0 seconds after the onset or interruption. The rising responses must be the following amounts before the steady-state level:

0.5 seconds: 4.0 ± 1.0 dB
1.0 seconds: 1.75 ± 0.75 dB
1.5 seconds: 1.0 ± 0.5 dB
2.0 seconds: 0.6 ± 0.5 dB

3.5.2 No equivalent requirement.

9.1.2, 9.1.3 If the correction factor exceeds 8 dB on take-off or 4 dB on approach, or the correction results in a final EPNL value which is within 1.0 dB of the noise level limits, the "integrated" method must be used. Note that there is no stated requirement for the use of the "integrated" procedure on sideline and the 1.0 dB test is not tied to the amount of the adjustment on take-off.

Appendix 4

5.2 FAR J36.205(c) requires an adjustment to account for the difference in duration between the reference airspeed and the adjusted reference airspeed prescribed in FAR J36.105(c). Appendix 4 does not contain a similar provision.

Appendix 6

4.4.1 The microphone performance, not its dimensions, is specified. The microphone must be mounted 1.2 m (4 ft) above ground level. A windscreen must be employed when the wind speed is in excess of 9 km/h (5 kt).

VANUATU

General While we do not disapprove of any of the amendments, we are not in a position to make a statement that differences will or will not exist on a certain date between the Vanuatu regulations and the Provisions of Annex 16, Volume I.

The Vanuatu Civil Aviation Directorate has been restructured and it is planned that as a result of this restructuring the necessary expertise will be available in approximately 12 months to commence a rewrite of the Vanuatu Civil Aviation Regulations. The rewrite will attempt to harmonize our regulations for the application of ICAO Standards with other States in the region.

As each part of our regulations is rewritten, we will advise you of any difference that may exist between our national rules and ICAO Standards.

INTERNATIONAL STANDARDS
AND RECOMMENDED PRACTICES

ENVIRONMENTAL PROTECTION

ANNEX 16

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

VOLUME II

AIRCRAFT ENGINE EMISSIONS

SECOND EDITION — 1993

This edition incorporates all amendments to Annex 16 adopted by the Council prior to 25 March 1993 and supersedes on 11 November 1993 all previous editions of the Annex.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword and the relevant clauses in each Chapter.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments in announced in the *ICAO Journal* and in the monthly supplements to the *Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-2	Incorporated in this Edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

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FOREWORD

Historical background

In 1972 the United Nations Conference on the Human Environment was held in Stockholm. The position of ICAO at this Conference was developed in Assembly Resolution A18-11 which contained the following clause among others:

> "2. in fulfilling this role ICAO is conscious of the adverse environmental impact that may be related to aircraft activity and its responsibility and that of its member States to achieve maximum compatibility between the safe and orderly development of civil aviation and the quality of the human environment;"

The 18th Assembly also adopted Resolution A18-12 relating to the environment which states:

> "THE ASSEMBLY:
>
> 1. REQUESTS the Council, with the assistance and co-operation of other bodies of the Organization and other international organizations to continue with vigour the work related to the development of Standards, Recommended Practices and Procedures and/or guidance material dealing with the quality of the human environment;"

This resolution was followed up by the establishment of an ICAO Action Programme Regarding the Environment. As part of this Action Programme a Study Group was established to assist the Secretariat in certain tasks related to aircraft engine emissions. As a result of the work of this Study Group, an ICAO Circular entitled *Control of Aircraft Engine Emissions* (Circular 134) was published in 1977. This Circular contained guidance material in the form of a certification procedure for the control of vented fuel, smoke and certain gaseous emissions for new turbo-jet and turbofan engines intended for propulsion at subsonic speeds.

It was agreed by the Council that the subject of aircraft engine emissions was not one that was solely confined to objective technical issues but was one that needed consideration by experts in many fields and included the direct views of Member States. A Council committee, known as the Committee on Aircraft Engine Emissions (CAEE) was therefore established in 1977 to pursue a number of aspects of the subject.

At the second meeting of the Committee on Aircraft Engine Emissions, held in May 1980, proposals were made for material to be included in an ICAO Annex. After amendment following the usual consultation with Member States of the Organization, the proposed material was adopted by the Council to form the text of this document. The Council agreed that it was desirable to include all provisions relating to environmental aspects of aviation in one Annex. It therefore renamed Annex 16 as "Environmental Protection", making the existing text of the Annex into "Volume I — Aircraft Noise", the material contained in this document becoming "Volume II — Aircraft Engine Emissions".

Applicability

Part I of Volume II of Annex 16 contains definitions and symbols and Part II contains Standards relating to vented fuel. Part III contains Standards relating to emissions certification applicable to the classes of aircraft engines specified in the individual chapters of the Part, where such engines are fitted to aircraft engaged in international civil aviation.

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Use of the Annex text in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as is practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of international air navigation. Wherever possible, the provisions of this Annex have been written in such a way as to facilitate incorporation, without major textual changes, into national legislation.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated.

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Provisions* governing the applicability of the Standards and Recommended Practices.

d) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

It is to be noted that in the English text the following practice has been adhered to when writing the specifications: Standards employ the operative verb "shall" while Recommended Practices employ the operative verb "should".

In accordance with Annex 5, the International System of Units (SI) is used throughout this document.

Any reference to a portion of this document which is identified by a number includes all subdivisions of that portion.

Table A. Amendments to Annex 16

Amendment	*Source(s)*	*Subject(s)*	*Adopted* *Effective* *Applicable*
1st Edition	Special Meeting on Aircraft Noise in the Vicinity of Aerodromes (1969)		2 April 1971 2 August 1971 6 January 1972
1	First Meeting of the Committee on Aircraft Noise	Noise certification of future production and derived versions of subsonic jet aeroplanes and updating of terminology used to describe aircraft weight.	6 December 1972 6 April 1973 16 August 1973
2	Third Meeting of the Committee on Aircraft Noise	Noise certification of light propeller-driven aeroplanes and subsonic jet aeroplanes of 5 700 kg and less maximum certificated take-off weight and guidance on discharge of functions by States in the cases of lease, charter and interchange of aircraft.	3 April 1974 3 August 1974 27 February 1975
3 (2nd Edition)	Fourth Meeting of the Committee on Aircraft Noise	Noise certification standards for future subsonic jet aeroplanes and propeller-driven aeroplanes, other than STOL aeroplanes, and guidelines for noise certification of future supersonic aeroplanes, propeller-driven STOL aeroplanes and installed APU and associated aircraft systems when operating on the ground.	21 June 1976 21 October 1976 6 October 1977
4 (3rd Edition)	Fifth Meeting of the Committee on Aircraft Noise	Introduction of a new parameter, viz, number of engines in the noise certification standards for subsonic jet aeroplanes, improvements in detailed test procedures to ensure that the same level of technology is applied to all types of aircraft, and editorial changes to simplify the language and eliminate inconsistencies.	6 March 1978 6 July 1978 10 August 1978
5 (Annex 16, Volume I — 1st Edition)	Sixth Meeting of the Committee on Aircraft Noise	1. Annex retitled *Environmental Protection* and to be issued in two volumes as follows: Volume I — *Aircraft Noise* (incorporating provisions in the third edition of Annex 16 as amended by Amendment 5) and Volume II — *Aircraft Engine Emissions*. 2. Introduction in Volume I of noise certification Standards for helicopters and for future production of existing SST aeroplanes, updating of guidelines for noise certification of installed APU and associated aircraft systems and editorial amendments including changes to units of measurement to bring the Annex in line with Annex 5 provisions.	11 May 1981 11 September 1981 26 November 1981
6 (Annex 16, Volume II — 1st Edition	Second Meeting of the Committee on Aircraft Engine Emissions	Introduction of Volume II containing Standards relating to the control of fuel venting, smoke and gaseous emissions from newly manufactured turbo-jet and turbofan engines intended for subsonic and supersonic propulsion.	30 June 1981 30 October 1981 18 February 1982
1	First Meeting of the Committee on Aviation Environmental Protection	Changes in test fuel specifications, Appendix 4.	4 March 1988 31 July 1988 17 November 1988
2 (2nd Edition)	Second Meeting of the Committee on Aviation Environmental Protection	a) increased stringency of NO_x emissions limits; b) improvements in the smoke and gaseous emissions certification procedure.	24 March 1993 26 July 1993 11 November 1993

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

PART I. DEFINITIONS AND SYMBOLS

CHAPTER 1. DEFINITIONS

Where the following expressions are used in Volume II of this Annex, they have the meanings ascribed to them below:

Afterburning. A mode of engine operation wherein a combustion system fed (in whole or part) by vitiated air is used.

Approach phase. The operating phase defined by the time during which the engine is operated in the approach operating mode.

Climb phase. The operating phase defined by the time during which the engine is operated in the climb operating mode.

Date of manufacture. The date of issue of the document attesting that the individual aircraft or engine as appropriate conforms to the requirements of the type or the date of an analogous document.

Derivative version. An aircraft gas turbine engine of the same generic family as an originally type-certificated engine and having features which retain the basic core engine and combustor design of the original model and for which other factors, as judged by the certificating authority, have not changed.

Note.— Attention is drawn to the difference between the definition of "derived version of aircraft" in Volume I of Annex 16 and the definition of "derivative version" in this Volume.

Oxides of nitrogen. The sum of the amounts of the nitric oxide and nitrogen dioxide contained in a gas sample calculated as if the nitric oxide were in the form of nitrogen dioxide.

Reference pressure ratio. The ratio of the mean total pressure at the last compressor discharge plane of the compressor to the mean total pressure at the compressor entry plane when the engine is developing take-off thrust rating in ISA sea level static conditions.

Note.— Methods of measuring reference pressure ratio are given in Appendix 1.

Smoke. The carbonaceous materials in exhaust emissions which obscure the transmission of light.

Smoke Number. The dimensionless term quantifying smoke emissions (*see* 3 of Appendix 2).

Take-off phase. The operating phase defined by the time during which the engine is operated at the rated output.

Rated output. For engine emissions purposes, the maximum power/thrust available for take-off under normal operating conditions at ISA sea level static conditions without the use of water injection as approved by the certificating authority. Thrust is expressed in kilonewtons.

Taxi/ground idle. The operating phases involving taxi and idle between the initial starting of the propulsion engine(s) and the initiation of the take-off roll and between the time of runway turn-off and final shutdown of all propulsion engine(s).

Unburned hydrocarbons. The total of hydrocarbon compounds of all classes and molecular weights contained in a gas sample, calculated as if they were in the form of methane.

CHAPTER 2. SYMBOLS

Where the following symbols are used in Volume II of this Annex, they have the meanings ascribed to them below:

CO	Carbon monoxide
D_p	The mass of any gaseous pollutant emitted during the reference emissions landing and take-off cycle
F_n	Thrust in International Standard Atmosphere (ISA), sea level conditions, for the given operating mode
F_{oo}	Rated output (*see* definition)
F^*_{oo}	Rated output with afterburning applied
HC	Unburned hydrocarbons (*see* definition)
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen (*see* definition)
SN	Smoke Number (*see* definition)
π_{oo}	Reference pressure ratio (*see* definition)

PART II. VENTED FUEL

CHAPTER 1. ADMINISTRATION

1.1 The provision of this Part shall apply to all turbine engine powered aircraft intended for operation in international air navigation manufactured after 18 February 1982.

1.2 Certification related to the prevention of intentional fuel venting shall be granted by the certificating authority on the basis of satisfactory evidence that either the aircraft or the aircraft engines comply with requirements of Chapter 2.

Note.— The document attesting certification relating to fuel venting may take the form of a separate fuel venting certificate or a suitable statement contained in another document approved by the certificating authority.

1.3 Contracting States shall recognize as valid a certification relating to fuel venting granted by the certificating authority of another Contracting State provided the requirements under which such certification was granted are not less stringent than the provision of Volume II of this Annex.

CHAPTER 2. PREVENTION OF INTENTIONAL FUEL VENTING

Aircraft shall be so designed and constructed as to prevent the intentional discharge into the atmosphere of liquid fuel from the fuel nozzle manifolds resulting from the process of engine shutdown following normal flight or ground operations.

11/11/93

PART III. EMISSIONS CERTIFICATION

CHAPTER 1. ADMINISTRATION

1.1 The provision of 1.2 to 1.4 shall apply to all engines included in the classifications defined for emission certification purposes in Chapters 2 and 3 where such engines are fitted to aircraft engaged in international air navigation.

1.2 Emissions certification shall be granted by the certificating authority on the basis of satisfactory evidence that the engine complies with requirements which are at least equal to the stringency of the provisions of Volume II of this Annex. Compliance with the emissions levels of Chapters 2 and 3 shall be demonstrated using the procedure described in Appendix 6.

Note.— The document attesting emissions certification may take the form of a separate emissions certificate or a suitable statement contained in another document approved by the certificating authority.

1.3 The document attesting emissions certification for each individual engine shall include at least the following information which is applicable to the engine type:

a) name of certificating authority;

b) manufacturer's type and model designation;

c) statement of any additional modifications incorporated for the purpose of compliance with the applicable emissions certification requirements;

d) rated output;

e) reference pressure ratio;

f) a statement indicating compliance with Smoke Number requirements;

g) a statement indicating compliance with gaseous pollutant requirements.

1.4 Contracting States shall recognize as valid emissions certification granted by the certificating authority of another Contracting State provided that the requirements under which such certification was granted are not less stringent than the provisions of Volume II of this Annex.

CHAPTER 2. TURBO-JET AND TURBOFAN ENGINES INTENDED FOR PROPULSION ONLY AT SUBSONIC SPEEDS

2.1 General

2.1.1 Applicability

The provisions of this chapter shall apply to all turbo-jet and turbofan engines, as further specified in 2.2 and 2.3, intended for propulsion only at subsonic speeds, except when certificating authorities make exemptions for specific engine types and derivative versions of such engines for which the type certificate of the first basic type was issued or other equivalent prescribed procedure was carried out before 1 January 1965. In such cases an exemption document shall be issued by the certificating authority. The provisions of this chapter shall also apply to engines designed for applications that otherwise would have been fulfilled by turbo-jet and turbofan engines.

Note.— In considering exemptions, certificating authorities should take into account the probable numbers of such engines that will be produced and their impact on the environment. When such an exemption is granted, the certificating authority should consider imposing a time limit on the future production of such engines for installation on new aircraft, although production of such engines as spares should be permitted indefinitely.

2.1.2 Emissions involved

The following emissions shall be controlled for certification of aircraft engines:

- Smoke
- Gaseous emissions
  - Unburned hydrocarbons (HC);
  - Carbon monoxide (CO); and
  - Oxides of nitrogen (NO_x).

2.1.3 Units of measurement

2.1.3.1 The smoke emission shall be measured and reported in terms of Smoke Number (SN).

2.1.3.2 The mass (D_p) of the gaseous pollutant HC, CO, or NO_x emitted during the reference emissions landing and take-off (LTO) cycle, defined in 2.1.4.2 and 2.1.4.3, shall be measured and reported in grams.

2.1.4 Reference conditions

2.1.4.1 *Atmospheric conditions*

The reference atmospheric conditions shall be ISA at sea level except that the reference absolute humidity shall be 0.00629 kg water/kg dry air.

2.1.4.2 *Thrust settings*

The engine shall be tested at sufficient power settings to define the gaseous and smoke emissions of the engine so that mass emission rates and Smoke Numbers corrected to the reference ambient conditions can be determined at the following specific percentages of rated output as agreed by the certificating authority:

Operating mode	*Thrust setting*
Take-off	100 per cent F_{oo}
Climb	85 per cent F_{oo}
Approach	30 per cent F_{oo}
Taxi/ground idle	7 per cent F_{oo}

2.1.4.3 *Reference emissions landing and take-off (LTO) cycle*

The reference emissions LTO cycle for the calculation and reporting of gaseous emissions shall be represented by the following time in each operating mode.

Phase	*Time in operating mode, minutes*
Take-off	0.7
Climb	2.2
Approach	4.0
Taxi/ground idle	26.0

2.1.4.4 *Fuel specifications*

The fuel used during tests shall meet the specifications of Appendix 4. Additives used for the purpose of smoke suppression (such as organo-metallic compounds) shall not be present.

2.1.5 Test conditions

2.1.5.1 The tests shall be made with the engine on its test bed.

2.1.5.2 The engine shall be representative of the certificated configuration (*see* Appendix 6); off-take bleeds and accessory loads other than those necessary for the engine's basic operation shall not be simulated.

2.1.6 When test conditions differ from the reference conditions in 2.1.4 the test results shall be corrected to the reference conditions by the methods given in Appendix 3.

2.2 Smoke

2.2.1 Applicability

The provisions of 2.2.2 shall apply to engines whose date of manufacture is on or after 1 January 1983.

2.2.2 Regulatory Smoke Number

The Smoke Number at any thrust setting when measured and computed in accordance with the procedures of Appendix 2 and converted to a characteristic level by the procedures of Appendix 6 shall not exceed the level determined from the following formula:

Regulatory Smoke Number = 83.6 $(F_{oo})^{-0.274}$
or a value of 50,
whichever is lower

2.3 Gaseous emissions

2.3.1 Applicability

The provisions of 2.3.2 shall apply to engines whose rated output is greater than 26.7 kN and whose date of manufacture is on or after 1 January 1986 and as further specified for oxides of nitrogen.

2.3.2 Regulatory levels

Gaseous emission levels when measured and computed in accordance with the procedures of Appendix 3 and converted to characteristic levels by the procedures of Appendix 6 shall not exceed the regulatory levels determined from the following formulas:

Hydrocarbons (HC): $D_p/F_{\infty} = 19.6$

Carbon monoxide (CO): $D_p/F_{\infty} = 118$

Oxides of nitrogen (NO_x):

a) for engines of type or model of which the date of manufacture of the first individual production model was on or before 31 December 1995 and for which the date of manufacture of the individual engine was on or before 31 December 1999.

$$D_p/F_{\infty} = 40 + 2\pi_{oo}$$

b) for engines of a type or model of which the date of manufacture of the first individual production model was after 31 December 1995 or for which the date of manufacture of the individual engine was after 31 December 1999.

$$D_p/F_{\infty} = 32 + 1.6\pi_{oo}$$

Note.— The characteristic level of the Smoke Number or gaseous pollutant emissions is the mean of the values of all the engines tested, measured and corrected to the reference standard engine and reference ambient conditions divided by the coefficient corresponding to the number of engines tested, as shown in Appendix 6.

2.4 Information required

Note.— The information required is divided into three groups: 1) general information to identify the engine characteristics, the fuel used and the method of data analysis; 2) the data obtained from the engine test(s); and 3) the results derived from the test data.

2.4.1 General information

The following information shall be provided for each engine type for which emissions certification is sought:

a) engine identification;

b) rated output (in kilonewtons);

c) reference pressure ratio;

d) fuel specification reference;

e) fuel hydrogen/carbon ratio;

f) the methods of data acquisition;

g) the method of making corrections for ambient conditions; and

g) the method of data analysis.

2.4.2 Test information

The following information shall be provided for each engine tested for certification purposes at each of the thrust settings specified in 2.1.4.2. The information shall be provided after correction to the reference ambient conditions where applicable:

a) fuel flow (kilograms/second);

b) emission index (grams/kilogram) for each gaseous pollutant; and

c) measured Smoke Number.

2.4.3 Derived information

2.4.3.1 The following derived information shall be provided for each engine tested for certification purposes:

a) emission rate, i.e. emission index × fuel flow, (grams/second) for each gaseous pollutant;

b) total gross emission of each gaseous pollutant measured over the LTO cycle (grams);

c) values of D_p/F_{∞} for each gaseous pollutant (grams/kilonewton); and

d) maximum Smoke Number.

2.4.3.2 The characteristic Smoke Number and gaseous pollutant emission levels shall be provided for each engine type for which emissions certification is sought.

Note.— The characteristic level of the Smoke Number or gaseous pollutant emissions is the mean of the values of all the engines tested, measured and corrected to the reference standard engine and reference ambient conditions, divided by the coefficient corresponding to the number of engines tested, as shown in Appendix 6.

CHAPTER 3. TURBO-JET AND TURBOFAN ENGINES INTENDED FOR PROPULSION AT SUPERSONIC SPEEDS

3.1 General

3.1.1 Applicability

The provisions of this chapter shall apply to all turbo-jet and turbofan engines intended for propulsion at supersonic speeds whose date of manufacture is on or after 18 February 1982.

3.1.2 Emissions involved

The following emissions shall be controlled for certification of aircraft engines:

Smoke
Gaseous emissions
 Unburned hydrocarbons (HC);
 Carbon monoxide (CO); and
 Oxides of nitrogen (NO_x).

3.1.3 Units of measurement

3.1.3.1 The smoke emission shall be measured and reported in terms of Smoke Number (SN).

3.1.3.2 The mass (D_p) of the gaseous pollutants HC, CO, or NO_x emitted during the reference emissions landing and take-off (LTO) cycle, defined in 3.1.5.2 and 3.1.5.3 shall be measured and reported in grams.

3.1.4 Nomenclature

Throughout this chapter, where the expression F^*_{∞} is used, it shall be replaced by F_{∞} for engines which do not employ afterburning. For taxi/ground idle thrust setting, F_{∞} shall be used in all cases.

3.1.5 Reference conditions

3.1.5.1 *Atmospheric conditions*

The reference atmospheric conditions shall be ISA at sea level except that the reference absolute humidity shall be 0.00629 kg water/kg dry air.

3.1.5.2 *Thrust settings*

The engine shall be tested at sufficient power settings to define the gaseous and smoke emissions of the engine so that mass emission rates and Smoke Numbers corrected to the reference ambient conditions can be determined at the following specific percentages of rated output as agreed by the certificating authority.

Operating mode	*Thrust setting*
Take-off	100 per cent F^*_{∞}
Climb	65 per cent F^*_{∞}
Descent	15 per cent F^*_{∞}
Approach	34 per cent F^*_{∞}
Taxi/ground idle	5.8 per cent F_{∞}

3.1.5.3 *Reference emissions landing and take-off (LTO) cycle)*

The reference emissions LTO cycle for the calculation and reporting of gaseous emissions shall be represented by the following time in each operating mode.

Phase	*Time in operating mode, minutes*
Take-off	1.2
Climb	2.0
Descent	1.2
Approach	2.3
Taxi/ground idle	26.0

3.1.5.4 *Fuel specifications*

The fuel used during tests shall meet the specifications of Appendix 4. Additives used for the purpose of smoke suppression (such as organo-metallic compounds) shall not be present.

3.1.6 Test conditions

3.1.6.1 The tests shall be made with the engine on its test bed.

3.1.6.2 The engine shall be representative of the certificated configuration (*see* Appendix 6); off-take bleeds and accessory loads other than those necessary for the engine's basic operation shall not be simulated.

3.1.6.3 Measurements made for determination of emission levels at the thrusts specified in 3.1.5.2 shall be made with the afterburner operating at the level normally used, as applicable.

3.1.7 When test conditions differ from the reference conditions in 3.1.5, the test results shall be corrected to the reference conditions by the methods given in Appendix 5.

3.2 Smoke

3.2.1 Regulatory Smoke Number

The Smoke Number at any thrust setting when measured and computed in accordance with the procedures of Appendix 2 and converted to a characteristic level by the procedures of Appendix 6 shall not exceed the regulatory level determined from the following formula:

Regulatory Smoke Number = $83.6\,(F^*_{\infty})^{-0.274}$
or a value of 50,
whichever is lower

Note.— Certificating authorities may alternatively accept values determined using afterburning provided that the validity of these data is adequately demonstrated.

3.3 Gaseous emissions

3.3.1 Regulatory levels

Gaseous emission levels when measured and computed in accordance with the procedures of Appendix 3 or Appendix 5, as applicable, and converted to characteristic levels by the procedures of Appendix 6 shall not exceed the regulatory levels determined from the following formulas:

Hydrocarbons (HC): $D_p/F^*_{\infty} = 140(0.92)^{\pi_{\infty}}$

Carbon monoxide (CO): $D_p/F^*_{\infty} = 4\,550(\pi_{\infty})^{-1.03}$

Oxides of nitrogen (NO_x): $D_p/F^*_{\infty} = 36 + 2.42\pi_{\infty}$

Note.— The characteristic level of the Smoke Number or gaseous pollutant emissions is the mean of the values of all the engines tested, measured and corrected to the reference standard engine and reference ambient conditions, divided by the coefficient corresponding to the number of engines tested, as shown in Appendix 6.

3.4 Information required

Note.— The information required is divided into three groups: 1) general information to identify the engine characteristics, the fuel used and the method of data analysis; 2) the data obtained from the engine test(s); and 3) the results derived from the test data.

3.4.1 The following information shall be provided for each engine type for which emissions certification is sought:

a) engine identification;

b) rated output (in kilonewtons);

c) rated output with afterburning applied, if applicable (in kilonewtons);

d) reference pressure ratio;

e) fuel specification reference;

f) fuel hydrogen/carbon ratio;

g) the methods of data acquisition;

h) the method of making corrections for ambient conditions; and

i) the method of data analysis.

3.4.2 Test information

The following information shall be provided for each engine tested for certification purposes at each of the thrust settings specified in 3.1.5.2. The information shall be provided after correction to the reference ambient conditions where applicable:

a) fuel flow (kilograms/second);

b) emission index (grams/kilogram) for each gaseous pollutant;

c) percentage of thrust contributed by afterburning; and

d) measured Smoke Number.

3.4.3 Derived information

3.4.3.1 The following derived information shall be provided for each engine tested for certification purposes:

a) emission rate, i.e. emission index × fuel flow, (grams/second), for each gaseous pollutant;

b) total gross emission of each gaseous pollutant measured over the LTO cycle (grams);

c) values of D_p/F^*_{∞} for each gaseous pollutant (grams/kilonewton); and

d) maximum Smoke Number.

3.4.3.2 The characteristic Smoke Number and gaseous pollutant emission levels shall be provided for each engine type for which emissions certification is sought.

Note.— The characteristic level of the Smoke Number or gaseous pollutant emissions is the mean of the values of all the engines tested, measured and corrected to the reference standard engine and reference ambient conditions, divided by the coefficient corresponding to the number of engines tested, as shown in Appendix 6.

APPENDIX 1. MEASUREMENT OF REFERENCE PRESSURE RATIO

1. GENERAL

1.1 Pressure ratio shall be established using a representative engine.

1.2 Reference pressure ratio shall be derived by correlating measured pressure ratio with engine thrust corrected to standard day ambient pressure and entering this correlation at the standard day rated take-off thrust.

2. MEASUREMENT

2.1 Total pressure shall be measured at the last compressor discharge plane and the first compressor front face by positioning at least four probes so as to divide the air flow area into four equal sectors and taking a mean of the four values obtained.

Note.— Compressor discharge total pressure may be obtained from total or static pressure measured at a position as close as possible to the compressor discharge plane. However, the certificating authority may approve alternative means of estimating the compressor discharge total pressure if the engine is so designed that the provision of the probes referred to above is impractical for the emissions test.

2.2 Necessary correlation factors shall be determined during type certification testing using a minimum of one engine and any associated engine component tests and analysis.

2.3 Procedures shall be acceptable to the certificating authority.

APPENDIX 2. SMOKE EMISSION EVALUATION

1. INTRODUCTION AND DEFINITIONS

Note.— The procedures specified here are concerned with the acquisition of representative exhaust samples and their transmission to, and analysis by, the emissions measuring system.

1.1 Variations in the procedure contained in this Appendix shall only be allowed after prior application to and approval by the certificating authority.

1.2 Where the following expressions and symbols are used in this Appendix, they have the meanings ascribed to them below:

Sampling reference size. The sample mass, 16.2 kg/m^2 of stained filter area, which if passed through the filter material results in a change of reflectance which gives a value of the SN parameter.

Sampling size. A chosen exhaust sample, the magnitude of whose mass (expressed in kilograms per square metre of stained filter surface area) lies in the range prescribed in 2.5.3 h) of this Appendix which, when passed through the filter material, causes a change in reflectance yielding a value for the SN′ parameter.

Sampling volume. The chosen sample volume (expressed in cubic metres) whose equivalent mass, calculated as indicated in 3 of this Appendix, conforms to the above definition of sampling size.

SN. Smoke Number; Dimensionless term quantifying smoke emission level based upon the staining of a filter by the reference mass of exhaust gas sample, and rated on a scale of 0 to 100 (*see* 3 of this Appendix).

SN′. Smoke Number obtained from an individual smoke sample, not necessarily of the reference size, as defined in 3 of this Appendix.

W. Mass of individual exhaust gas smoke sample, in kilograms, calculated from the measurements of sample volume, pressure and temperature (*see* 3 of this Appendix).

2. MEASUREMENT OF SMOKE EMISSIONS

2.1 Sampling probe for smoke emissions

a) The probe shall be made of stainless steel. If a mixing probe is used, all sampling orifices shall be of equal diameter.

b) The probe design shall be such that at least 80 per cent of the pressure drop through the probe assembly is taken at the orifices.

c) The number of sampling orifices shall not be less than 12.

d) The sampling plane shall be as close to the engine exhaust nozzle exit plane as permitted by considerations of engine performance but in any case shall be within 0.5 nozzle diameters of the exit plane.

e) The applicant shall provide evidence to the certificating authority, by means of detailed traverses, that the proposed probe design and position does provide a representative sample for each prescribed power setting.

2.2 Sampling line for smoke emissions

2.2.1 The sample shall be transferred from the probe to the sample collection system via a line of 4.0 to 8.5 mm inside diameter taking the shortest route practicable which shall in no case be greater than 25 m. The line temperature shall be maintained at a temperature between 60°C and 175°C with a stability of ±15°C, except for the distance required to cool the gas from the engine exhaust temperature down to the line control temperature.

2.2.2 Sampling lines shall be as "straight through" as possible. Any necessary bends shall have radii which are greater than 10 times the inside diameter of the lines. The material of the lines shall be such as to discourage build-up of particulate matter or static electricity.

Note.— Stainless steel, copper or carbon-loaded grounded polytetrafluoroethylene (PTFE) meet these requirements.

2.3 Smoke analysis system

Note.— The method prescribed herein is based upon the measurement of the reduction in reflectance of a filter when stained by a given mass flow of exhaust sample.

The arrangement of the various components of the system for acquiring the necessary stained filter samples shall be as shown schematically in Figure 2-1. An optional bypass around the volume meter may be installed to facilitate meter reading. The major elements of the system shall meet the following requirements:

a) *sample size measurement:* a wet or dry positive displacement volume meter shall be used to measure sample volume to an accuracy of ±2 per cent. The pressure and temperature at entry to this meter shall also be measured to accuracies of 0.2 per cent and ±2°C respectively;

b) *sample flow rate measurement:* the sample flow rate shall be maintained at a value of 14 ±0.5 L/min and the flowmeter for this purpose shall be able to make this measurement with an accuracy of ±5 per cent;

c) *filter and holder:* the filter holder shall be constructed in corrosion-resistant material and shall have the flow channel configuration shown in Figure 2-1. The filter material shall be Whatman type No. 4, or any equivalent approved by the certificating authority;

d) *valves:* four valve elements shall be provided as indicated in Figure 2-1:

1) valve A shall be a quick-acting, full-flow, flow diverter enabling the incoming sample to be directed through the measuring filter or around the bypass circuits or shut off;

Note.— Valve A may, if necessary, consist of two valves interlocked to give the requisite function.

2) valves B and C shall be throttling valves used to establish the system flow rate;

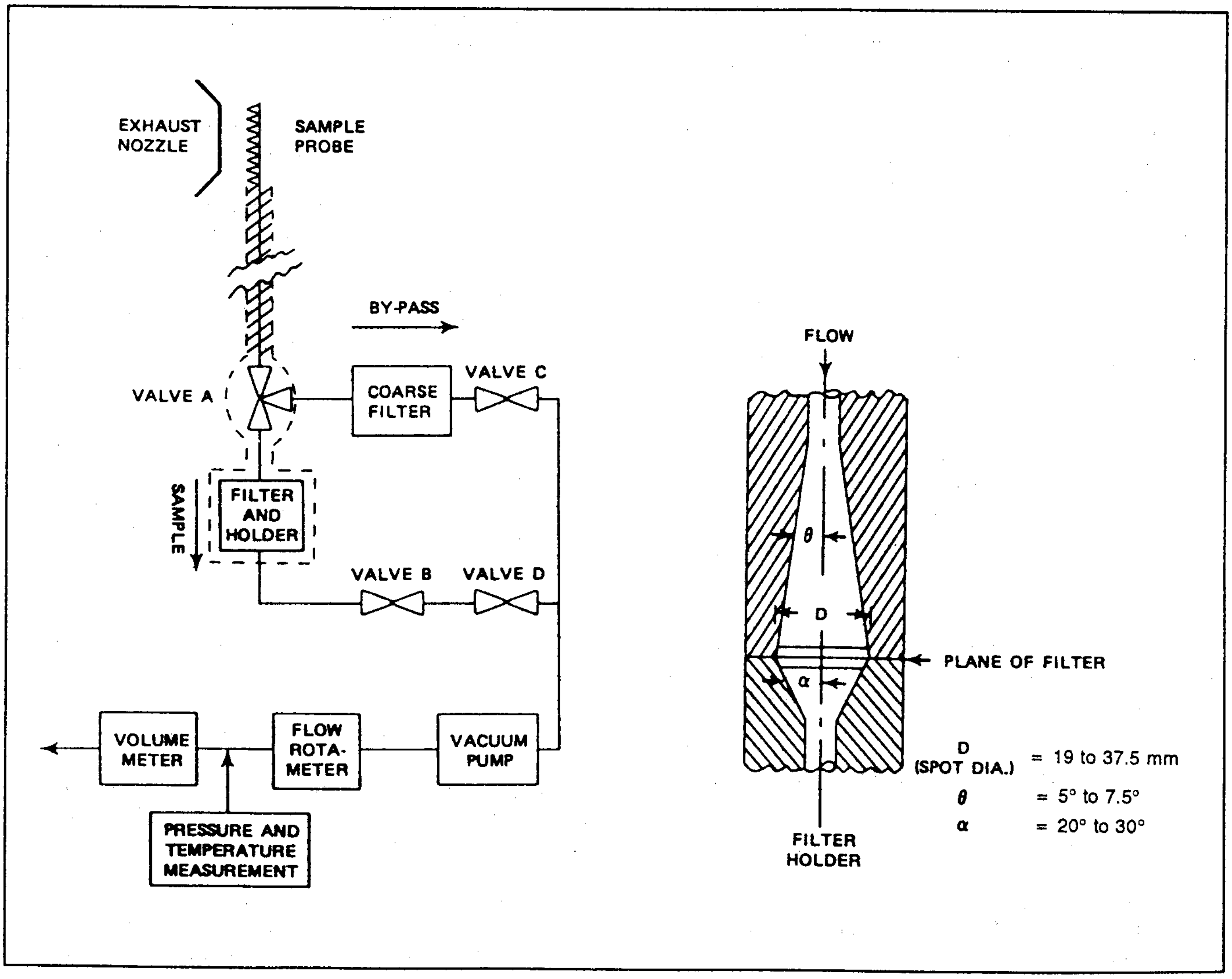

Figure 2-1. Smoke analysis system

3) valve D shall be a shut-off valve to enable the filter holder to be isolated;

all valves shall be made of corrosion-resistant material;

e) *vacuum pump:* this pump shall have a no-flow vacuum capability of –75 kPa with respect to atmospheric pressure; its full-flow rate shall not be less than 28 L/min at normal temperature and pressure;

f) *temperature control:* the incoming sample line through to the filter holder shall be maintained at a temperature between 60°C and 175°C with a stability of ±15°C;

Note.— The objective is to prevent water condensation prior to reaching the filter holder and within it.

g) If it is desired to draw a higher sample flow rate through the probe than through the filter holder, an optional flow splitter may be located between the probe and valve A (Figure 2-1), to dump excess flow. The dump line shall be as close as possible to probe off-take and shall not affect the ability of the sampling system to maintain the required 80 per cent pressure drop across the probe assembly. The dump flow may also be sent to the CO_2 analyser or complete emissions analysis system.

h) If a flow splitter is used, a test shall be conducted to demonstrate that the flow splitter does not change the smoke level passing to the filter holder. This may be accomplished by reversing the outlet lines from the flow splitter and showing that, within the accuracy of the method, the smoke level does not change.

i) *leak performance:* the sub-system shall meet the requirements of the following test:

1) clamp clean filter material into holder,

2) shut off valve A, fully open valves B, C and D.

3) run vacuum pump for one minute to reach equilibrium conditions;

4) continue to pump and measure the volume flow through the meter over a period of five minutes. This volume shall not exceed 5 L (referred to normal temperature and pressure) and the system shall not be used until this standard has been achieved.

j) *reflectometer:* the measurements of the reflectance of the filter material shall be by an instrument conforming to the American National Standards Institute (ANSI) Standard No. PH2.17/1977 for diffuser reflection density. The diameter of the reflectometer light beam on the filter paper shall not exceed D/2 nor be less than D/10 where D is the diameter of filter stained spot as defined in Figure 2-1.

2.4 Fuel specifications

The fuel shall meet the specifications of Appendix 4. Additives used for the purpose of smoke suppression (such as organo-metallic compounds) shall not be present.

2.5 Smoke measurement procedures

2.5.1 Engine operation

2.5.1.1 The engine shall be operated on a static test facility which is suitable and properly equipped for high accuracy performance testing.

2.5.1.2 The tests shall be made at the power settings approved by the certificating authority. The engine shall be stabilized at each setting.

2.5.2 Leakage and cleanliness checks

No measurements shall be made until all sample transfer lines and valves are warmed up and stable. Prior to a series of tests the system shall be checked for leakage and cleanliness as follows:

a) *leakage check:* isolate probe and close off end of sample line, perform leakage test as specified in 2.3 g) with the exceptions that valve A is opened and set to "bypass", valve D is closed and that the leakage limit is 2 L. Restore probe and line interconnection;

b) *cleanliness check:*

1) open valves B, C and D;

2) run vacuum pump and alternately set valve A to "bypass" and "sample" to purge the entire system with clean air for five minutes;

3) set valve A to "bypass";

4) close valve D and clamp clean filter material into holder. Open valve D;

5) set valve A to "sample" and reset back to "bypass" after 50 kg of air per square metre of filter has passed through the filter material;

6) measure resultant filter spot SN′ as described in paragraph 3 of this Appendix.;

7) if this SN′ exceeds 3, the system shall be cleaned (or otherwise rectified) until a value lower than 3 is obtained.

The system shall not be used until the requirements of these leakage and cleanliness checks have been met.

2.5.3 Smoke measurement

Smoke measurement shall be made independently of other measurements unless the smoke values so measured are significantly below the limiting values, or unless it can be demonstrated that the smoke values from simultaneous smoke and gaseous emissions measurements are valid, in which case smoke measurements may be made simultaneously with gaseous emissions measurements. In all cases the bend radius requirements for sampling lines detailed in 2.2.2 shall be strictly observed. The smoke analysis sub-system shall be set up and conform to the specifications of 2.3. Referring to Figure 2-1, the following shall be the major operations in acquiring the stained filter specimens:

a) during engine operation with the probe in position, valve A shall not be placed in the no-flow condition, otherwise particulate buildup in the lines might be encouraged;

b) set valve A to "bypass", close valve D and clamp clean filter into holder. Continue to draw exhaust sample in the bypass setting for at least five minutes while the engine is at or near to the requisite operating mode, valve C being set to give a flow rate of 14 ±0.5 L/min;

c) open valve D and set valve A to "sample", use valve B to set flow rate again to value set in b);

d) set valve A to "bypass" and close valve D, clamp clean filter material into the holder;

e) when the engine is stabilized on condition, allow one minute of sample flow with settings as at d);

f) open valve D, set valve A to "sample", reset flow rate if necessary, and allow chosen sample volume (*see* h)) to pass, before setting valve A back to "bypass" and close valve D;

g) set aside stained filter for analysis, clamp clean filter into holder;

h) the chosen sample sizes shall be such as to be within the range of 12 kg to 21 kg of exhaust gas per square metre of filter, and shall include samples which are either at the value of 16.2 kg of exhaust gas per square metre of filter or lie above and below that value. The number of samples at each engine operating condition shall not be less than 3 and e) to g) shall be repeated as necessary.

3. CALCULATION OF SMOKE NUMBER FROM MEASURED DATA

The stained filter specimens obtained as outlined in 2.5.3 shall be analysed using a reflectometer as specified in 2.3. The backing material used shall be black with an absolute reflectance of less than 3 per cent. The absolute reflectance reading R_S of each stained filter shall be used to calculate the reduction in reflectance by

$$SN' = 100(1 - R_S/R_W)$$

where R_W is the absolute reflectance of clean filter material.

The masses of the various samples shall be calculated by

$$W = 0.348\ PV/T \times 10^{-2}(\text{kg})$$

where P and T are, respectively, the sample pressure in pascals and the temperature in kelvin, measured immediately upstream of the volume meter. V is the measured sample volume in cubic metres.

For each engine condition in the case that the sample sizes range above and below the reference value, the various values of SN′ and W shall be plotted as SN′ versus log W/A, where A is the filter stain area (m^2). Using a least squares straight line fit, the value of SN′ for $W/A = 16.2$ kg/m^2 shall be estimated and reported as the Smoke Number (SN) for that engine mode. Where sampling at the reference size value only is employed, the reported SN shall be the arithmetic average of the various individual values of SN′.

4. REPORTING OF DATA TO THE CERTIFICATING AUTHORITY

The measured data shall be reported to the certificating authority. In addition the following data shall be reported for each test:

a) sample temperature;

b) sample pressure;

c) actual sample volume at sampling conditions;

d) actual sample flow rate at sampling conditions; and

e) leak and cleanliness checks substantiation (*see* 2.5.2).

11/11/93

APPENDIX 3. INSTRUMENTATION AND MEASUREMENT TECHNIQUES FOR GASEOUS EMISSIONS

1. INTRODUCTION

Note.— The procedures specified in this appendix are concerned with the acquisition of representative exhaust samples and their transmission to, and analysis by, the emissions measuring system. The procedures do not apply to engines employing afterburning. The methods proposed are representative of the best readily available and most established practice.

Variations in the procedure contained in this appendix shall only be allowed after prior application to and approval by the certificating authority.

2. DEFINITIONS

Where the following expressions are used in this appendix, they have the meanings ascribed to them below:

Accuracy. The closeness with which a measurement approaches the true value established independently.

Air/fuel ratio. The mass rate of airflow through the hot section of the engine divided by the mass rate of fuel flow to the engine.

Calibration gas. A high accuracy reference gas to be used for alignment, adjustment and periodic checks of instruments.

Concentration. The volume fraction of the component of interest in the gas mixture — expressed as volume percentage or as parts per million.

Exhaust nozzle. In the exhaust emissions sampling of gas turbine engines where the jet effluxes are not mixed (as in some turbofan engines for example) the nozzle considered is that for the gas generator (core) flow only. Where, however, the jet efflux is mixed the nozzle considered is the total exit nozzle.

Flame ionization detector. A hydrogen-air diffusion flame detector that produces a signal nominally proportional to the mass-flow rate of hydrocarbons entering the flame per unit of time — generally assumed responsive to the number of carbon atoms entering the flame.

Interference. Instrument response due to presence of components other than the gas (or vapour) that is to be measured.

Noise. Random variation in instrument output not associated with characteristics of the sample to which the instrument is responding, and distinguishable from its drift characteristics.

Non-dispersive infra-red analyser. An instrument that by absorption of infra-red energy selectively measures specific components.

Parts per million (ppm). The unit volume concentration of a gas per million unit volume of the gas mixture of which it is a part.

Parts per million carbon (ppmC). The mole fraction of hydrocarbon multiplied by 10^6 measured on a methane-equivalence basis. Thus, 1 ppm of methane is indicated as 1 ppmC. To convert ppm concentration of any hydrocarbon to an equivalent ppmC value, multiply ppm concentration by the number of carbon atoms per molecule of the gas. For example, 1 ppm propane translates as 3 ppmC hydrocarbon; 1 ppm hexane as 6 ppmC hydrocarbon.

Reference gas. A mixture of gases of specified and known composition used as the basis for interpreting instrument response in terms of the concentration of the gas to which the instrument is responding.

Repeatability. The closeness with which a measurement upon a given, invariant sample can be reproduced in short-term repetitions of the measurement with no intervening instrument adjustment.

Resolution. The smallest change in a measurement which can be detected.

Response. The change in instrument output signal that occurs with change in sample concentration. Also the output signal corresponding to a given sample concentration.

Stability. The closeness with which repeated measurements upon a given invariant sample can be maintained over a given period of time.

Zero drift. Time-related deviation of instrument output from zero set point when it is operating on gas free of the component to be measured.

Zero gas. A gas to be used in establishing the zero, or no-response, adjustment of an instrument.

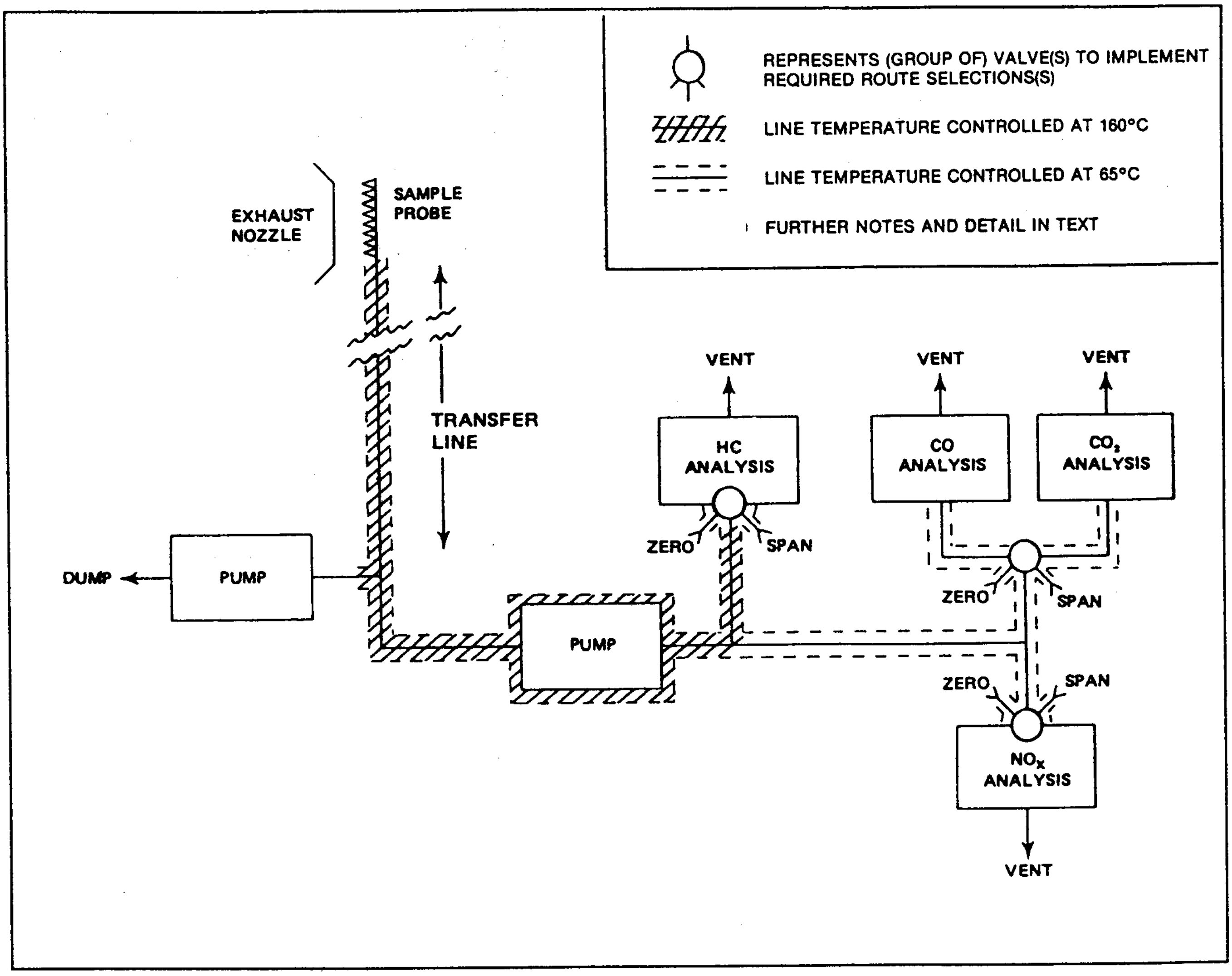

Figure 3-1. Sampling and analysis system, schematic

3. DATA REQUIRED

3.1 Gaseous emissions

Concentrations of the following emissions shall be determined:

a) Hydrocarbons (HC): a combined estimate of all hydrocarbon compounds present in the exhaust gas.

b) Carbon monoxide (CO).

c) Carbon dioxide (CO_2).

Note.— CO_2 is not considered a pollutant but its concentration is required for calculation and check purposes.

d) Oxides of nitrogen (NO_x): an estimate of the sum of the two oxides, nitric oxide (NO) and nitrogen dioxide (NO_2).

e) Nitric oxide (NO).

3.2 Other information

In order to normalize the emissions measurement data and to quantify the engine test characteristics, the following additional information shall be provided:

— inlet temperature;
— inlet humidity;
— atmospheric pressure;
— hydrogen/carbon ratio of fuel;
— other required engine parameters (for example, thrust, rotor speeds, turbine temperatures and gas-generator air flow).

This data shall be obtained either by direct measurement or by calculation, as presented in Attachment F to this appendix.

4. GENERAL ARRANGEMENT OF THE SYSTEM

No desiccants, dryers, water traps or related equipment shall be used to treat the exhaust sample flowing to the oxides of nitrogen and the hydrocarbon analysis instrumentation. Requirements for the various component sub-systems are given in 5, but the following list gives some qualifications and variations:

a) it is assumed that each of the various individual sub-systems includes the necessary flow control, conditioning and measurement facilities;

b) the necessity for a dump and/or a hot-sample pump will depend on ability to meet the sample transfer time and analysis sub-system sample flow rate requirements. This in turn depends on the exhaust sample driving pressure and line losses. It is considered that these pumps usually will be necessary at certain engine running conditions; and

c) the position of the hot pump, relative to the gas analysis sub-systems, may be varied as required. (For example, some HC analysers contain hot pumps and so may be judged capable of being used upstream of the system hot pump.)

Note.— Figure 3-1 is a schematic drawing of the exhaust gas sampling and analytical system and typifies the basic requirements for emissions testing.

5. DESCRIPTION OF COMPONENT PARTS

Note.— A general description and specification of the principal elements in the engine exhaust emissions measurement system follows. Greater detail, where necessary, will be found in Attachments A, B and C to this appendix.

5.1 Sampling system

5.1.1 Sampling probe

a) The probe shall be made of stainless steel. If a mixing probe is used, all sampling orifices shall be of equal diameter;

b) the probe design shall be such that at least 80 per cent of the pressure drop through the probe assembly is taken at the orifices;

c) the number of sampling orifices shall not be less than 12;

d) the sampling plane shall be as close to the engine exhaust nozzle exit plane as permitted by considerations of engine performance but in any case shall be within 0.5 nozzle diameter of the exit plane; and

e) the applicant shall provide evidence to the certificating authority, by means of detailed traverses, that the proposed probe design and position does provide a representative sample for each prescribed power setting.

5.1.2 Sampling lines

The sample shall be transferred from the probe to the analysers via a line of 4.0 to 8.5 mm inside diameter, taking the shortest route practicable and using a flow rate such that the transport time is less than 10 seconds. The line shall be maintained at a temperature of 160°C ±15°C (with a stability of ±10°C), except for a) the distance required to cool the gas from the engine exhaust temperature down to the line control temperature, and b) the branch which supplies samples to the CO, CO_2, and NO_x analysers. This branch line shall be maintained at a temperature of 65°C ± 15°C (with a stability of ±10°C). When sampling to measure HC, CO, CO_2 and NO_x components the line shall be constructed in stainless steel or carbon-loaded grounded PTFE.

5.2 HC analyser

The measurement of total hydrocarbon sample content shall be made by an analyser using the heated flame ionization detector (FID), between the electrodes of which passes an ionization current proportional to the mass rate of hydrocarbon entering a hydrogen flame. The analyser shall be deemed to include components arranged to control temperature and flow rates of sample, sample bypass, fuel and diluent gases, and to enable effective span and zero calibration checks.

Note.— An over-all specification is given in Attachment A to this appendix.

5.3 CO and CO_2 analysers

Non-dispersive infra-red analysers shall be used for the measurements of these components, and shall be of the design which utilizes differential energy absorption in parallel reference and sample gas cells, the cell or group of cells for each of these gas constituents being sensitized appropriately. This analysis sub-system shall include all necessary functions for the control and handling of sample, zero and span gas flows. Temperature control shall be that appropriate to whichever basis of measurement, wet or dry, is chosen.

Note.— An over-all specification is given in Attachment B to this appendix.

5.4 NO_x analyser

The measurement of NO concentration shall be by the chemiluminescent method in which the measure of the radiation intensity emitted during the reaction of the NO in the sample with added O_3 is the measure of the NO concentration. The NO_2 component shall be converted to NO in a converter of the requisite efficiency prior to measurement. The resultant NO_x measurement system shall include all necessary flow, temperature and other controls and provide for routine zero and span calibration as well as for converter efficiency checks.

Note.— An over-all specification is given in Attachment C to this appendix.

6. GENERAL TEST PROCEDURES

6.1 Engine operation

6.1.1 The engine shall be operated on a static test facility which is suitable and properly equipped for high accuracy performance testing.

6.1.2 The emissions tests shall be made at the power settings prescribed by the certificating authority. The engine shall be stabilized at each setting.

6.2 Major instrument calibration

Note.— The general objective of this calibration is to confirm stability and linearity.

6.2.1 The applicant shall satisfy the certificating authority that the calibration of the analytical system is valid at the time of the test.

6.2.2 For the hydrocarbon analyser this calibration shall include checks that the detector oxygen and differential hydrocarbon responses are within the limits specified, as laid down in Attachment A to this appendix. The efficiency of the NO_2/NO converter shall also be checked and verified to meet the requirements in Attachment C to this appendix.

6.2.3 The procedure for checking the performance of each analyser shall be as follows (using the calibration and test gases as specified in Attachment D to this appendix):

a) introduce zero gas and adjust instrument zero, recording setting as appropriate;

b) for each range to be used operationally, introduce calibration gas of (nominally) 90 per cent range full-scale deflection (FSD) concentration; adjust instrument gain accordingly and record its setting;

c) introduce approximately 30 per cent, 60 per cent, and 90 per cent range FSD concentration and record analyser readings;

d) fit a least squares straight line to the zero, 30 per cent, 60 per cent and 90 per cent concentration points. For the CO and/or CO_2 analyser used in their basic form without linearization of output, a least squares curve of appropriate mathematical formulation shall be fitted using additional calibration points if judged necessary. If any point deviates by more than 2 per cent of the full scale value (or ±1 ppm*, whichever is greater) then a calibration curve shall be prepared for operational use.

6.3 Operation

6.3.1 No measurements shall be made until all instruments and sample transfer lines are warmed up and stable and the following checks have been carried out:

a) leakage check: prior to a series of tests the system shall be checked for leakage by isolating the probe and the analysers, connecting and operating a vacuum pump of equivalent performance to that used in the smoke measurement system to verify that the system leakage flow rate is less than 0.4 L/min referred to normal temperature and pressure;

b) cleanliness check: isolate the gas sampling system from the probe and connect the end of the sampling line to a source of zero gas. Warm the system up to the operational temperature needed to perform hydrocarbon measurements. Operate the sample flow pump and set the flow rate to that used during engine emission testing. Record the hydrocarbon analyser reading. The reading shall not exceed 1 per cent of the engine idle emission level or 1 ppm (both expressed as methane), whichever is the greater.

Note 1.— It is good practice to back-purge the sampling lines during engine running, while the probe is in the engine exhaust but emissions are not being measured, to ensure that no significant contamination occurs.

Note. 2.— It is also good practice to monitor the inlet air quality at the start and end of testing and at least once per hour during a test. If levels are considered significant, then they should be taken into account.

6.3.2 The following procedure shall be adopted for operational measurements:

a) apply appropriate zero gas and make any necessary instrument adjustments;

b) apply appropriate calibration gas at a nominal 90 per cent FSD concentration for the ranges to be used, adjust and record gain settings accordingly;

c) when the engine has been stabilized at the requisite operating mode, continue to run it and observe pollutant concentrations until a stabilized reading is obtained, which shall be recorded;

d) recheck zero and calibration points at the end of the test and also at intervals not greater than 1 hour during tests. If either has changed by more than ±2 per cent of range FSD, the test shall be repeated after restoration of the instrument to within its specification.

6.4 Carbon balance check

Each test shall include a check that the air/fuel ratio as estimated from the integrated sample total carbon concentration exclusive of smoke, agrees with the estimate based on engine air/fuel ratio within ±15 per cent for the taxi/ground idle mode, and within 10 per cent for all other modes (*see* 7.1.2).

7. CALCULATIONS

7.1 Gaseous emissions

7.1.1 General

The analytical measurements made shall be the concentrations of the various classes of pollutant, as detected at their respective analysers for the several engine operation modes, and these values shall be reported. In addition, other parameters shall be computed and reported, as follows**.

7.1.2 Basic parameters

$$EI_p \text{ (emission index for component } p) = \frac{\text{mass of } p \text{ produced in g}}{\text{mass of fuel used in kg}}$$

$$EI(CO) = \left(\frac{[CO]}{[CO_2] + [CO] + [HC]}\right)\left(\frac{10^3 M_{CO}}{M_C + (n/m)M_H}\right)\left(1 + T(P_0/m)\right)$$

$$EI(HC) = \left(\frac{[HC]}{[CO_2] + [CO] + [HC]}\right)\left(\frac{10^3 M_{HC}}{M_C + (n/m)M_H}\right)\left(1 + T(P_0/m)\right)$$

$$\underset{(\text{as } NO_2)}{EI(NO_x)} = \left(\frac{[NO_x]}{[CO_2] + [CO] + [HC]}\right)\left(\frac{10^3 M_{NO_2}}{M_C + (n/m)M_H}\right)\left(1 + T(P_0/m)\right)$$

$$\text{Air/fuel ratio} = \left(P_0/m\right)\left(\frac{M_{AIR}}{M_C + (n/m)M_H}\right)$$

* Except for the CO_2 analyser, for which the value shall be ±100 ppm.

** A more comprehensive and precise alternative methodology which is acceptable is presented in Attachment E to this appendix.

where:

$$P_o/m = \frac{2Z - (n/m)}{4(1 + h - |TZ/2|)}$$

and

$$Z = \frac{2 - [CO] - (|2/x| - |y/2x|)\,[HC] + [NO_2]}{[CO_2] + [CO] + [HC]}$$

M_{AIR} molecular mass of dry air = 28.966 g or, where appropriate, = (32 R + 28.156 4 S + 44.011 T)g

M_{HC} molecular mass of exhaust hydrocarbons, taken as CH_4 = 16.043 g

M_{CO} molecular mass of CO = 28.011 g

M_{NO_2} molecular mass of NO_2 = 46.008 g

M_C atomic mass of carbon = 12.011 g

M_H atomic mass of hydrogen = 1.008 g

R concentration of O_2 in dry air, by volume = 0.209 5 normally

S concentration of N_2 + rare gases in dry air, by volume = 0.709 2 normally

T concentration of CO_2 in dry air, by volume = 0.000 3 normally

[HC] mean concentration of exhaust hydrocarbons vol/vol, expressed as carbon

[CO] mean concentration of CO vol/vol, wet

[CO_2] mean concentration of CO_2 vol/vol, wet

[NO_x] mean concentration of NO_x vol/vol, wet = [NO + NO_2]

[NO] mean concentration of NO in exhaust sample, vol/vol, wet

[NO_2] mean concentration of NO_2 in exhaust sample, vol/vol, wet

$$= \frac{([NO_x]_c - [NO])}{\eta}$$

$[NO_x]_c$ mean concentration of NO in exhaust sample after passing through the NO_2/NO converter, vol/vol, wet

η efficiency of NO_2/NO converter

h humidity of ambient air, vol water/vol dry air

m number of C atoms in characteristic fuel molecule

n number of H atoms in characteristic fuel molecule

x number of C atoms in characteristic exhaust hydrocarbon molecule

y number of H atoms in characteristic exhaust hydrocarbon molecule

The value of n/m, the ratio of the atomic hydrogen to atomic carbon of the fuel used, is evaluated by fuel type analysis. The ambient air humidity, h, shall be measured at each set condition. In the absence of contrary evidence as to the characterization (x,y) of the exhaust hydrocarbons, the values $x = 1$, $y = 4$ are to be used. If dry or semi-dry CO and CO_2 measurements are to be used then these shall first be converted to the equivalent wet concentration as shown in Attachment E to this appendix, which also contains interference correction formulas for use as required.

7.1.3 Correction of emission indices to reference conditions

Corrections shall be made to the measured engine emission indices for all pollutants in all relevant engine operating modes to account for deviations from the reference conditions (ISA at sea level) of the actual test inlet air conditions of temperature and pressure. The reference value for humidity shall be 0.00629 kg water/kg dry air.

Thus, EI corrected = $K \times$ EI measured,

where the generalized expression for K is:

$$K = (P_{Bref}/P_B)^a \times (FAR_{ref}/FAR_B)^b \times \exp(|T_{Bref} - T_B|/c) \times \exp(d|h - 0.006\,29|)$$

P_B Combustor inlet pressure, measured

T_B Combustor inlet temperature, measured

FAR_B Fuel/air ratio in the combustor

h Ambient air humidity

P_{ref} ISA sea level pressure

T_{ref} ISA sea level temperature

P_{Bref} Pressure at the combustor inlet of the engine tested (or the reference engine if the data is corrected to a reference engine) associated with T_B under ISA sea level conditions.

T_{Bref} Temperature at the combustor inlet under ISA sea level conditions for the engine tested (or the reference engine if the data is to be corrected to a reference engine). This temperature is the temperature associated with each thrust level specified for each mode.

FAR_{ref} Fuel/air ratio in the combustor under ISA sea level conditions for the engine tested (or the reference engine if the data is to be corrected to a reference engine).

a,b,c,d Specific constants which may vary for each pollutant and each engine type.

The combustor inlet parameters shall preferably be measured but may be calculated from ambient conditions by appropriate formulas.

7.1.4 Using the recommended curve fitting technique to relate emission indices to combustor inlet temperature effectively eliminates the exp $((T_{Bref} - T_B)/c)$ term from the generalized equation and for most cases the (FAR_{ref}/FAR_B) term may be considered unity. For the emissions indices of CO and HC many testing facilities have determined that the humidity term is sufficiently close to unity to be eliminated from the expression and that the exponent of the (P_{Bref}/P_B) term is close to unity.

Thus,

EI(CO) corrected = EI derived from
$(P_B/P_{Bref}) \cdot$ EI(CO) v. T_B curve

EI(HC) corrected = EI derived from
$(P_B/P_{Bref}) \cdot$ EI(HC) v. T_B curve

$EI(NO_x)$ corrected = EI derived from
$EI(NO_x)\ (P_{Bref}/P_B)^{0.5} \exp(19\,|\,h - 0.006\ 29\,|\,)$ v. T_B curve

If this recommended method for the CO and HC emissions index correction does not provide a satisfactory correlation, an alternative method using parameters derived from component tests may be used.

Any other methods used for making corrections to CO, HC and NO_x emission indices shall have the approval of the certificating authority.

7.2 Control parameter functions (D_p, F_{oo}, π)

7.2.1 Definitions

D_p The mass of any gaseous pollutant emitted during the reference emissions landing and take-off cycle.

F_{oo} The maximum thrust available for take-off under normal operating conditions at ISA sea level static conditions, without the use of water injection, as approved by the applicable certificating authority.

π The ratio of the mean total pressure at the last compressor discharge plane of the compressor to the mean total pressure at the compressor entry plane when the engine is developing take-off thrust rating at ISA sea level static conditions.

7.2.2 The emission indices (EI) for each pollutant, corrected for pressure and humidity (as appropriate) to the reference ambient atmospheric conditions as indicated in 7.1.4 and if necessary to the reference engine, shall be obtained for the required LTO engine operating mode settings (n) of idle, approach, climb-out and take-off, at each of the equivalent corrected thrust conditions. A minimum of three test points shall be required to define the idle mode. The following relationships shall be determined for each pollutant:

a) between EI and T_B ; and

b) between W_f (engine fuel mass flow rate) and T_B ; and

c) between F_n (corrected to ISA sea level conditions) and T_B (corrected to ISA sea level conditions);

Note.— These are illustrated, for example, by Figure 3-2 a), b) and c).

When the engine being tested is not a "reference" engine, the data may be corrected to "reference" engine conditions using the relationships b) and c) obtained from a reference engine. A reference engine is defined as an engine substantially configured to the description of the engine to be certificated and accepted by the certificating authority to be representative of the engine type for which certification is sought.

The manufacturer shall also supply to the certificating authority all of the necessary engine performance data to substantiate these relationships and for ISA sea level ambient conditions:

d) maximum rated thrust (F_{oo}); and

e) engine pressure ratio (π) at maximum rated thrust.

Note.— These are illustrated by Figure 3-2 d).

7.2.3 The estimation of EI for each pollutant at each of the required engine mode settings, corrected to the reference ambient conditions, shall comply with the following general procedure:

a) at each mode ISA thrust condition F_n, determine the equivalent combustor inlet temperature (T_B) (Figure 3-2 c));

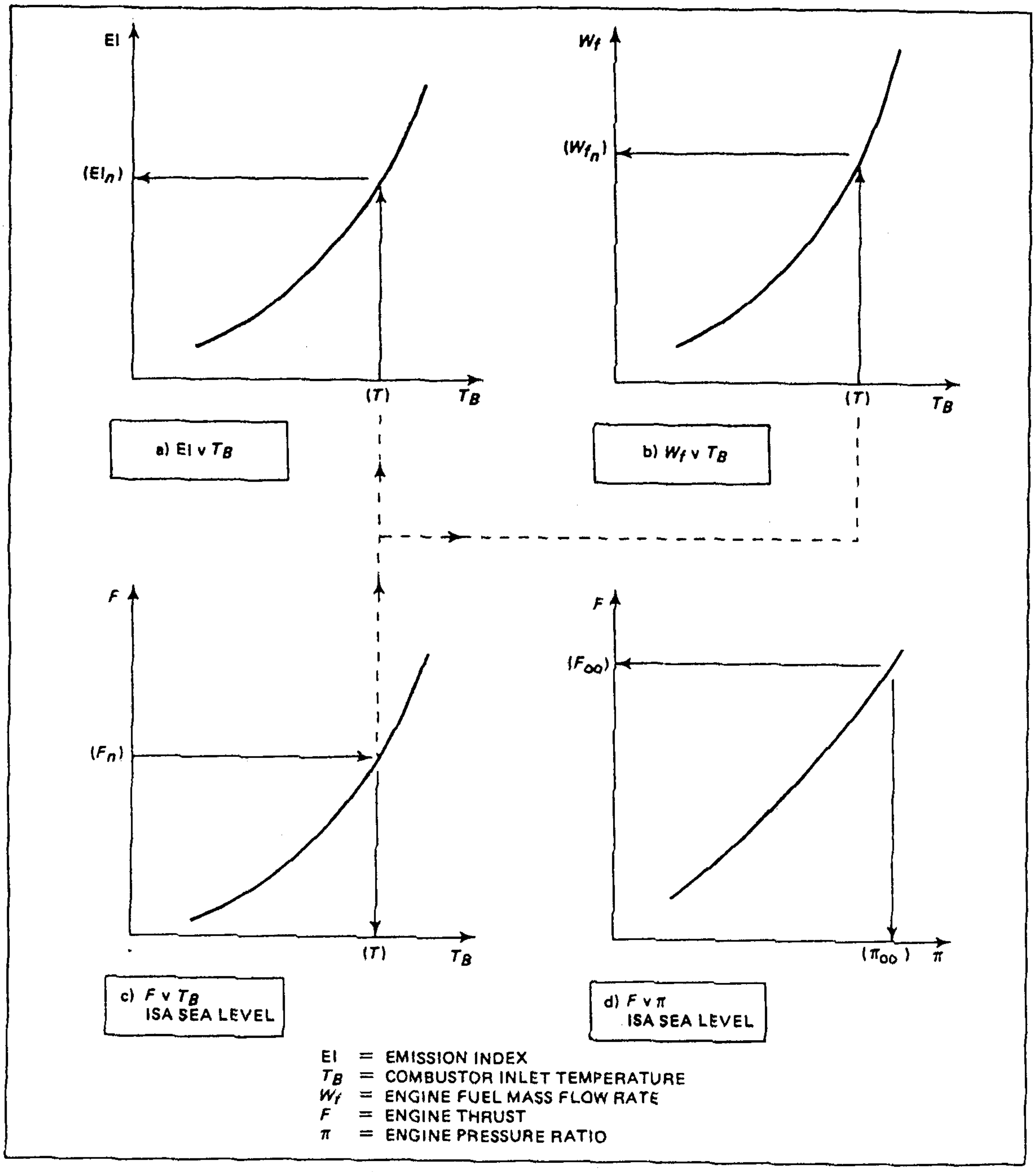

Figure 3-2. Calculation procedure

b) from the EI/T_B characteristic (Figure 3-2 a)), determine the EI_n value corresponding to T_B;

c) from the W_f/T_B characteristic (Figure 3-2 b)), determine the W_{f_n} value corresponding to T_B;

d) note the ISA maximum rated thrust and pressure ratio values. These are F_{oo} and π respectively (Figure 3-2 d));

e) calculate, for each pollutant $D_p = \Sigma\ (EI_n)\ (W_{f_n})\ (t)$ where:

t time in LTO mode (minutes)

W_{f_n} fuel mass flow rate (kg/min)

Σ is the summation for the set of modes comprising the reference LTO cycle.

7.2.4 While the methodology described above is the recommended method, the certificating authority may accept equivalent mathematical procedures which utilize mathematical expressions representing the curves illustrated if the expression have been derived using an accepted curve fitting technique.

7.3 Exceptions to the proposed procedures

In those cases where the configuration of the engine or other extenuating conditions exist which would prohibit the use of this procedure, the certificating authority, after receiving satisfactory technical evidence of equivalent results obtained by an alternative procedure, may approve an alternative procedure.

ATTACHMENT A TO APPENDIX 3. SPECIFICATION FOR HC ANALYSER

Note.— As outlined in 5.2 of Appendix 3, the measuring element in this analyser is the flame ionization detector (FID) in which the whole or a representative portion of the sample flow is admitted into a hydrogen-fuelled flame. With suitably positioned electrodes an ionization current can be established which is a function of the mass rate of hydrocarbon entering the flame. It is this current which, referred to an appropriate zero, is amplified and ranged to provide the output response as a measure of the hydrocarbon concentration expressed as ppmC equivalent.

1. GENERAL

Precautions: The performance specifications indicated are generally for analyser full scale. Errors at part scale may be a significantly greater percentage of reading. The relevance and importance of such increases shall be considered when preparing to make measurements. If better performance is necessary, then appropriate precautions shall be taken.

The instrument to be used shall be such as to maintain the temperature of the detector and sample-handling components at a set point temperature within the range 155°C to 165°C to a stability of ±2°C. The leading specification points shall be as follows, the detector response having been optimized and the instrument generally having stabilized:

a) *Total range:* 0 to 5 000 ppmC in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 0.5 ppmC, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used, or ±0.5 ppmC, whichever is greater.

d) *Stability:* better than ±2 per cent of full scale of range used or ±1.0 ppmC, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±0.5 ppmC, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1 per cent of full scale of range used or ±0.5 ppmC, whichever is greater.

g) *Response time:* shall not exceed 10 seconds from inlet of the sample to the analysis system, to the achievement of 90 per cent of the final reading.

h) *Linearity:* response with propane in air shall be linear for each range within ±2 per cent of full scale, otherwise calibration corrections shall be used.

2. SYNERGISTIC EFFECTS

Note.— In application there are two aspects of performance which can affect the accuracy of measurement:

a) the oxygen effect (whereby differing proportions of oxygen present in the sample give differing indicated hydrocarbon concentration for constant actual HC concentrations); and

b) the relative hydrocarbon response (whereby there is a different response to the same sample hydrocarbon concentrations expressed as equivalent ppmC, dependent on the class or admixture of classes of hydrocarbon compounds).

The magnitude of the effects noted above shall be determined as follows and limited accordingly.

Oxygen response: measure the response with two blends of propane, at approximately 500 ppmC concentration known to a relative accuracy of ±1 per cent, as follows:

1) propane in 10 ± 1 per cent O_2, balance N_2

2) propane in 21 ± 1 per cent O_2, balance N_2

If R_1 and R_2 are the respective normalized responses then $(R_1 - R_2)$ shall be less than 3 per cent of R_1.

Differential hydrocarbon response: measure the response with four blends of different hydrocarbons in air, at concentrations of approximately 500 ppmC, known to a relative accuracy of ±1 per cent, as follows:

a) propane in zero air

b) propylene in zero air

c) toluene in zero air

d) n-hexane in zero air.

If R_a, R_b, R_c and R_d are, respectively, the normalized responses (with respect to propane), then $(R_a - R_b)$, $(R_a - R_c)$ and $(R_a - R_d)$ shall each be less than 5 per cent of R_a.

3. OPTIMIZATION OF DETECTOR RESPONSE AND ALIGNMENT

3.1 The manufacturer's instructions for initial setting up procedures and ancillary services and supplies required shall be implemented, and the instrument allowed to stabilize. All setting adjustments shall involve iterative zero checking, and correction as necessary. Using as sample a mixture of approximately 500 ppmC of propane in air, the response characteristics for variations first in fuel flow and then, near an optimum fuel flow, for variations in dilution air flow to select its optimum shall be determined. The oxygen and differential hydrocarbon responses shall then be determined as indicated above.

3.2 The linearity of each analyser range shall be checked by applying propane in air samples at concentrations of approximately 30, 60 and 90 per cent of full scale. The maximum response deviation of any of these points from a least squares straight line (fitted to the points and zero) shall not exceed ±2 per cent of full scale value. If it does, a calibration curve shall be prepared for operational use.

ATTACHMENT B TO APPENDIX 3. SPECIFICATION FOR CO AND CO_2 ANALYSERS

Note.— Paragraph 5.3 of Appendix 3 summarizes the characteristics of the analysis sub-system to be employed for the individual measurements of CO and CO_2 concentrations in the exhaust gas sample. The instruments are based on the principle of non-dispersive absorption of infra-red radiation in parallel reference and sample gas cells. The required ranges of sensitivity are obtained by use of stacked sample cells or changes in electronic circuitry or both. Interferences from gases with overlapping absorption bands may be minimized by gas absorption filters and/or optical filters, preferably the latter.

Precautions: The performance specifications indicated are generally for analyser full scale. Errors at part scale may be a significantly greater percentage of reading. The relevance and importance of such increases shall be considered when preparing to make measurements. If better performance is necessary, then appropriate precautions shall be taken.

The principal performance specification shall be as follows:

CO Analyser

a) *Total range:* 0 to 2 500 ppm in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 1 ppm, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used, or ±2 ppm, whichever is greater.

d) *Stability:* better than ±2 per cent of full scale of range used or ±2 ppm, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±2 ppm, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1 per cent of full scale of range used or ±1 ppm, whichever is greater.

g) *Interferences:* to be limited with respect to indicated CO concentration as follows:

   1) less than 500 ppm/per cent ethylene concentration

   2) less than 2 ppm/per cent CO_2 concentration

   3) less than 2 ppm/per cent water vapour.*

If the interference limitation(s) for CO_2 and/or water vapour cannot be met, appropriate correction factors shall be determined, reported and applied.

Note.— It is recommended as consistent with good practice that such correction procedures be adopted in all cases.

CO_2 Analyser

a) *Total range:* 0 to 10 per cent in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 100 ppm, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used or ±100 ppm, whichever is greater.

* Need not apply where measurements are on a "dry" basis.

d) *Stability:* better than ±2 per cent of full scale of range used or ±100 ppm, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±100 ppm, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1 per cent of full scale of range used or ±100 ppm, whichever is greater.

g) The effect of oxygen (O_2) on the CO_2 analyser response shall be checked. For a change from 0 per cent O_2 to 21 per cent O_2, the response of a given CO_2 concentration shall not change by more than 2 per cent of reading. If this limit cannot be met an appropriate correction factor shall be applied.

Note.— It is recommended as consistent with good practice that such correction procedures be adopted in all cases.

CO and CO_2 Analysers

a) *Response time:* shall not exceed 10 seconds from inlet of the sample to the analysis system, to the achievement of 90 per cent of the final reading.

b) *Sample temperature:* the normal mode of operation is for analysis of the sample in its (untreated) "wet" condition. This requires that the sample cell and all other components in contact with the sample in this sub-system be maintained at a temperature of not less than 50°C, with a stability of ±2°C. The option to measure CO and CO_2 on a dry basis (with suitable water traps) is allowed, in which case unheated analysers are permissible and the interference limits for H_2O vapour removed, and subsequent correction for inlet water vapour and water of combustion is required.

c) *Calibration curves:*

i) Analysers with a linear signal output characteristic shall be checked on all working ranges using calibration gases at known concentrations of approximately 0, 30, 60 and 90 per cent of full scale. The maximum response deviation of any of these points from a least squares straight line, fitted to the points and the zero reading, shall not exceed ±2 per cent of the full scale value. If it does then a calibration curve shall be prepared for operational use.

ii) Analysers with a non-linear signal output characteristic, and those that do not meet the requirements of linearity given above, shall have calibration curves prepared for all working ranges using calibration gases at known concentrations of approximately 0, 30, 60 and 90 per cent of full scale. Additional mixes shall be used, if necessary, to define the curve shape properly.

ATTACHMENT C TO APPENDIX 3. SPECIFICATION FOR NO_x ANALYSER

1. As indicated in 5.4 of Appendix 3, the measurement of the oxides of nitrogen concentration shall be by the chemiluminescent technique in which radiation emitted by the reaction of NO and O_3 is measured. This method is not sensitive to NO_2 and therefore the sample shall be passed through a converter in which NO_2 is converted to NO before the measurement of total NO_x is made. Both the original NO and the total NO_x concentrations shall be recorded. Thus by difference, a measure of the NO_2 concentration shall be obtained.

2. The instrument to be used shall be complete with all necessary flow control components, such as regulators, valves, flowmeters, etc. Materials in contact with the sample gas shall be restricted to those which are resistant to attack by oxides of nitrogen, such as stainless steel, glass, etc. The temperature of the sample shall everywhere be maintained at values, consistent with the local pressures, which avoid condensation of water.

Precautions: The performance specifications indicated are generally for analyser full scale. Errors at part scale may be a significantly greater percentage of reading. The relevance and importance of such increases shall be considered when preparing to make measurements. If better performance is necessary, then appropriate precautions shall be taken.

3. The principal performance specification, determined for the instrument operated in an ambient temperature stable to within 2°C, shall be as follows:

a) *Total range:* 0 to 2 500 ppm in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 1 ppm, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used, or ±1 ppm, whichever is greater.

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d) *Stability:* better than ±2 per cent of full scale of range used or ±1 ppm, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±1 ppm, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1.0 per cent of full scale of range used or ±1 ppm, whichever is greater, in a period of 2 hours.

g) *Interference:* suppression for samples containing CO_2 and water vapour, shall be limited as follows:

— less than 0.05 per cent reading/per cent CO_2 concentration;

— less than 0.1 per cent reading/per cent water vapour concentration.

If the interference limitation(s) for CO_2 and/or water vapour cannot be met, appropriate correction factors shall be determined, reported and applied.

Note.— It is recommended as consistent with good practice that such correction procedures be adopted in all cases.

h) *Response time:* shall not exceed 10 seconds from inlet of the sample to the analysis system to the achievement of 90 per cent of the final reading.

i) *Linearity:* better than ±2 per cent of full scale of range used or ±2 ppm, whichever is greater.

j) *Converter:* this shall be designed and operated in such a matter as to reduce NO_2 present in the sample to NO. The converter shall not affect the NO originally in the sample.

The converter efficiency shall not be less than 90 per cent.

This efficiency value shall be used to correct the measured sample NO_2 value (i.e. $[NO_x]_c - [NO]$) to that which would have been obtained if the efficiency had not been 100 per cent.

ATTACHMENT D TO APPENDIX 3. CALIBRATION AND TEST GASES

Note.— The following table lists the gases which will cover the range of setting and calibration procedures, described elsewhere.

Analyser	*Gas*	*Accuracy**
HC	propane in 10 ±1 per cent O_2 balance N_2	±1 per cent
HC	propane in 21 ±1 per cent O_2 balance N_2	±1 per cent
HC	propylene in zero air	±1 per cent
HC	toluene in zero air	±1 per cent
HC	n-hexane in zero air	±1 per cent
HC	propane in zero air	±2 per cent or ±0.05 ppm**
CO	CO in air	±2 per cent or ±2 ppm**
CO_2	CO_2 in air	±2 per cent or ±100 ppm**
NO_x	NO in N_2	±2 per cent or ±1 ppm**

* Taken over the 95 per cent confidence interval.
** Whichever is greater.

Carbon monoxide and carbon dioxide calibration gases may be blended singly or as dual component mixtures. Three component mixtures of carbon monoxide, carbon dioxide and propane in zero air may be used, provided the stability of the mixture is assured.

Zero gas as specified for the CO, CO_2 and HC analysers shall be zero air (which includes "artificial" air with 20 to 22 per cent O_2 blended with N_2). For the NO_x analyser zero nitrogen shall be used as the zero gas. Impurities in both kinds of zero gas shall be restricted to be less than the following concentrations:

1 ppm C
1 ppm CO
100 ppm CO_2
1 ppm NO_x

The applicant shall ensure that commercial gases supplied to him do in fact meet this specification, or are so specified by the vendor.

ATTACHMENT E TO APPENDIX 3. THE CALCULATION OF THE EMISSIONS PARAMETERS — BASIS, MEASUREMENT CORRECTIONS AND ALTERNATIVE NUMERICAL METHOD

1. SYMBOLS

AFR	air/fuel ratio, the ratio of the mass flow rate of dry air to that of the fuel
EI	emission index; 10^3 × mass flow rate of gaseous emission product in exhaust per unit mass flow rate of fuel
K	ratio of concentration measured wet to that measured dry (after cold trap)
L, L'	analyser interference coefficient for interference by CO_2
M, M'	analyser interference coefficient for interference by H_2O
M_{AIR}	molecular mass of dry air = 28.966 g or, where appropriate, = (32 R + 28.156 4 S + 44.011 T) g
M_{CO}	molecular mass of CO = 28.011 g
M_{HC}	molecular mass of exhaust hydrocarbon, taken as CH_4 = 16.043 g
M_{NO_2}	molecular mass of NO_2 = 46.008 g
M_C	atomic mass of carbon = 12.011 g
M_H	atomic mass of hydrogen = 1.008 g
P_1	number of moles of CO_2 in the exhaust sample per mole of fuel
P_2	number of moles of N_2 in the exhaust sample per mole of fuel
P_3	number of moles of O_2 in the exhaust sample per mole of fuel
P_4	number of moles of H_2O in the exhaust sample per mole of fuel
P_5	number of moles of CO in the exhaust sample per mole of fuel
P_6	number of moles of C_xH_y in the exhaust sample per mole of fuel
P_7	number of moles of NO_2 in the exhaust sample per mole of fuel
P_8	number of moles of NO in the exhaust sample per mole of fuel
P_T	$P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_8$
R	concentration of O_2 in dry air, by volume = 0.2095 normally
S	concentration of N_2 + rare gases in dry air, by volume = 0.7902 normally
T	concentration of CO_2 in dry air, by volume = 0.0003 normally
P_0	number of moles of air per mole of fuel in initial air/fuel mixture
Z	symbol used and defined in 3.4
$[CO_2]$	mean concentration of CO_2 in exhaust sample, vol/vol
[CO]	mean concentration of CO in exhaust sample, vol/vol
[HC]	mean concentration of HC in exhaust sample, vol C/vol
[NO]	mean concentration of NO in exhaust sample, vol/vol
$[NO_2]$	mean concentration of NO_2 in exhaust sample, vol/vol
$[NO_x]$	mean concentration of NO and NO_2 in exhaust sample, vol/vol
$[NO_x]_c$	mean concentration of NO in exhaust sample, after passing through the NO_2/NO converter, vol/vol
$[NO_2]$	mean $= \dfrac{\left([NO_x]_c - [NO]\right)}{\eta}$
$[\ ]_d$	mean concentration in exhaust sample after cold trap, vol/vol
$[\ ]_m$	mean concentration measurement indicated before instrument correction applied, vol/vol

h	humidity of ambient air, vol water/vol dry air
h_d	humidity of exhaust sample leaving "drier" or "cold trap", vol water/vol dry sample
m	number of C atoms in characteristic fuel molecule
n	number of H atoms in characteristic fuel molecule
x	number of C atoms in characteristic exhaust hydrocarbon molecule
y	number of H atoms in characteristic exhaust hydrocarbon molecule
η	efficiency of NO_2/NO converter

2. BASIS OF CALCULATION OF EI AND AFR PARAMETERS

2.1 It is assumed that the balance between the original fuel and air mixture and the resultant state of the exhaust emissions as sampled can be represented by the following equation:

$$C_mH_n + P_0[R(O_2) + S(N_2) + T(CO_2) + h(H_2O)]$$
$$= P_1(CO_2) + P_2(N_2) + P_3(O_2) + P_4(H_2O)$$
$$+ P_5(CO) + P_6(C_xH_y) + P_7(NO_2) + P_8(NO)$$

from which the required parameters can, by definition, be expressed as

$$EI(CO) = P_5\left(\frac{10^3 M_{CO}}{mM_C + nM_H}\right)$$

$$EI(HC) = xP_6\left(\frac{10^3 M_{HC}}{mM_C + nM_H}\right) \text{ expressed as methane equivalent}$$

$$EI(NO_x) = (P_7 + P_8)\left(\frac{10^3 M_{NO_2}}{mM_C + nM_H}\right) \text{ expressed as } NO_2 \text{ equivalent}$$

$$AFR = P_0\left(\frac{M_{AIR}}{mM_C + nM_H}\right)$$

2.2 Values for fuel hydrocarbon composition (m, n) are assigned by fuel specification or analysis. If only the ratio n/m is so determined, the value $m = 12$ may be assigned. The mole fractions of the dry air constituents (R, S, T) are normally taken to be the recommended standard values but alternative values may be assigned, subject to the restriction $R + S + T = 1$ and the approval of the certificating authority.

2.3 The ambient air humidity, h, is as measured at each test condition. It is recommended that, in the absence of contrary evidence as to the characterization (x, y) of the exhaust hydrocarbon, values of $x = 1$ and $y = 4$ are assigned.

2.4 Determination of the remaining unknowns requires the solution of the following set of linear simultaneous equations, where (1) to (4) derive from the fundamental atomic conservation relationships and (5) to (9) represent the gaseous product concentration relationships.

$$m + TP_0 = P_1 + P_5 + xP_6 \quad (1)$$

$$n + 2hP_0 = 2P_4 + yP_6 \quad (2)$$

$$(2R + 2T + h)P_0 = 2P_1 + 2P_3 + P_4 + P_5 + 2P_7 + P_8 \quad (3)$$

$$2SP_0 = 2P_2 + P_7 + P_8 \quad (4)$$

$$[CO_2]\, P_T = P_1 \quad (5)$$

$$[CO]\, P_T = P_5 \quad (6)$$

$$[HC]\, P_T = xP_6 \quad (7)$$

$$[NO_x]_c\, P_T = \eta\, P_7 + P_8 \quad (8)$$

$$[NO]\, P_T = P_8 \quad (9)$$

$$P_T = P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_8 \quad (10)$$

The above set of conditional equations is for the case where all measured concentrations are true ones, that is, not subject to interference effects or to the need to correct for sample drying. In practice, interference effects are usually present to a significant degree in the CO, NO_x and NO measurements, and the option to measure CO_2 and CO on a dry or partially dry basis is often used. The necessary modifications to the relevant equations are described in 2.5 and 2.6.

2.5 The interference effects are mainly caused by the presence of CO_2 and H_2O in the sample which can affect the CO and the NO_x analysers in basically different ways. The CO analyser is prone to a zero-shifting effect and the NO_x analyser to a sensitivity change, represented thus:

$$[CO] = [CO]_m + L[CO_2] + M[H_2O]$$

$$\text{and } [NO_x]_c = [NO_x]_{cm}\,(1 + L'[CO_2] + M'[H_2O])$$

which transform into the following alternative equations to (6), (8) and (9), when interference effects require to be corrected,

$$[CO]_m P_T + LP_1 + MP_4 = P_5 \quad \ldots\ldots (6A)$$

$$[NO_x]_{cm} (P_T + L'P_1 + M'P_4) = \eta P_7 + P_8 \quad \ldots\ldots (8A)$$

$$[NO]_m (P_T + L'P_1 + M'P_4) = P_8 \quad \ldots\ldots (9A)$$

2.6 The option to measure CO_2 and CO concentrations on a dry or partially dry sample basis, that is, with a sample humidity reduced to h_d, requires the use of modified conditional equations as follows:

$$[CO_2]_d (P_T - P_4)(1 + h_d) = P_1 \quad \ldots\ldots (5A)$$

and

$$[CO]_d (P_T - P_4)(1 + h_d) = P_5$$

However, the CO analyser may also be subject to interference effects as described in 2.5 above and so the complete alternative CO measurement concentration equation becomes

$$[CO]_{md} (P_T - P_4)(1 + h_d) + LP_1 + Mh_d (P_T - P_4) = P_5 \quad \ldots\ldots (6B)$$

3. ANALYTICAL FORMULATIONS

3.1 General

Equations (1) to (10) can be reduced to yield the analytical formulations for the EI and AFR parameters, as given in 7.1 to this appendix. This reduction is a process of progressive elimination of the roots P_0, P_1 through P_8, P_T, making the assumptions that all concentration measurements are of the "wet" sample and do not require interference corrections or the like. In practice the option is often chosen to make the CO_2 and CO concentration measurements on a "dry" or "semi-dry" basis; also it is often found necessary to make interference corrections. Formulations for use in these various circumstances are given in 3.2, 3.3 and 3.4 below.

3.2 Equation for conversion of dry concentration measurements to wet basis

Concentration wet = K × concentration dry; that is,

$$[\ \ ] = K[\ \ ]_d$$

The following expression for K applies when CO and CO_2 are determined on a "dry" basis:

$$K = \frac{\left\{4 + (n/m)T + (|n/m|T - 2h)\left([NO_2] - (2[HC]/x)\right)\right.}{(2 + h)\left\{2 + (n/m)(1 + h_d)\left([CO_2]_d + [CO]_d\right)\right\}}$$

$$\frac{\left. + (2 + h)\left(|y/x| - |n/m|\right)[HC]\right\}(1 + h_d)}{-\left(|n/m|T - 2h\right)\left(1 - |1 + h_d|[CO]_d\right)}$$

3.3 Interference corrections

The measurements of CO and/or NO_x and NO may require corrections for interference by the sample CO_2 and water concentrations before use in the above analytical equations. Such corrections can normally be expressed in the following general ways:

$$[CO] = [CO]_m + L[CO_2] + M[H_2O]$$

$$[CO]_d = [CO]_{md} + L[CO_2]_d + M\left(\frac{h_d}{1 + h_d}\right)$$

$$[NO] = [NO]_m \left(1 + L'[CO_2] + M'[H_2O]\right)$$

$$\eta[NO_2] = \left([NO_x]_{cm} - [NO]_m\right)\left(1 + L'[CO_2] + M'[H_2O]\right)$$

3.4 Equation for estimation of sample water content

Water concentration in sample

$$[H_2O] = \frac{\left(|n/2m| + h|P_0/m|\right)\left([CO_2] + [CO] + [HC]\right)}{1 + T(P_0/m)} - (y/2x)[HC]$$

where

$$P_0/m = \frac{2Z - (n/m)}{4\left(1 + h - |TZ/2|\right)}$$

and

$$Z = \frac{2 - [CO] - \left(|2/x| - |y/2x|\right)[HC] + [NO_2]}{[CO_2] + [CO] + [HC]}$$

It should be noted that this estimate is a function of the various analyses concentration readings, which may themselves require water interference correction. For better accuracy an iterative procedure is required in these cases with successive recalculation of the water concentration until the requisite stability is obtained. The use of the alternative, numerical solution methodology (4) avoids this difficulty.

4. ALTERNATIVE METHODOLOGY — NUMERICAL SOLUTION

4.1 As an alternative to the analytical procedures summarized in 3 above, it is possible to obtain readily the emissions indices, fuel/air ratio, corrected wet concentrations, etc., by a numerical solution of equations (1) to (10) for each set of measurements, using a digital computer.

4.2 In the equation set (1) to (10) the actual concentration measurements are substituted using whichever of the alternative equations (5A), (6A), etc. applies for the particular measuring system, to take account of interference corrections and/or dried sample measurements.

4.3 Suitable simple two-dimensional array equation-solving computer programmes are widely available and their use for this purpose is convenient and flexible, allowing ready incorporation and identification of any sample drying options and interference or other corrections.

ATTACHMENT F TO APPENDIX 3. SPECIFICATIONS FOR ADDITIONAL DATA

As required in 3.2 of Appendix 3, in addition to the measured sample constituent concentrations, the following data shall also be provided:

a) inlet temperature: measured as the total temperature at a point within one diameter of the engine intake plane to an accuracy of ±0.5°C;

b) inlet humidity (kg water/kg dry air): measured at a point within 15 m of the intake plane ahead of the engine to an accuracy of ±5 per cent of reading;

c) atmospheric pressure: measured within 1 km of the engine test location and corrected as necessary to the test stand altitude to an accuracy of ±100 Pa;

d) fuel mass flow: by direct measurement to an accuracy of ±2 per cent;

e) fuel H/C ratio: defined as n/m, where C_mH_n is the equivalent hydrocarbon representation of the fuel used in the test and evaluated by reference to the engine fuel type analysis;

f) engine parameters:

   1) thrust: by direct measurement to an accuracy of ±1 per cent at take-off power and ±5 per cent at the minimum thrust used in the certification test, with linear variation between these points;

   2) rotation speed(s): by direct measurement to an accuracy of at least ±0.5 per cent;

   3) gas generator airflow: determined to an accuracy of ±2 per cent by reference to engine performance calibration.

The parameters a), b), d) and f) shall be determined at each engine emissions test setting, while c) shall be determined at intervals of not less than 1 hour over a period encompassing that of the emissions tests.

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APPENDIX 4. SPECIFICATION FOR FUEL TO BE USED IN AIRCRAFT TURBINE ENGINE EMISSION TESTING

Property	*Allowable range of values*
Density kg/m³ at 15°C	780 – 820
Distillation temperature, °C	
10% boiling point	155 – 201
Final boiling point	235 – 285
Net heat of combustion, MJ/kg	42.86 – 43.50
Aromatics, volume %	15 – 23
Naphthalenes, volume %	1.0 – 3.5
Smoke point, mm	20 – 28
Hydrogen, mass %	13.4 – 14.1
Sulphur, mass %	less than 0.3%
Kinematic viscosity at −20°C, mm²/s	2.5 – 6.5

APPENDIX 5. INSTRUMENTATION AND MEASUREMENT TECHNIQUES FOR GASEOUS EMISSIONS FROM AFTERBURNING GAS TURBINE ENGINES

1. INTRODUCTION

Note.— The procedures specified in this appendix are concerned with the acquisition of representative exhaust samples and their transmission to, and analysis by, the emissions measuring system. These procedures only apply when afterburning is employed. The methods proposed are representative of the best readily available and most established modern practice. The need to correct for ambient conditions is recognized and a method will be specified when one becomes available. Meanwhile any correction methods used when afterburning is employed should be approved by the certificating authority.

Variations in the procedure contained in this appendix shall only be allowed after prior application to and approval by the certificating authority.

2. DEFINITIONS

Where the following expressions are used without further explanation in this appendix, they have the meanings ascribed to them below:

Accuracy. The closeness with which a measurement approaches the true value established independently.

Calibration gas. A high accuracy reference gas to be used for alignment, adjustment and periodic checks of instruments.

Concentration. The volume fraction of the component of interest in the gas mixture — expressed as volume percentage or as parts per million.

Flame ionization detector. A hydrogen-air diffusion flame detector that produces a signal nominally proportional to the mass-flow rate of hydrocarbons entering the flame per unit of time — generally assumed responsive to the number of carbon atoms entering the flame.

Interference. Instrument response due to presence of components other than the gas (or vapour) that is to be measured.

Noise. Random variation in instrument output not associated with characteristics of the sample to which the instrument is responding, and distinguishable from its drift characteristics.

Non-dispersive infra-red analyser. An instrument that by absorption of infra-red energy selectively measures specific components.

Parts per million (ppm). The unit volume concentration of a gas per million unit volume of the gas mixture of which it is a part.

Parts per million carbon (ppmC). The mole fraction of hydrocarbon multiplied by 10^6 measured on a methane-equivalence basis. Thus, 1 ppm of methane is indicated as 1 ppmC. To convert ppm concentration of any hydrocarbon to an equivalent ppmC value, multiply ppm concentration by the number of carbon atoms per molecule of the gas. For example, 1 ppm propane translates as 3 ppmC hydrocarbon; 1 ppm hexane as 6 ppmC hydrocarbon.

Plume. Total external engine exhaust flow, including any ambient air with which the exhaust mixes.

Reference gas. A mixture of gases of specified and known composition used as the basis for interpreting instrument response in terms of the concentration of the gas to which the instrument is responding.

Repeatability. The closeness with which a measurement upon a given, invariant sample can be reproduced in short-term repetitions of the measurement with no intervening instrument adjustment.

Resolution. The smallest change in a measurement which can be detected.

Response. The change in instrument output signal that occurs with change in sample concentration. Also the output signal corresponding to a given sample concentration.

Stability. The closeness with which repeated measurements upon a given invariant sample can be maintained over a given period of time.

Zero drift. Time-related deviation of instrument output from zero set point when it is operating on gas free of the component to be measured.

Zero gas. A gas to be used in establishing the zero, or no-response, adjustment of an instrument.

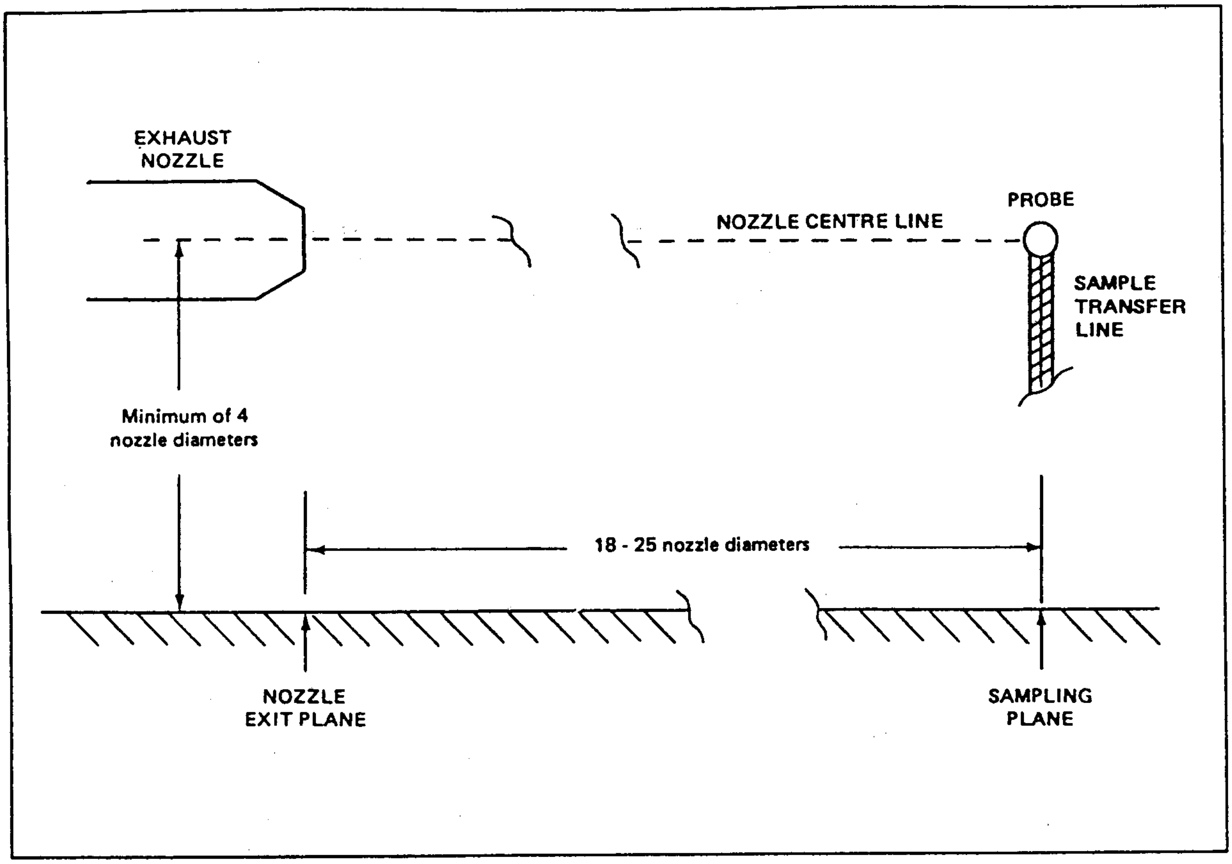

Figure 5-1. Exhaust gas sampling system, schematic

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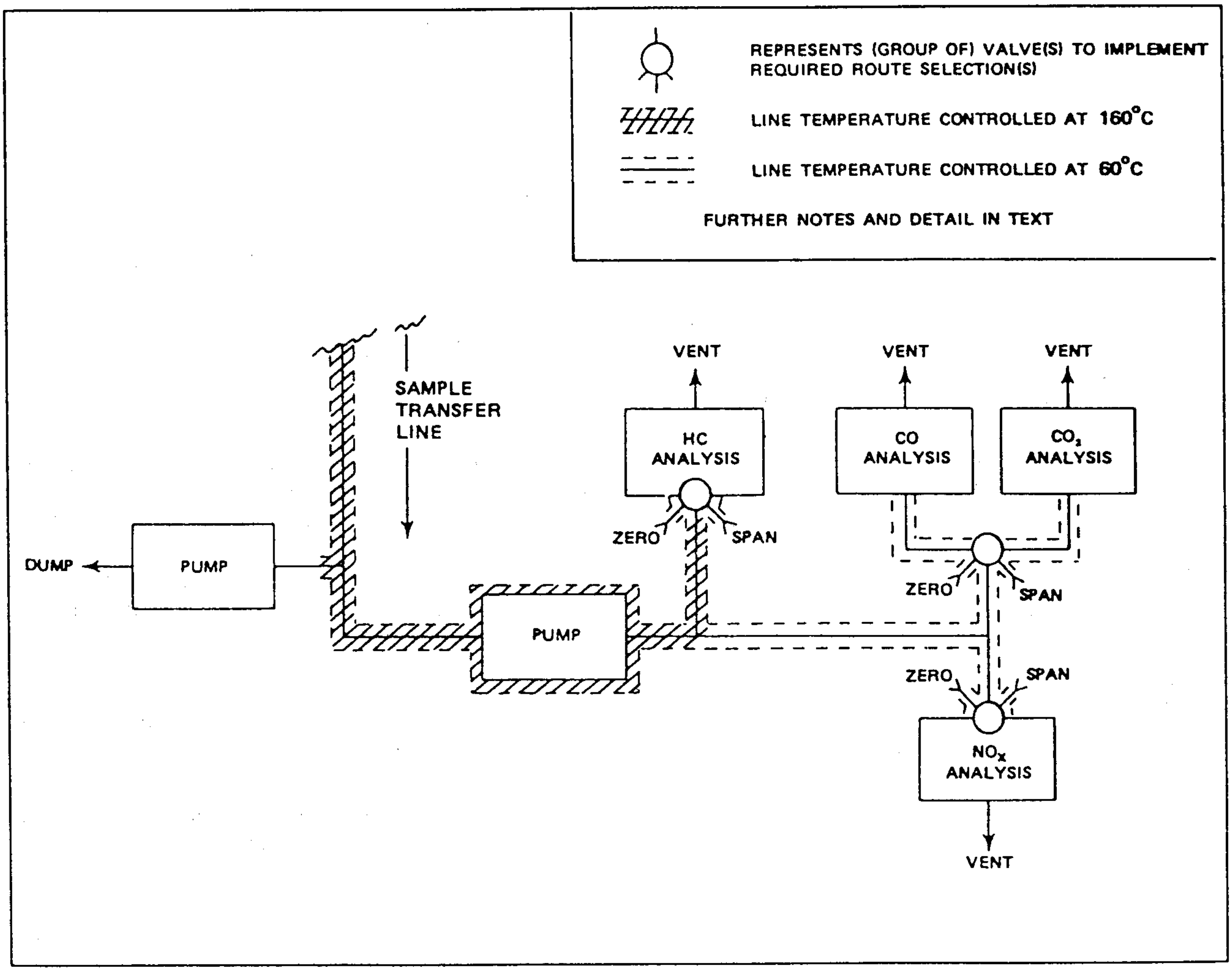

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Figure 5-2. Sample transfer and analysis system, schematic

3. DATA REQUIRED

3.1 Gaseous emissions

Concentrations of the following emissions shall be determined:

a) Hydrocarbons (HC): a combined estimate of all hydrocarbon compounds present in the exhaust gas.

b) Carbon monoxide (CO).

c) Carbon dioxide (CO_2).

Note.— CO_2 is not considered a pollutant but its concentration is required for calculation and check purposes.

d) Oxides of nitrogen (NO_x): an estimate of the sum of the two oxides, nitric oxide (NO) and nitrogen dioxide (NO_2).

e) Nitric oxide (NO).

3.2 Other information

In order to normalize the emissions measurement data and to quantify the engine test characteristics, other information in addition to the requirements of Chapter 3, 3.4 shall be provided as follows:

— inlet temperature;
— inlet humidity;
— atmospheric pressure;
— wind vectors relative to engine exhaust axis;
— hydrogen/carbon ratio of fuel;
— engine installation details;
— other required engine parameters (for example, thrust, rotor speeds, turbine temperatures);
— pollutant concentration data and statistical validation parameters.

This data shall be obtained either by direct measurement or by calculation, as presented in Attachment F to this appendix.

4. GENERAL ARRANGEMENT OF THE SYSTEM

Owing to the reactive nature of the exhaust plume from engines using afterburning, it is necessary to ensure that the measured emissions do in fact correspond to those actually emitted into the surrounding atmosphere. This is achieved by sampling the plume sufficiently far downstream from the engine that the exhaust gases have cooled to a temperature where reactions have ceased. No desiccants, dryers, water traps or related equipment shall be used to treat the exhaust sample flowing to the oxides of nitrogen and the hydrocarbon analysis instrumentation. Requirements for the various component sub-systems are given in 5, but the following list gives some qualifications and variations:

a) it is assumed that each of the various individual sub-systems includes the necessary flow control, conditioning and measurement facilities;

b) the necessity for a dump and/or a hot-sample pump will depend on the ability to meet the sample transfer time and analysis sub-system sample flow rate requirements. This in turn depends on the exhaust sample-driving pressure and line losses. It is considered that these pumps usually will be necessary at certain engine running conditions; and

c) the position of the hot pump, relative to the gas analysis sub-systems, may be varied as required. (For example, some HC analysers contain hot pumps and so may be judged capable of being used upstream of the system hot pump.)

Note.— Figures 5-1 and 5-2 are schematic drawings of the exhaust gas sampling and analytical system and typify the basic requirements for emissions testing.

5. DESCRIPTION OF COMPONENT PARTS

Note.— A general description and specification of the principal elements in the engine exhaust emissions measurement system follows. Greater detail, where necessary, will be found in Attachments A, B and C to this appendix.

5.1 Sampling system

5.1.1 Sampling probe

a) The probe shall be constructed so that individual samples can be withdrawn at various locations across a diameter of the plume. Mixed samples shall not be permitted.

b) The material with which the sample is in contact shall be stainless steel and its temperature shall be maintained at a value not less than 60°C.

c) The sampling plane shall be perpendicular to the projected engine nozzle centre line, and shall be situated as close as possible to a position 18 nozzle diameters from the nozzle exit plane, consistent with 7.1.2, but in no case greater than 25 nozzle diameters. The nozzle exit diameter shall be for the maximum engine power condition. Between and including exit and sampling planes there shall be an unobstructed region of at least 4 nozzle exit diameters in radial distance about the project engine nozzle centre line.

d) The miminum number of sampling points shall be equal to 11. The measurement plane, located at a distance X from the engine shall be divided into three sections demarcated by circles centred around the exhaust stream axis with radii

$R1 = 0.05X$
$R2 = 0.09X$

and a minimum of 3 samples shall be taken from each section. The difference between the number of samples in each section must be less than 3. The sample taken at the most remote distance from the axis shall be from a point located at a radius of between $0.11X$ and $0.16X$.

5.1.2 Sampling lines

The sample shall be transferred from the probe to the analysers via a line of 4.0 to 8.5 mm inside diameter, taking the shortest route practicable and using a flow rate such that the transport time is less than 10 seconds. The line shall be maintained at a temperature of 160°C ±15°C (with a stability of ±10°C). When sampling to measure HC, CO, CO_2 and NO_x components, the line shall be constructed in stainless steel or carbon-loaded grounded PTFE.

5.2 HC analyser

The measurement of total hydrocarbon sample content shall be made by an analyser using the heated flame ionization detector (FID), between the electrodes of which passes an ionization current proportional to the mass rate of hydrocarbon entering a hydrogen flame. The analyser shall be deemed to include components arranged to control temperature and flow rates of sample, sample bypass, fuel and diluent gases, and to enable effective span and zero calibration checks.

Note.— An over-all specification is given in Attachment A to this appendix.

5.3 CO and CO_2 analysers

Non-dispersive infra-red analysers shall be used for the measurement of these components, and shall be of the design which utilizes differential energy absorption in parallel reference and sample gas cells, the cell or group of cells for each of these gas constituents being sensitized appropriately. This analysis sub-system shall include all necessary functions for the control and handling of sample, zero and span gas flows. Temperature control shall be that appropriate to whichever basis of measurement, wet or dry, is chosen.

Note.— An over-all specification is given in Attachment B to this appendix.

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5.4 NO_x analyser

The measurement of NO concentration shall be by the chemiluminescent method in which the measure of the radiation intensity emitted during the reaction of the NO in the sample with added O_3 is the measure of the NO concentration. The NO_2 component shall be converted to NO in a converter of the requisite efficiency prior to measurement. The resultant NO_x measurement system shall include all necessary flow, temperature and other controls and provide for routine zero and span calibration as well as for converter efficiency checks.

Note.— An over-all specification is given in Attachment C to this appendix.

6. GENERAL TEST PROCEDURES

6.1 Engine operation

The engine shall be operated on an open air static test facility which is suitable and properly equipped for high accuracy performance testing, and which conforms to the requirements for sampling probe installation as specified in 5.1. The emissions tests shall be made at the power settings prescribed by the certificating authority. The engine shall be stabilized at each setting.

6.2 Ambient air conditions

6.2.1 A check shall be made on the ambient concentrations of CO, HC, CO_2 and NO_x, with the engine under test running at the test condition. Unusually high concentrations indicate abnormal conditions such as exhaust gas recirculation, fuel spillage or some other source of unwanted emissions in the test area and such situations shall be rectified or avoided as appropriate.

Note.— For guidance, the normal ambient concentration of CO_2 is 0.03 per cent, and ambient concentration levels for CO and HC of 5 ppm and NO_x of 0.5 ppm are unlikely to be exceeded under normal conditions.

6.2.2 Extreme climatic conditions, such a those involving precipitation or excessive wind speed shall also be avoided.

6.3 Major instrument calibration

Note.— The general objective of this calibration is to confirm stability and linearity.

6.3.1 The applicant shall satisfy the certificating authority that the calibration of the analytical system is valid at the time of the test.

6.3.2 For the hydrocarbon analyser this calibration shall include checks that the detector oxygen and differential hydrocarbon responses are within the limits specified in Attachment A to this appendix. The efficiency of the NO_2/NO converter shall also be checked and verified to meet the requirements in Attachment C to this appendix.

6.3.3 The procedure for checking the performance of each analyser shall be as follows (using the calibration and test gases as specified in Attachment D to this appendix):

a) introduce zero gas and adjust instrument zero, recording setting as appropriate;

b) for each range to be used operationally, introduce calibration gas of (nominally) 90 per cent range full-scale deflection (FSD) concentration; adjust instrument gain accordingly and record its setting;

c) introduce approximately 30 per cent, 60 per cent, and 90 per cent range FSD concentrations and record analyser readings;

d) fit a least squares straight line to the zero, 30 per cent, 60 per cent and 90 per cent concentration points. For the CO and/or CO_2 analyser used in its basic form without linearization of output, a least squares curve of appropriate mathematical formulation shall be fitted using additional calibration points if judged necessary. If any point deviates by more than 2 per cent of the full scale value (or ±1 ppm*, whichever is greater) then a calibration curve shall be prepared for operational use.

6.4 Operation

6.4.1 No measurements shall be made until all instruments and sample transfer lines are warmed up and stable and the following checks have been carried out:

a) leakage check: prior to a series of tests the system shall be checked for leakage by isolating the probe and the analysers, connecting and operating a vacuum pump of equivalent performance to that used in the smoke measurement system to verify that the system leakage flow rate is less than 0.4 L/min referred to normal temperature and pressure;

b) cleanliness check: isolate the gas sampling system from the probe and connect the end of the sampling line to a source of zero gas. Warm the system up to the operational temperature needed to perform hydrocarbon measurements. Operate the sample flow pump and set the flow rate to that used during engine emission testing. Record the hydrocarbon analyser reading. The reading shall not exceed 1 per cent of the engine idle emission level or 1 ppm (both expressed as methane), whichever is the greater.

Note 1.— It is good practice to back-purge the sampling lines during engine running, while the probe is in the engine exhaust but emissions are not being measured, to ensure that no significant contamination occurs.

Note. 2— It is also good practice to monitor the inlet air quality at the start and end of testing and at least once per hour during a test. If levels are considered significant, then they should be taken into account.

6.4.2 The following procedure shall be adopted for operational measurements:

a) apply appropriate zero gas and make any necessary instrument adjustments;

b) apply appropriate calibration gas at a nominal 90 per cent FSD concentration for the ranges to be used, adjust and record gain settings accordingly;

c) when the engine has been stabilized at the requisite operating conditions and sampling location, continue to run it and observe pollutant concentrations until a stabilized reading is obtained, which shall be recorded. At the same engine operating condition repeat the measurement procedure for each of the remaining sampling locations;

d) recheck zero and calibration points at the end of the test and also at intervals not greater than 1 hour during tests. If either has changed by more than ±2 per cent of full scale of range, the test shall be repeated after restoration of the instrument to within its specification.

7. CALCULATIONS

7.1 Gaseous emissions

7.1.1 General

The analytical measurements made shall be the concentrations of the various classes of pollutant, at the relevant afterburning mode(s) of the engine, at the various locations in the sampling plane. In addition to the recording of these basic parameters, other parameters shall be computed and reported, as follows.

* Except for the CO_2 analyser, for which the value shall be ±100 ppm.

7.1.2 Analysis and validation of measurements

a) At each engine setting, the concentrations measured at different probe sampling positions must be averaged as follows:

$$C_{i\,moy} = \sum_{j=1}^{n} C_{ij}$$

where

$\sum_{j=1}^{n}$ Summation of the total number n of sampling positions used.

C_{ij} Concentration of species i measured at the jth sampling position.

$C_{i\,moy}$ average or mean concentration of species i.

All dry concentration measurements shall be converted into real wet concentrations. (*See* Attachment E to this appendix).

b) The quality of the measurements for each pollutant will be determined through a comparison with measurements of CO_2 using the correlation coefficient:

$$r_i = \frac{n\sum_{j=1}^{n} C_{ij}CO_{2j} - \sum_{j=1}^{n} C_{ij}\sum_{j=1}^{n} CO_{2j}}{\sqrt{\left(\left\{n\sum_{j=1}^{n}(CO_{2j})^2 - \left(\sum_{j=1}^{n} CO_{2j}\right)^2\right\}\left\{n\sum_{j=1}^{n} C_{ij}^2 - \left(\sum_{j=1}^{n} C_{ij}\right)^2\right\}\right)}}$$

Values of r_i which are near to 1 indicate that measurements taken over the entire sampling period are sufficiently stable and that the curves are gaussian. In the event that r_i is less than 0.95, measurements must be repeated in a sampling plane located at a more remote distance from the aircraft engine. The measurement process, per se, is then followed by the same calculations and the same demonstration as previously.

7.1.3 Basic parameters

For the measurements at each engine operating mode the average concentration for each gaseous species is estimated as shown in 7.1.2, any necessary corrections for dry sample measurement and/or interferences having been made as indicated in Attachment E to this appendix. These average concentrations are used to compute the following basic parameters:

$$EI_p \text{ (emission index for component } p) = \frac{\text{mass of } p \text{ produced in g}}{\text{mass of fuel used in kg}}$$

$$EI(CO) = \left(\frac{[CO]}{[CO_2] + [CO] + [HC]}\right)\left(\frac{10^3 M_{CO}}{M_C + (n/m)M_H}\right)\left(1 + T(P_o/m)\right)$$

$$EI(HC) = \left(\frac{[HC]}{[CO_2] + [CO] + [HC]}\right)\left(\frac{10^3 M_{HC}}{M_C + (n/m)M_H}\right)\left(1 + T(P_o/m)\right)$$

$$\begin{matrix}EI(NO_x)\\(\text{as } NO_2)\end{matrix} = \left(\frac{[NO_x]}{[CO_2] + [CO] + [HC]}\right)\left(\frac{10^3 M_{NO_2}}{M_C + (n/m)M_H}\right)\left(1 + T(P_o/m)\right)$$

$$\text{Air/fuel ratio} = (P_o/m)\left(\frac{M_{AIR}}{M_C + (n/m)M_H}\right)$$

where:

$$P_o/m = \frac{2Z - (n/m)}{4(1 + h - |TZ/2|)}$$

and

$$Z = \frac{2 - [CO] - (|2/x| - |y/2x|)\,[HC] + [NO_2]}{[CO_2] + [CO] + [HC]}$$

M_{AIR} molecular mass of dry air = 28.966 g or, where appropriate, = (32 R + 28.156 4 S + 44.011 T) g

M_{HC} molecular mass of exhaust hydrocarbons, taken as CH_4 = 16.043 g

M_{CO} molecular mass of CO = 28.011 g

M_{NO_2} molecular mass of NO_2 = 46.088 g

M_C atomic mass of carbon = 12.011 g

M_H atomic mass of hydrogen = 1.008 g

R concentration of O_2 in dry air, by volume = 0.209 5 normally

S concentration of N_2 + rare gases in dry air, by volume = 0.709 2 normally

T concentration of CO_2 in dry air, by volume = 0.000 3 normally

[HC] mean concentration of exhaust hydrocarbons vol/vol, wet, expressed as carbon

[CO] mean concentration of CO vol/vol, wet

[CO_2] mean concentration of CO_2 vol/vol, wet

[NO_x] mean concentration of NO_x vol/vol, wet = [NO + NO_2]

[NO] mean concentration of NO in exhaust sample, vol/vol, wet

$[NO_2]$ — mean concentration of NO_2 in exhaust sample, vol/vol, wet

$$= \frac{([NO_x]_c - [NO])}{\eta}$$

$[NO_x]_c$ — mean concentration of NO in exhaust sample after passing through the NO_2/NO converter, vol/vol, wet

η — efficiency of NO_2/NO converter

h — humidity of ambient air, vol water/vol dry air

m — number of C atoms in characteristic fuel molecule

n — number of H atoms in characteristic fuel molecule

x — number of C atoms in characteristic exhaust hydrocarbon molecule

y — number of H atoms in characteristic exhaust hydrocarbon molecule

The value of *n/m*, the ratio of the atomic hydrogen to atomic carbon of fuel used, is evaluated by fuel type analysis. The ambient air humidity, *h*, shall be measured at each set condition. In the absence of contrary evidence as to the characterization (x,y) of the exhaust hydrocarbons, the values $x = 1$, $y = 4$ are to be used. If dry or semi-dry CO and CO_2 measurements are to be used then these shall first be converted to the equivalent wet concentrations as shown in Attachment E to this appendix, which also contains interference correction formulas for use as required.

Note.— The procedure given in 7.1.4 and 7.2 is only applicable to tests made when afterburning is not used. For tests when afterburning is used, a similar procedure could be used after approval by the certificating authority.

7.1.4 Correction of emission indices to reference conditions

Corrections shall be made to the measured engine emission indices for all pollutants in all relevant engine operating modes to account for deviations from the reference conditions (ISA at sea level) of the actual test inlet air conditions of temperature and pressure. The reference value for humidity shall be 0.006 29 kg water/kg dry air.

Thus, EI corrected = $K \times$ EI measured,

where the generalized expression for K is:

$$K = (P_{Bref}/P_B)^a \times (FAR_{ref}/FAR_B)^b \times \exp(|T_{Bref} - T_B|/c) \times \exp(d|h - 0.006\,29|)$$

P_B — Combustor inlet pressure, measured

T_B — Combustor inlet temperature, measured

FAR_B — Fuel/air ratio in the combustor

h — Ambient air humidity

P_{ref} — ISA sea level pressure

T_{ref} — ISA sea level temperature

P_{Bref} — Pressure at the combustor inlet of the engine tested (or the reference engine if the data is corrected to a reference engine) associated with T_B under ISA sea level conditions.

T_{Bref} — Temperature at the combustor inlet under ISA sea level conditions for the engine tested (or the reference engine if the data is to be corrected to a reference engine). This temperature is the temperature associated with each thrust level specified for each mode.

FAR_{ref} — Fuel/air ratio in the combustor under ISA sea level conditions for the engine tested (or the reference engine if the data is to be corrected to a reference engine).

a,b,c,d — Specific constants which may vary for each pollutant and each engine type.

The combustor inlet parameters shall preferably be measured but may be calculated from ambient conditions by appropriate formulas.

7.1.5 Using the recommended curve fitting technique to relate emission indices to combustor inlet temperature effectively eliminates the exp $(|T_{Bref} - T_B|/c)$ term from the generalized equation and for most cases the (FAR_{ref}/FAR_B) term may be considered unity. For the emissions indices of CO and HC many testing facilities have determined that the humidity term is sufficiently close to unity to be eliminated from the expression and that the exponent of the (P_{Bref}/P_B) term is close to unity.

Thus,

EI(CO) corrected = EI derived from $(P_B/P_{Bref}) \cdot$ EI(CO) v. T_B curve

EI(HC) corrected = EI derived from $(P_B/P_{Bref}) \cdot$ EI(HC) v. T_B curve

$EI(NO_x)$ corrected = EI derived from
$EI(NO_x)\ (P_{Bref}/P_B)^{0.5}\ \exp(19\,|\,h - 0.006\ 29\,|)$ v. T_B curve

If this recommended method for the CO and HC emissions index correction does not provide a satisfactory correlation, an alternative method using parameters derived from component tests may be used.

Any other methods used for making corrections to CO, HC and NO_x emissions indices shall have the approval of the certificating authority.

7.2 Control parameter functions (D_p, F_{oo}, π)

7.2.1 Definitions

D_p The mass of any gaseous pollutant emitted during the reference emissions landing and take-off cycle.

F_{oo} The maximum thrust available for take-off under normal operating conditions at ISA sea level static conditions, without the use of water injection, as approved by the applicable certificating authority.

π The ratio of the mean total pressure at the last compressor discharge plane of the compressor to the mean total pressure at the compressor entry plane when the engine is developing take-off thrust rating at ISA sea level static conditions.

7.2.2 The emission indices (EI) for each pollutant, corrected for pressure and humidity (as appropriate) to the reference ambient atmospheric conditions as indicated in 7.1.4 and if necessary to the reference engine, shall be obtained for the required LTO engine operating mode settings (n) of idle, approach, climb-out and take-off, at each of the equivalent corrected thrust conditions. A minimum of three test points shall be required to define the idle mode. The following relationships shall be determined for each pollutant:

a) between EI and T_B ; and

b) between W_f (engine fuel mass flow rate) and T_B ; and

c) between F_n (corrected to ISA sea level conditions) and T_B (corrected to ISA sea level conditions);

Note.— These are illustrated, for example, by Figure 5-3 a), b) and c).

When the engine being tested is not a "reference" engine, the data may be corrected to "reference" engine conditions using the relationships b) and c) obtained from a reference engine. A reference engine is defined as an engine substantially configured to the description of the engine to be certificated and accepted by the certificating authority to be representative of the engine type for which certification is sought.

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The manufacturer shall also supply to the certificating authority all of the necessary engine performance data to substantiate these relationships and for ISA sea level ambient conditions:

d) maximum rated thrust (F_{oo}); and

e) engine pressure ratio (π) at maximum rated thrust.

Note.— These are illustrated by Figure 5-3 d).

7.2.3 The estimation of EI for each pollutant at each of the required engine mode settings, corrected to the reference ambient conditions, shall comply with the following general procedure:

a) at each mode ISA thrust condition F_n, determine the equivalent combustor inlet temperature (T_B) (Figure 5-3 c));

b) from the EI/T_B characteristic (Figure 5-3 a)), determine the EI_n value corresponding to T_B;

c) from the W_f/T_B characteristics (Figure 5-3 b)), determine the W_{f_n} value corresponding to TB;

d) note the ISA maximum rated thrust and pressure ratio values. These are F_{oo} and π respectively (Figure 5-3 d));

e) calculate, for each pollutant $Dp = \Sigma\ (EI_n)\ (W_{f_n})\ (t)$ where:

t time in LTO mode (minutes)

W_{f_n} fuel mass flow rate (kg/min)

Σ is the summation for the set of modes comprising the reference LTO cycle.

7.2.4 While the methodology described above is the recommended method, the certificating authority may accept equivalent mathematical procedures which utilize mathematical expressions representing the curves illustrated if the expressions have been derived using an accepted curve fitting technique.

7.3 Exceptions to the proposed procedures

In those cases where the configuration of the engine or other extenuating conditions exist which would prohibit the use of this procedure, the certificating authority, after receiving satisfactory technical evidence of equivalent results obtained by an alternative procedure, may approve an alternative procedure.

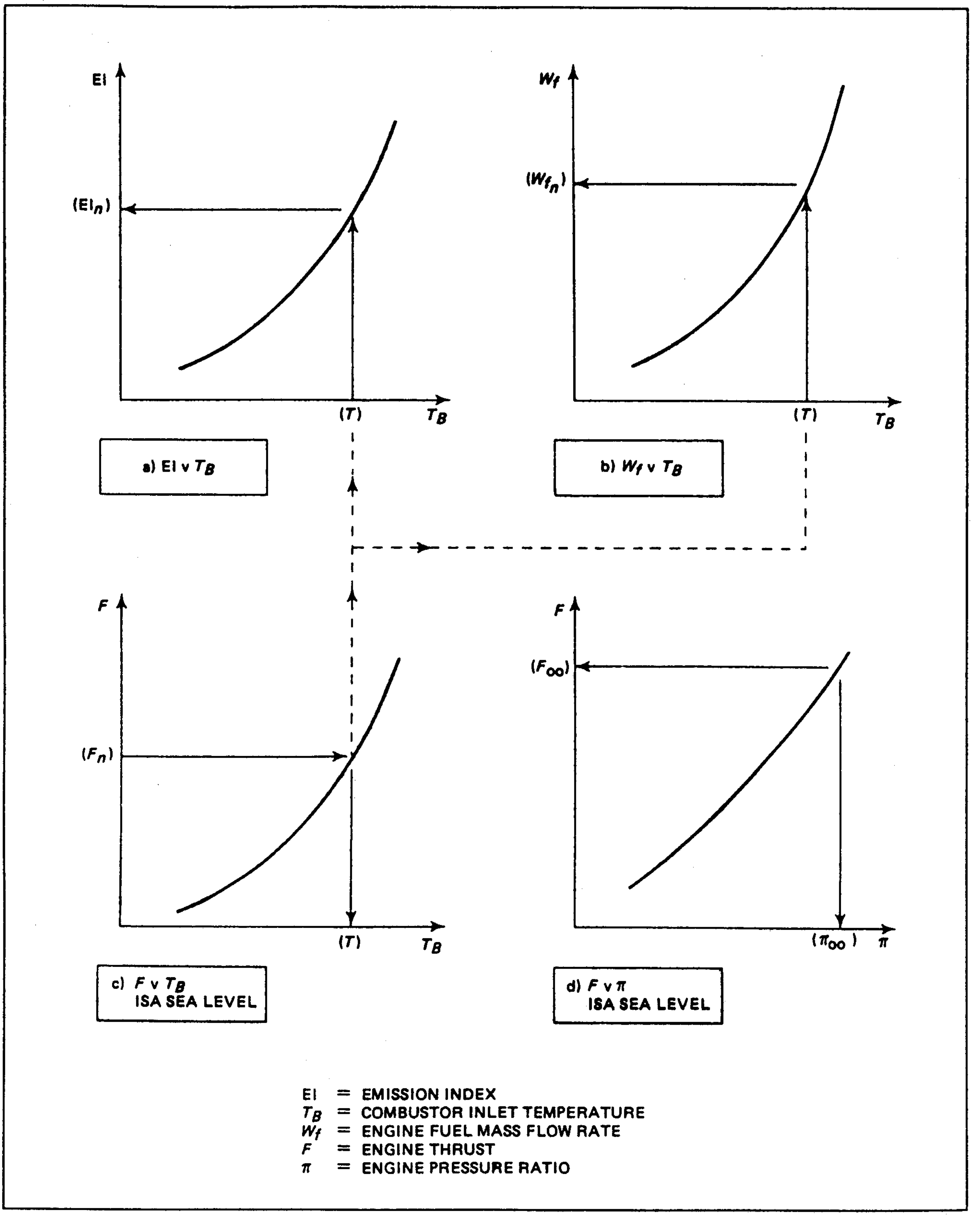

Figure 5-3. Calculation procedure

ATTACHMENT A TO APPENDIX 5. SPECIFICATION FOR HC ANALYSER

Note.— As outlined in 5.2 of Appendix 5, the measuring element in this analyser is the flame ionization detector (FID) in which the whole or a representative portion of the sample flow is admitted into a hydrogen-fuelled flame. With suitably positioned electrodes an ionization current can be established which is a function of the mass rate of hydrocarbon entering the flame. It is this current which, referred to an appropriate zero, is amplified and ranged to provide the output response as a measure of the hydrocarbon concentration expressed as ppmC equivalent.

1. GENERAL

Precautions: The performance specifications indicated are generally for analyser full scale. Errors at part scale may be a significantly greater percentage of reading. The relevance and importance of such increases shall be considered when preparing to make measurements. If better performance is necessary, then appropriate precautions shall be taken.

The instrument to be used shall be such as to maintain the temperature of the detector and sample-handling components at a set point temperature within the range 155°C to 165°C to a stability of ±2°C. The leading specification points shall be as follows, the detector response having been optimized and the instrument generally having stabilized:

a) *Total range:* 0 to 500 ppmC in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 0.5 ppmC, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used, or ±0.5 ppmC, whichever is greater.

d) *Stability:* better than ±2 per cent of full scale of range used or ±1 ppmC, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±0.5 ppmC, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1 per cent of full scale of range used or ±0.5 ppmC, whichever is greater.

g) *Response time:* shall not exceed 10 seconds from inlet of the sample to the analysis system, to the achievement of 90 per cent of the final reading.

h) *Linearity:* response with propane in air shall be linear for each range within ±2 per cent of full scale, otherwise calibration corrections shall be used.

2. SYNERGISTIC EFFECTS

Note.— In application there are two aspects of performance which can affect the accuracy of measurement:

a) the oxygen effect (whereby differing proportions of oxygen present in the sample give differing indicated hydrocarbon concentration for constant actual HC concentrations); and

b) the relative hydrocarbon response (whereby there is a different response to the same sample hydrocarbon concentrations expressed as equivalent ppmC, dependent on the class or admixture of classes of hydrocarbon compounds).

The magnitude of the effects noted above shall be determined as follows and limited accordingly.

Oxygen response: measure the response with two blends of propane, at approximately 500 ppmC concentration known to a relative accuracy of ±1 per cent, as follows:

1) propane in 10 ± 1 per cent O_2, balance N_2

2) propane in 21 ± 1 per cent O_2, balance N_2

If R_1 and R_2 are the respective normalized responses then $(R_1 - R_2)$ shall be less than 3 per cent of R_1.

Differential hydrocarbon response: measure the response with four blends of different hydrocarbons in air, at concentrations of approximately 500 ppmC, known to a relative accuracy of ±1 per cent, as follows:

a) propane in zero air

b) propylene in zero air

c) toluene in zero air

d) n-hexane in zero air.

If R_a, R_b, R_c and R_d are, respectively, the normalized responses (with respect to propane), then $(R_a - R_b)$, $(R_a - R_c)$ and $(R_a - R_d)$ shall each be less than 5 per cent of R_a.

3. OPTIMIZATION OF DETECTOR RESPONSE AND ALIGNMENT

3.1 The manufacturer's instructions for initial setting up procedures and ancillary services and supplies required shall be implemented, and the instrument allowed to stabilize. All setting adjustments shall involve iterative zero checking, and correction as necessary. Using as sample a mixture of approximately 500 ppmC of propane in air, the response characteristics for variations first in fuel flow and then, near an optimum fuel flow, for variations in dilution air flow to select its optimum shall be determined. The oxygen and differential hydrocarbon responses shall then be determined as indicated above.

3.2 The linearity of each analyser range shall be checked by applying propane in air samples at concentrations of approximately 30, 60 and 90 per cent of full scale. The maximum response deviation of any of these points from a least squares straight line (fitted to the points and zero) shall not exceed ±2 per cent of full scale value. If it does, a calibration curve shall be prepared for operational use.

ATTACHMENT B TO APPENDIX 5. SPECIFICATION FOR CO AND CO_2 ANALYSERS

Note.— Paragraph 5.3 of Appendix 5 summarizes the characteristics of the analysis sub-system to be employed for the individual measurements of CO and CO_2 concentrations in the exhaust gas sample. The instruments are based on the principle of non-dispersive absorption of infra-red radiation in parallel reference and sample gas cells. The required ranges of sensitivity are obtained by use of stacked sample cells or changes in electronic circuitry or both. Interferences from gases with overlapping absorption bands may be minimized by gas absorption filters and/or optical filters, preferably the latter.

Precautions: The performance specifications indicated are generally for analyser full scale. Errors at part scale may be a significantly greater percentage of reading. The relevance and importance of such increases shall be considered when preparing to make measurements. If better performance is necessary, then appropriate precautions shall be taken.

The principal performance specification shall be as follows:

CO Analyser

a) *Total range:* 0 to 2 500 ppm in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 1 ppm, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used, or ±2 ppm, whichever is greater.

d) *Stability:* better than ±2 per cent of full scale of range used or ±2 ppm, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±2 ppm, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1 per cent of full scale of range used or ±1 ppm, whichever is greater.

g) *Interferences:* to be limited with respect to indicated CO concentration as follows:

   1) less than 500 ppm/per cent ethylene concentration

   2) less than 2 ppm/per cent CO_2 concentration

   3) less than 2 ppm/per cent water vapour.*

If the interference limitation(s) for CO_2 and/or water vapour cannot be met, appropriate correction factors shall be determined, reported and applied.

Note.— It is recommended as consistent with good practice that such correction procedures be adopted in all cases.

CO_2 Analyser

a) *Total range:* 0 to 10 per cent in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 100 ppm, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used or ±100 ppm, whichever is greater.

* Need not apply where measurements are on a "dry" basis.

d) *Stability:* better than ±2 per cent of full scale of range used or ±100 ppm, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±100 ppm, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1 per cent of full scale of range used or ±100 ppm, whichever is greater.

g) The effect of oxygen (O_2) on the CO_2 analyser response shall be checked. For a change from 0 per cent O_2 to 21 per cent O_2 the response of a given CO_2 concentration shall not change by more than 2 per cent of reading. If this limit cannot be met an appropriate correction factor shall be applied.

Note.— It is recommended as consistent with good practice that such correction procedures be adopted in all cases.

CO and CO_2 Analysers

a) *Response time:* shall not exceed 10 seconds from inlet of the sample to the analysis system, to the achievement of 90 per cent of the final reading.

b) *Sample temperature:* the normal mode of operation is for analysis of the sample in its (untreated) "wet" condition. This requires that the sample cell and all other components in contact with the sample in this sub-system be maintained at a temperature of not less than 50°C, with a stability of ±2°C. The option to measure CO and CO_2 on a dry basis (with suitable water traps) is allowed, in which case unheated analysers are permissible and the interference limits for H_2O vapour removed, and subsequent correction for inlet water vapour and water of combustion is required.

c) *Calibration curves:*

i) Analysers with a linear signal output characteristic shall be checked on all working ranges using calibration gases at known concentrations of approximately 0, 30, 60 and 90 per cent of full scale. The maximum response deviation of any of these points from a least squares straight line, fitted to the points and the zero reading, shall not exceed ±2 per cent of the full scale value. If it does then a calibration curve shall be prepared for operational use.

ii) Analysers with a non-linear signal output characteristic, and those that do not meet the requirements of linearity given above, shall have calibration curves prepared for all working ranges using calibration gases at known concentrations of approximately 0, 30, 60 and 90 per cent of full scale. Additional mixes shall be used, if necessary, to define the curve shape properly.

ATTACHMENT C TO APPENDIX 5. SPECIFICATION FOR NO_x ANALYSER

1. As indicated in 5.4 of Appendix 5, the measurement of the oxides of nitrogen concentration shall be by the chemiluminescent technique in which radiation emitted by the reaction of NO and O_3 is measured. This method is not sensitive to NO_2 and therefore the sample shall be passed through a converter in which NO_2 is converted to NO before the measurement of total NO_x is made. Both the original NO and the total NO_x concentrations shall be recorded. Thus by difference, a measure of the NO_2 concentration shall be obtained.

2. The instrument to be used shall be complete with all necessary flow control components, such as regulators, valves, flowmeters, etc. Materials in contact with the sample gas shall be restricted to those which are resistant to attack by oxides of nitrogen, such as stainless steel, glass, etc. The temperature of the sample shall everywhere be maintained at values, consistent with the local pressures, which avoid condensation of water.

Precautions: The performance specifications indicated are generally for analyser full scale. Errors at part scale may be a significantly greater percentage of reading. The relevance and importance of such increases shall be considered when preparing to make measurements. If better performance is necessary, then appropriate precautions shall be taken.

3. The principal performance specification, determined for the instrument operated in an ambient temperature stable to within 2°C, shall be as follows:

a) *Total range:* 0 to 2 500 ppm in appropriate ranges.

b) *Resolution:* better than 0.5 per cent of full scale of range used or 1 ppm, whichever is greater.

c) *Repeatability:* better than ±1 per cent of full scale of range used, or ±1 ppm, whichever is greater.

d) *Stability:* better than ±2 per cent of full scale of range used or ±1 ppm, whichever is greater, in a period of 1 hour.

e) *Zero drift:* less than ±1 per cent of full scale of range used or ±1 ppm, whichever is greater, in a period of 1 hour.

f) *Noise:* 0.5 Hz and greater, less than ±1.0 per cent of full scale of range used or ±1 ppm, whichever is greater, in a period of 2 hours.

g) *Interference:* suppression for samples containing CO_2 and water vapour, shall be limited as follows:

— less than 0.05 per cent reading/per cent CO_2 concentration;

— less than 0.1 per cent reading/per cent water vapour concentration.

If the interference limitation(s) for CO_2 and/or water vapour cannot be met, appropriate correction factors shall be determined, reported and applied.

Note.— It is recommended as consistent with good practice that such correction procedures be adopted in all cases.

h) *Response time:* shall not exceed 10 seconds from inlet of the sample to the analysis system to the achievement of 90 per cent of the final reading.

i) *Linearity:* better than ±2 per cent of full scale of range used or ±2 ppm, whichever is greater.

j) *Converter:* this shall be designed and operated in such a matter as to reduce NO_2 present in the sample to NO. The converter shall not affect the NO originally in the sample.

The converter efficiency shall not be less than 90 per cent.

This efficiency value shall be used to correct the measured sample NO_2 value (i.e. $[NO_x]_c - [NO]$) to that which would have been obtained if the efficiency had not been 100 per cent.

ATTACHMENT D TO APPENDIX 5. CALIBRATION AND TEST GASES

Note.— The following table lists the gases which will cover the range of setting and calibration procedures, described elsewhere.

Analyser	*Gas*	*Accuracy**
HC	propane in 10 ±1 per cent O_2 balance N_2	±1 per cent
HC	propane in 21 ±1 per cent O_2 balance N_2	±1 per cent
HC	propylene in zero air	±1 per cent
HC	toluene in zero air	±1 per cent
HC	n-hexane in zero air	±1 per cent
HC	propane in zero air	±2 per cent or ±0.05 ppm**
CO	CO in air	±2 per cent or ±2 ppm**
CO_2	CO_2 in air	±2 per cent or ±100 ppm**
NO_x	NO in N_2	±2 per cent or ±1 ppm**

* Taken over the 95 per cent confidence interval.
** Whichever is greater.

Carbon monoxide and carbon dioxide calibration gases may be blended singly or as dual component mixtures. Three component mixtures of carbon monoxide, carbon dioxide and propane in zero air may be used, provided the stability of the mixture is assured.

Zero gas as specified for the CO, CO_2 and HC analysers shall be zero air (which includes "artificial" air with 20 to 22 per cent O_2 blended with N_2). For the NO_x analyser zero nitrogen shall be used as the zero gas. Impurities in both kinds of zero gas shall be restricted to be less than the following concentrations:

1 ppm C
1 ppm CO
100 ppm CO_2
1 ppm NO_x

The applicant shall ensure that commercial gases supplied to him do in fact meet this specification, or are so specified by the vendor.

ATTACHMENT E TO APPENDIX 5. THE CALCULATION OF THE EMISSIONS PARAMETERS — BASIS, MEASUREMENT CORRECTIONS AND ALTERNATIVE NUMERICAL METHOD

1. SYMBOLS

AFR	air/fuel ratio; the ratio of the mass flow rate of dry air to that of the fuel
EI	emission index; 10^3 × mass flow rate of gaseous emission product in exhaust per unit mass flow rate of fuel
K	ratio of concentration measured wet to that measured dry (after cold trap)
L, L'	analyser interference coefficient for interference by CO_2
M, M'	analyser interference coefficient for interference by H_2O
M_{AIR}	molecular mass of dry air = 28.966 g or, where appropriate, = (32 R + 28.156 4 S + 44.011 T) g
M_{CO}	molecular mass of CO = 28.011 g
M_{HC}	molecular mass of exhaust hydrocarbon, taken as CH_4 = 16.043 g
M_{NO_2}	molecular mass of NO_2 = 46.008 g
M_C	atomic mass of carbon = 12.011 g
M_H	atomic mass of hydrogen = 1.008 g
P_1	number of moles of CO_2 in the exhaust sample per mole of fuel
P_2	number of moles of N_2 in the exhaust sample per mole of fuel
P_3	number of moles of O_2 in the exhaust sample per mole of fuel
P_4	number of moles of H_2O in the exhaust sample per mole of fuel
P_5	number of moles of CO in the exhaust sample per mole of fuel
P_6	number of moles of C_xH_y in the exhaust sample per mole of fuel
P_7	number of moles of NO_2 in the exhaust sample per mole of fuel
P_8	number of moles of NO in the exhaust sample per mole of fuel
P_T	$P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_8$
R	concentration of O_2 in dry air, by volume = 0.2095 normally
S	concentration of N_2 + rare gases in dry air, by volume = 0.7902 normally
T	concentration of CO_2 in dry air, by volume = 0.0003 normally
P_0	number of moles of air per mole of fuel in initial air/fuel mixture
Z	symbol used and defined in 3.4
$[CO_2]$	mean concentration of CO_2 in exhaust sample, vol/vol
[CO]	mean concentration of CO in exhaust sample, vol/vol
[HC]	mean concentration of HC in exhaust sample, vol/vol
[NO]	mean concentration of NO in exhaust sample, vol/vol
$[NO_2]$	mean concentration of NO_2 in exhaust sample, vol/vol
$[NO_x]$	mean concentration of NO and NO_2 in exhaust sample, vol/vol
$[NO_x]_c$	mean concentration of NO in exhaust sample, after passing through the NO_2/NO converter, vol/vol
$[NO_2]$	mean $= \dfrac{([NO_x]_c - [NO])}{\eta}$
$[\ ]_d$	mean concentration in exhaust sample after cold trap, vol/vol
$[\ ]_m$	mean concentration measurement indicated before instrument correction applied, vol/vol
h	humidity of ambient air, vol water/vol dry air
h_d	humidity of exhaust sample leaving "drier" or "cold trap", vol water/vol dry sample

m number of C atoms in characteristic fuel molecule

n number of H atoms in characteristic fuel molecule

x number of C atoms in characteristic exhaust hydrocarbon molecule

y number of H atoms in characteristic exhaust hydrocarbon molecule

η efficiency of NO_2/NO converter

2. BASIS OF CALCULATION OF EI AND AFR PARAMETERS

2.1. It is assumed that the balance between the original fuel and air mixture and the resultant state of the exhaust emissions as sampled can be represented by the following equation:

$$C_mH_n + P_0[R(O_2) + S(N_2) + T(CO_2) + h(H_2O)]$$

$$= P_1(CO_2) + P_2(N_2) + P_3(O_2) + P_4(H_2O)$$

$$+ P_5(CO) + P_6(C_xH_y) + P_7(NO_2) + P_8(NO)$$

from which the required parameters can, by definition, be expressed as

$$EI(CO) = P_5\left(\frac{10^3 M_{CO}}{mM_C + nM_H}\right)$$

$$EI(HC) = xP_6\left(\frac{10^3 M_{HC}}{mM_C + nM_H}\right) \text{ expressed as methane equivalent}$$

$$EI(NO_x) = (P_7 + P_8)\left(\frac{10^3 M_{NO_2}}{mM_C + nM_H}\right) \text{ expressed as } NO_2 \text{ equivalent}$$

$$AFR = P_0\left(\frac{M_{AIR}}{mM_C + nM_H}\right)$$

2.2 Values for fuel hydrocarbon composition (m, n) are assigned by fuel specification or analysis. If only the ratio n/m is so determined, the value $m = 12$ may be assigned. The mole fractions of the dry air constituents (R, S, T) are normally taken to be the recommended standard values but alternative values may be assigned, subject to the restriction $R + S + T = 1$ and the approval of the certificating authority.

2.3 The ambient air humidity, h, is as measured at each test condition. It is recommended that, in the absence of contrary evidence as to the characterization (x, y) of the exhaust hydrocarbon, values of $x = 1$ and $y = 4$ are assigned.

2.4 Determination of the remaining unknowns requires the solution of the following set of linear simultaneous equations, where (1) to (4) derive from the fundamental atomic conservation relationships and (5) to (9) represent the gaseous product concentration relationships.

$$m + TP_0 = P_1 + P_5 + xP_6 \quad \ldots \quad (1)$$

$$n + 2hP_0 = 2P_4 + yP_6 \quad \ldots \quad (2)$$

$$(2R + 2T + h)P_0 = 2P_1 + 2P_3 + P_4 + P_5 + 2P_7 + P_8 \quad \ldots \quad (3)$$

$$2SP_0 = 2P_2 + P_7 + P_8 \quad \ldots \quad (4)$$

$$[CO_2]\, P_T = P_1 \quad \ldots \quad (5)$$

$$[CO]\, P_T = P_5 \quad \ldots \quad (6)$$

$$[HC]\, P_T = xP_6 \quad \ldots \quad (7)$$

$$[NO_x]_c P_T = \eta\, P_7 + P_8 \quad \ldots \quad (8)$$

$$[NO]\, P_T = P_8 \quad \ldots \quad (9)$$

$$P_T = P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_8 \quad \ldots \quad (10)$$

The above set of conditional equations is for the case where all measured concentrations are true ones, that is, not subject to interference effects or to the need to correct for sample drying. In practice, interference effects are usually present to a significant degree in the CO, NO_x and NO measurements, and the option to measure CO_2 and CO on a dry or partially dry basis is often used. The necessary modifications to the relevant equations are described in 2.5 and 2.6.

2.5 The interference effects are mainly caused by the presence of CO_2 and H_2O in the sample which can affect the CO and NO_x analysers in basically different ways. The CO analyser is prone to a zero-shifting effect and the NO_x analyser to a sensitivity change, represented thus:

$$[CO] = [CP]_m + L[CO_2] + M[H_2O]$$

and

$$[NO_x]_c = [NO_x]_{cm}\,(1 + L'[CO_2] + M'[H_2O])$$

which transform into the following alternative equations to (6), (8) and (9), when interference effects require to be corrected,

$$[CO]_m P_T + LP_1 + MP_4 = P_5 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6A)$$

$$[NO_x]_{cm} (P_T + L'P_1 + M'P_4) = \eta P_7 + P_8 \quad \ldots\ldots\ldots \quad (8A)$$

$$[NO]_m (P_T + L'P_1 + M'P_4) = P_8 \quad \ldots\ldots\ldots\ldots\ldots \quad (9A)$$

2.6 The option to measure CO_2 and CO concentrations on a dry or partially dry sample basis, that is, with a sample humidity reduced to h_d, requires the use of modified conditional equations as follows:

$$[CO_2]_d (P_T - P_4) (1 + h_d) = P_1 \quad \ldots\ldots\ldots\ldots\ldots \quad (5A)$$

and

$$[CO]_d (P_T - P_4) (1 + h_d) = P_5$$

However, the CO analyser may also be subject to interference effects as described in 2.5 above and so the complete alternative CO measurement concentration equation becomes

$$[CO]_{md} (P_T - P_4) (1 + h_d)$$
$$+ LP_1 + Mh_d (P_T - P_4) = P_5 \quad \ldots\ldots\ldots\ldots\ldots \quad (6B)$$

3. ANALYTICAL FORMULATIONS

3.1 General

Equations (1) to (10) can be reduced to yield the analytical formulations for the EI and AFR parameters, as given in 7.1 to this appendix. This reduction is a process of progressive elimination of the roots P_0, P_1 through P_8, P_T, making the assumptions that all concentration measurements are of the "wet" sample and do not require interference corrections or the like. In practice the option is often chosen to make the CO_2 and CO concentration measurements on a "dry" or "semi-dry" basis; also it is often found necessary to make interference corrections. Formulations for use in these various circumstances are given in 3.2, 3.3 and 3.4 below.

3.2 Equation for conversion of dry concentration measurements to wet basis

Concentration wet = K × concentration dry; that is,

$$[\ \ ] = K\,[\ \ ]_d$$

The following expression for K applies when CO and CO_2 are determined on a "dry" basis:

$$K = \frac{\left\{4 + (n/m)\,T + (|n/m|T - 2h)\left([NO_2] - (2[HC]/x)\right)\right.}{(2 + h)\left\{2 + (n/m)\,(1 + h_d)\left([CO_2]_d + [CO]_d\right)\right\}}$$

$$\frac{\left. + (2 + h)\left(|y/x| - |n/m|\right)[HC]\right\}(1 + h_d)}{-\left(|n/m|T - 2h\right)\left(1 - |1 + h_d|[CO]_d\right)}$$

3.3 Interference corrections

The measurements of CO and/or NO_x and NO may require corrections for interference by the sample CO_2 and water concentrations before use in the above analytical equations. Such corrections can normally be expressed in the following general ways:

$$[CO] = [CO]_m + L[CO_2] + M[H_2O]$$

$$[CO]_d = [CO]_{md} + L[CO_2]_d + M\left(\frac{h_d}{1 + h_d}\right)$$

$$[NO] = [NO]_m \left(1 + L'[CO_2] + M'[H_2O]\right)$$

$$\eta[NO_2] = \left([NO_x]_{cm} - [NO]_m\right)\left(1 + L'[CO_2] + M'[H_2O]\right)$$

3.4 Equation for estimation of sample water content

Water concentration in sample

$$[H_2O] = \frac{\left(|n/2m| + h|P_0/m|\right)\left([CO_2] + [CO] + [HC]\right)}{1 + T(P_0/m)} - (y/2x)\ [HC]$$

where

$$P_0/m = \frac{2Z - (n/m)}{4\left(1 + h - |TZ/2|\right)}$$

and

$$Z = \frac{2 - [CO] - \left(|2/x| - |y/2x|\right)[HC] + [NO_2]}{[CO_2] + [CO] + [HC]}$$

It should be noted that this estimate is a function of the various analyses concentration readings, which may themselves require water interference correction. For better accuracy an iterative procedure is required in these cases with successive recalculation of the water concentration until the requisite stability is obtained. The use of the alternative, numerical solution methodology (4) avoids this difficulty.

4. ALTERNATIVE METHODOLOGY — NUMERICAL SOLUTION

4.1 As an alternative to the analytical procedures summarized in 3 above, it is possible to obtain readily the emissions indices, fuel/air ratio, corrected wet concentrations, etc., by a numerical solution of equations (1) to (10) for each set of measurements, using a digital computer.

4.2 In the equation set (1) to (10) the actual concentration measurements are substituted using whichever of the alternative equations (5A), (6A), etc. applies for the particular measuring system, to take account of interference corrections and/or dried sample measurements.

4.3 Suitable simple two-dimensional array equation-solving computer programmes are widely available and their use for this purpose is convenient and flexible, allowing ready incorporation and identification of any sample drying options and interference or other corrections.

ATTACHMENT F TO APPENDIX 5. SPECIFICATIONS FOR ADDITIONAL DATA

As required in 3.2 of Appendix 5, in addition to the measured sample constituent concentrations, the following data shall also be provided:

a) inlet temperature: measured as the total temperature at a point within one diameter of the engine intake plane to an accuracy of ±0.5°C;

b) inlet humidity (kg water/kg dry air): measured at a point within 15 m of the intake plane ahead of the engine to an accuracy of ±5 per cent of reading;

c) atmospheric pressure: measured within 1 km of the engine test location and corrected as necessary to the test stand altitude to an accuracy of ±100 Pa;

d) fuel mass flow: by direct measurement to an accuracy of ±2 per cent;

e) fuel H/C ratio: defined as n/m, where C_mH_n is the equivalent hydrocarbon representation of the fuel used in the test and evaluated by reference to the engine fuel type analysis;

f) engine parameters:

1) thrust: by direct measurement to an accuracy of ±1 per cent at take-off power and ±5 per cent at the minimum thrust used in the certification test, with linear variation between these points;

2) rotation speed(s): by direct measurement to an accuracy of at least ±0.5 per cent;

3) gas generator airflow: determined to an accuracy of ±2 per cent by reference to engine performance calibration.

The parameters a), b), d) and f) shall be determined at each engine emissions test setting, while c) shall be determined at intervals of not less than 1 hour over a period encompassing that of the emissions tests.

APPENDIX 6. COMPLIANCE PROCEDURE FOR GASEOUS EMISSIONS AND SMOKE

1. GENERAL

The following general principles shall be followed for compliance with the regulatory levels set forth in Volume II, Part III, 2.2, 2.3, 3.2 and 3.3 of this Annex:

a) the manufacturer shall be allowed to select for certification testing any number of engines, including a single engine if so desired;

b) all the results obtained during the certification tests shall be taken into account by the certification authority;

c) a total of at least 3 engine tests shall be conducted, so that if a single engine is presented for certification it must be tested at least 3 times;

d) if a given engine is tested several times, the arithmetic mean value of the tests shall be considered to be the mean value for that engine. The certification result (X) is then the mean of the values (X_i) obtained for each engine tested;

e) the manufacturer shall provide to the certificating authority, the information specified in Volume II, Part III, 2.4 or 3.4 of this Annex as appropriate;

f) the engines submitted for testing shall have emissions features representative of the engine type for which certification is sought. However, at least one of the engines shall be substantially configured to the production standard of the engine type and have fully representative operating and performance characteristics. One of these engines shall be declared to be the reference standard engine. The methods for correcting to this reference standard engine from any other engines tested shall have the approval of the national certificating authority. The methods for correcting test results for ambient effects shall be those outlined in 7 of Appendix 3 or 7 of Appendix 5, as applicable.

2. COMPLIANCE PROCEDURES

The certificating authority shall award a certificate of compliance if the mean of the values measured and corrected (to the reference standard engine and reference ambient conditions) for all the engines tested, when converted to a characteristic level using the appropriate factor which is determined by the number of engines tested (i) as shown in the table below, does not exceed the regulatory level.

Note.— The characteristic level of the Smoke Number or gaseous pollutant emissions is the mean of the values of all the engines tested, measured and corrected to the reference standard engine and reference ambient conditions divided by the coefficient corresponding to the number of engines tested, as shown in the table below.

Number of engines tested (i)	CO	HC	NO_x	SN
1	0.814 7	0.649 3	0.862 7	0.776 9
2	0.877 7	0.768 5	0.909 4	0.852 7
3	0.924 6	0.857 2	0.944 1	0.909 1
4	0.934 7	0.876 4	0.951 6	0.921 3
5	0.941 6	0.889 4	0.956 7	0.929 6
6	0.946 7	0.899 0	0.960 5	0.935 8
7	0.950 6	0.906 5	0.963 4	0.940 5
8	0.953 8	0.912 6	0.965 8	0.944 4
9	0.956 5	0.917 6	0.967 7	0.947 6
10	0.958 7	0.921 8	0.969 4	0.950 2
more than 10	$1 - \frac{0.130\ 59}{\sqrt{i}}$	$1 - \frac{0.247\ 24}{\sqrt{i}}$	$1 - \frac{0.096\ 78}{\sqrt{i}}$	$1 - \frac{0.157\ 36}{\sqrt{i}}$

3. PROCEDURE IN THE CASE OF FAILURE

Note.— When a certification test fails, it does not necessarily mean that the engine type does not comply with the requirements, but it may mean that the confidence given to the certificating authority in compliance is not sufficiently high, i.e. less than 90 per cent. Consequently, the manufacturer should be allowed to present additional evidence of engine type compliance.

3.1 If an engine type fails a certification test, the certificating authority shall permit the manufacturer, if he so wishes, to conduct additional tests on the certification engines. If the total results available still show that the engine type fails the certification requirements, the manufacturer shall be allowed to test as many additional engines as desired. The resulting test results shall then be considered with all previous data.

3.2 If the result is still failure, the manufacturer shall be allowed to select one or more engines for modification. The results of the tests already made on the selected engine(s) while unmodified shall be inspected, and further testing shall be done so that at least three tests are available. The mean of these tests shall be determined for each engine and described as the "unmodified mean".

3.3 The engine(s) may then be modified, and at least three tests shall be conducted on the modified engine(s), the mean of which shall be described as the "modified mean" in each case. This "modified mean" shall be compared to the "unmodified mean" to give a proportional improvement which shall then be applied to the previous certification test result to determine if compliance has been achieved. It shall be determined before testing of any modified engine is begun that the modification(s) comply with the appropriate airworthiness requirements.

3.4 This procedure shall be repeated until compliance has been demonstrated or the engine type application is withdrawn.

— END —

11/11/93

**SUPPLEMENT TO ANNEX 16 —
ENVIRONMENTAL PROTECTION**

Volume II — Aircraft Engine Emissions

Second Edition

Differences between the national regulations and practices of Contracting States and the corresponding International Standards and Recommended Practices contained in Annex 16, Volume II as notified to ICAO in accordance with Article 38 of the *Convention on International Civil Aviation* and the Council's resolution of 21 November 1950.

DECEMBER 1994

INTERNATIONAL CIVIL AVIATION ORGANIZATION

RECORD OF AMENDMENTS TO SUPPLEMENT

No.	*Date*	*Entered by*

No.	*Date*	*Entered by*

AMENDMENTS TO ANNEX 16, VOLUME II ADOPTED OR APPROVED BY THE COUNCIL SUBSEQUENT TO THE SECOND EDITION ISSUED JULY 1993

No.	*Date of adoption or approval*	*Date applicable*

No.	*Date of adoption or approval*	*Date applicable*

1. Contracting States which have notified ICAO of differences

The Contracting States listed below have notified ICAO of differences which exist between their national regulations and practices and the International Standards of Annex 16, Volume II, Second Edition, or have commented on implementation.

The page numbers shown for each State and the dates of publication of those pages correspond to the actual pages in this Supplement.

State	*Date of notification*	*Pages in Supplement*	*Date of publication*
France	18/11/93	1	31/12/94
Netherlands, Kingdom of the	3/11/93	1	31/12/94
New Zealand	19/10/93	1	31/12/94
Qatar	22/6/93	1	31/12/94
Russian Federation	30/9/93	1	31/12/94
Saudi Arabia	16/7/93	1	31/12/94
Vanuatu	2/8/93	1	31/12/94

2. Contracting States which have notified ICAO that no differences exist

State	*Date of notification*
Argentina	2/9/93
Australia	2/8/93
Austria	26/7/93
Barbados	9/6/93
Canada	13/7/93
Chile	26/10/93
Cyprus	8/7/93
Denmark	12/10/93
Egypt	25/7/93
Fiji	12/7/93
Finland	28/4/93
Germany	30/9/93
Iceland	31/10/94
Ireland	10/10/93
Jordan	17/10/93
Lithuania	30/6/93
Norway	13/10/93
Poland	30/9/93
Portugal	12/1/94
Singapore	16/9/93
Turkey	24/6/93
Uganda	13/5/93
Uruguay	19/10/93

3. Contracting States from which no information has been received

Afghanistan
Albania
Algeria
Angola
Antigua and Barbuda
Armenia
Azerbaijan
Bahamas
Bahrain
Bangladesh
Belarus
Belgium
Belize
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Botswana
Brazil
Brunei Darussalam
Bulgaria
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Colombia
Comoros
Congo
Cook Islands
Costa Rica
Côte d'Ivoire
Croatia
Cuba
Czech Republic
Democratic People's Republic of Korea
Djibouti
Dominican Republic
Ecuador
El Salvador
Equatorial Guinea
Eritrea
Estonia
Ethiopia
Gabon
Gambia
Georgia
Ghana
Greece
Grenada
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hungary
India
Indonesia
Iran, Islamic Republic of
Iraq
Israel
Italy
Jamaica
Japan
Kazakhstan
Kenya
Kiribati
Kuwait
Kyrgyzstan
Lao People's Democratic Republic
Latvia
Lebanon
Lesotho
Liberia
Libyan Arab Jamahiriya
Luxembourg
Madagascar
Malawi
Malaysia
Maldives
Mali
Malta
Marshall Islands
Mauritania
Mauritius
Mexico
Micronesia, Federated States of
Monaco
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nauru
Nepal
Nicaragua
Niger
Nigeria
Oman
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Republic of Korea
Republic of Moldova
Romania
Rwanda
Saint Lucia
Saint Vincent and the Grenadines
San Marino
Sao Tome and Principe
Senegal
Seychelles
Sierra Leone
Slovakia
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syrian Arab Republic
Tajikistan
Thailand
The former Yugoslav Republic of Macedonia
Togo
Tonga
Trinidad and Tobago
Tunisia
Turkmenistan
Ukraine
United Arab Emirates
United Kingdom
United Republic of Tanzania
United States
Uzbekistan
Venezuela
Viet Nam
Yemen
Zaire
Zambia
Zimbabwe

31/12/94

4. Paragraphs with respect to which differences have been notified

Paragraph	*Differences notified by*
General	Netherlands, Kingdom of the
	New Zealand
	Qatar
	Russian Federation
	Saudi Arabia
	Vanuatu
Chapter 2	
General	France
Chapter 3	
General	France

31/12/94

FRANCE

Chapter 2

General — The new engines certificated in France meet the emission conditions specified by Chapters 2 and 3 of Annex 16, Volume II. To date, France still does not issue an emission certificate and does not make an explicit reference to these technical specifications in its regulations.

Chapter 3

General — The new engines certificated in France meet the emission conditions specified by Chapters 2 and 3 of Annex 16, Volume II. To date, France still does not issue an emission certificate and does not make an explicit reference to these technical specifications in its regulations.

31/12/94

NETHERLANDS, KINGDOM OF THE

General — Engine emission standards are not applicable. The Ministry of the Environment is responsible for setting emission standards. Discussions between the Ministry of Transport and the Ministry of the Environment on rulemaking have commenced.

31/12/94

NEW ZEALAND

General — New Zealand does not certificate aircraft with respect to the prevention of intentional fuel venting. New Zealand does not itself carry out aircraft engine emission certification.

31/12/94

QATAR

General No regulations for aircraft engine emissions exist currently in the State of Qatar and no specific date can be given at present regarding incorporation of the ICAO provisions in the national regulations.

31/12/94

SAUDI ARABIA

General Standards for control of aircraft engine emissions have not yet been established for the Kingdom of Saudi Arabia.

31/12/94

VANUATU

General While we do not disapprove of any of the amendments, we are not in a position to make a statement that differences will or will not exist on a certain date between the Vanuatu regulations and the Provisions of Annex 16, Volume I.

The Vanuatu Civil Aviation Directorate has been restructured and it is planned that as a result of this restructuring the necessary expertise will be available in approximately 12 months to commence a rewrite of the Vanuatu Civil Aviation Regulations. The rewrite will attempt to harmonize our regulations for the application of ICAO Standards with other States in the region.

As each part of our regulations is rewritten, we will advise you of any difference that may exist between our national rules and ICAO Standards.

31/12/94

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

SECURITY

SAFEGUARDING INTERNATIONAL CIVIL AVIATION AGAINST ACTS OF UNLAWFUL INTERFERENCE

ANNEX 17

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

FIFTH EDITION — DECEMBER 1992

This edition incorporates all amendments adopted by the Council prior to 12 September 1992 and supersedes on 1 April 1993 all previous editions of Annex 17.

For information regarding the applicability of the Standards and Recommended Practices, *see* Foreword.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio Visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date applicable	Date entered	Entered by
1-8	Incorporated in this edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

ATTACHMENT TO ANNEX 17

FOREWORD

Historical background

The material included in this Annex was developed by the Council pursuant to the following two resolutions of the Assembly:

Resolution A17-10: Implementation by States of Security Specifications and Practices adopted by this Assembly and further work by ICAO related to such Specifications and Practices

......

THE ASSEMBLY:

......

(3) REQUESTS the Council, with the assistance of the other constituent bodies of the Organization, to develop and incorporate, as appropriate, the material in the Appendices to this Resolution as Standards, Recommended Practices and Procedures in existing or new Annexes or other regulatory documents or guidance material of the Organization.

Resolution A18-10: Additional Technical Measures for the Protection of the Security of International Civil Air Transport

......

THE ASSEMBLY:

(1) REQUESTS the Council to ensure, with respect to the technical aspects of air transportation security, that:

(a) the subject of air transportation security continues to be given adequate attention by the Secretary General, with a priority commensurate with the current threat to the security of air transportation;

......

Following the work of the Air Navigation Commission, the Air Transport Committee and the Committee on Unlawful Interference, and as a result of the comments received from Contracting States and interested International Organizations, to whom draft material had been circulated, Standards and Recommended Practices on Security were adopted by the Council on 22 March 1974, pursuant to the provisions of Article 37 of the Convention on International Civil Aviation, and designated as Annex 17 to the Convention with the title "Standards and Recommended Practices — *Security* — Safeguarding International Civil Aviation against Acts of Unlawful Interference".

Table A shows the origin of subsequent amendments together with a list of the principal subjects involved and the dates on which the Annex and the amendments were adopted by the Council, when they became effective and when they became applicable.

Introduction

In order that a comprehensive document may be available to States for implementation of the security measures prescribed by this Annex, an Attachment hereto reproduces extracts from other Annexes, PANS-RAC and PANS-OPS bearing on the subject of action to be taken by States to prevent unlawful interference with civil aviation, or when such interference has been committed.

Guidance material

The *Security Manual for Safeguarding Civil Aviation Against Acts of Unlawful Interference* (Doc 8973) provides detailed procedures and guidance on aspects of aviation security and is intended to assist States in the implementation of their respective national civil aviation security programmes required by the specifications in the Annexes to the Convention on International Civil Aviation.

Action by Contracting States

Applicability. The provisions of the Standards and Recommended Practices in this document are to be applied by Contracting States.

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention, by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any difference previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each Amendment to this Annex.

Contracting States are also invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendment thereto, when the notification of such differences is important for the safety of air navigation.

Attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

Promulgation of information. Information relating to the establishment and withdrawal of and changes to facilities, services and procedures affecting aircraft operations provided according to the Standards and Recommended Practices specified in this Annex should be notified and take effect in accordance with Annex 15.

Use of the text of the Annex in national regulations. The Council, on 13 April 1948, adopted a resolution inviting the attention of Contracting States to the desirability of using in their own national regulations, as far as practicable, the precise language of those ICAO Standards that are of a regulatory character and also of indicating departures from the Standards, including any additional national regulations that were important for the safety or regularity of air navigation. Wherever possible, the provisions of this Annex have been written in such a way as would facilitate incorporation, without major textual changes, into national legislation.

General information

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38 of the Convention.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interests of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have an independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

This Annex has been adopted in five languages — English, Arabic, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

Any reference to a portion of this document which is identified by a number includes all subdivisions of that portion.

Table A. Amendments to Annex 17

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
1st Edition	Council action in pursuance of Assembly Resolutions A17-10 and A18-10	—	22 March 1974 22 August 1974 27 February 1975
1	Council action in pursuance of Assembly Resolution A21-23	Change in status of paragraphs 3.1.2 and 5.1.2 to a Standard; compilation and dissemination of information related to an aircraft being subjected to an act of unlawful interference.	31 March 1976 31 July 1976 30 December 1976
2	Proposals of some States and Council action in pursuance of Assembly Resolution A22-17	Transfer of specifications appearing in Chapter 9 of Annex 9 — Facilitation (Seventh Edition) to Annex 17; new provision in Chapter 5 concerning measures to be taken to control transfer and transit passengers and their cabin baggage; and amplification of the Note to paragraph 5.2.4 (Annex 17, Chapter 5) on measures and procedures to prevent unauthorized access to specified areas on an aerodrome.	15 December 1977 15 April 1978 10 August 1978
3	Proposals of some States and the Secretariat and Council action in pursuance of Assembly Resolution A22-17	Specifications were added on the review of the level of threat by States, the development of training programmes, the isolation of security processed passengers, the inspection of aircraft for concealed weapons or other dangerous devices and the adoption of measures for the safety of passengers and crew of unlawfully diverted aircraft. A number of specifications were amplified and the status of one was changed to a Standard, related to the segregation and special guarding of aircraft liable to attack during stopovers.	13 December 1978 13 April 1979 29 November 1979
4 (2nd Edition)	Proposals of some States and an international organization and Council action in pursuance of Assembly Resolution A22-17	A specification was added on the transportation of persons in custody, and two specifications revised to provide for aircraft which were leased, chartered or interchanged. The status of a specification dealing with the safety of passengers and crew of an aircraft subjected to an act of unlawful interference was changed to a Standard; the provisions of a specification dealing with the prevention of sabotage were amplified and Chapter 1. — Applicability, deleted.	15 June 1981 15 October 1981 26 November 1981
5	Proposals of the Committee on Unlawful Interference and Council action in pursuance of Assembly Resolution A22-17	The Note to Chapter 1 — Definitions was deleted. A specification setting out the action required for the transportation of weapons on board aircraft by law enforcement and other duly authorized persons was modified. A specification on the carriage of weapons in all other cases was added and the note to a specification dealing with the safeguarding of unattended aircraft was clarified.	30 November 1984 14 April 1985 21 November 1985
6 (3rd Edition)	Proposals of the Committee on Unlawful Interference with the assistance of an Ad Hoc Group of Experts — Unlawful Interference and Council action in pursuance of Assembly Resolution A22-17	On the instruction of the Council this amendment was undertaken as a matter of urgency by the Committee on Unlawful Interference with the assistance of an Ad Hoc Group of Experts on aviation security which had been appointed on the instruction of the Council. As a consequence 11 new specifications were introduced into the Annex and 19 specifications were adopted as Standards. Special effective and applicable dates for 5.1.4 are shown in the adjacent column. The Council recommended that those States that are able to implement the substance of 5.1.4 do so as soon as it is feasible and practicable before the applicable date.	19 December 1985 19 March 1986 19 May 1986 19 October 1987 19 December 1987

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
7 (4th Edition)	Proposals of the Committee on Unlawful Interference with the assistance of the Aviation Security Panel and Council action in pursuance of Assembly Resolution A26-7	This amendment includes: a) a reorganization of the chapters of the Annex directed at a rationalization of the sequence of objectives, obligations and necessary actions relating to organization, preventive security measures and management of response; b) the introduction of important new provisions to reflect developments and assist States in confronting new situations which arose from grave acts of unlawful interference against civil aviation, since the last revision of Annex 17 in 1985; and c) the amendment or fine tuning of existing provisions consequential to a) and b) above, as well as to reflect the experience gained in the implementation of such measures.	22 June 1989 30 October 1989 16 November 1989
8 (5th Edition)	Proposals of the Committee on Unlawful Interference with the assistance of the Aviation Security Panel (AVSECP) and Council action in pursuance of Assembly Resolution A27-7	This amendment includes the introduction of important new provisions in relation to the comprehensive security screening of checked baggage, security control over cargo, courier and express parcels and mail, variations to procedures relating to security programmes, pre-flight checks of international aircraft, and measures relating to the incorporation of security consideration into airport design for the purpose of assisting States in the consistent and uniform implementation of such measures.	11 September 1992 16 December 1992 1 April 1993

1/4/93

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

Air side. The movement area of an airport, adjacent terrain and buildings or portions thereof, access to which is controlled.

Known shipper. An agent, freight forwarder or any other entity who conducts business with an operator and provides security controls that are accepted by the appropriate authority in respect of cargo, courier and express parcels or mail.

Screening. The application of technical or other means which are intended to detect weapons, explosives or other dangerous devices which may be used to commit an act of unlawful interference.

Security. A combination of measures and human and material resources intended to safeguard international civil aviation against acts of unlawful interference.

Security Control. A means by which the introduction of weapons, explosives or articles likely to be utilized to commit an act of unlawful interference can be prevented.

Security Programme. Measures adopted to safeguard international civil aviation against acts of unlawful interference.

CHAPTER 2. GENERAL

2.1 Aims and objectives

2.1.1 The aim of aviation security shall be to safeguard international civil aviation operations against acts of unlawful interference.

2.1.2 Safety of passengers, crew, ground personnel and the general public shall be the primary objective of each Contracting State in all matters related to safeguarding against acts of unlawful interference with international civil aviation.

2.1.3 Each Contracting State shall establish an organization, develop plans and implement procedures, which together provide a standardized level of security for the operation of international flights in normal operating conditions and which are capable of rapid expansion to meet any increased security threat.

2.2 Security and facilitation

2.2.1 **Recommendation.—** *Each Contracting State should whenever possible arrange for the security measures and procedures to cause a minimum of interference with, or delay to the activities of, international civil aviation.*

Note.— Guidance material on achieving international civil aviation security objectives through application of the Standards and Recommended Practices in the following chapters is to be found in the Security Manual for Safeguarding Civil Aviation Against Acts of Unlawful Interference *(Doc 8973).*

CHAPTER 3. ORGANIZATION

3.1 National organization

3.1.1 Each Contracting State shall establish a national civil aviation security programme.

3.1.2 Each Contracting State shall ensure that the objective of their national civil aviation security programme shall be to protect the safety, regularity and efficiency of international civil aviation by providing, through regulations, practices and procedures, safeguards against acts of unlawful interference.

3.1.3 Each Contracting State shall designate an appropriate authority within its administration to be responsible for the development, implementation and maintenance of the national civil aviation security programme.

3.1.4 Each Contracting State shall specify to ICAO the appropriate authority designated under 3.1.3.

3.1.5 Each Contracting State shall keep under constant review the level of threat within its territory taking into account the international situation and adjust relevant elements of its national civil aviation security programme accordingly.

3.1.6 Each Contracting State shall require the appropriate authority to establish means of co-ordinating activities between the departments, agencies and other organizations of the State concerned with or responsible for various aspects of the national civil aviation security programme.

3.1.7 Each Contracting State shall require the appropriate authority to define and allocate the tasks for implementation of the national civil aviation security programme as between agencies of the State, airport administrations, operators and others concerned.

3.1.8 Each Contracting State shall ensure the establishment of an airport security programme, adequate to the needs of international traffic, for each airport serving international civil aviation.

3.1.9 **Recommendation.—** *Each Contracting State should make available to its airport administrations, airlines operating in its territory and others concerned, a written version of the appropriate parts of its national civil aviation security programme.*

3.1.10 Each Contracting State shall arrange for an authority at each airport serving international civil aviation to be responsible for co-ordinating the implementation of security measures.

3.1.11 Each Contracting State shall arrange for the establishment of airport security committees to advise on the development and co-ordination of security measures and procedures at each airport serving international civil aviation.

3.1.12 **Recommendation.—** *Each Contracting State should ensure that arrangements are made for the investigation of suspected sabotage devices or other potential hazards at airports serving international civil aviation and for their disposal.*

3.1.13 Each Contracting State shall ensure that duly authorized and suitably trained officers are readily available for deployment at their airports serving international civil aviation to assist in dealing with suspected, or actual, cases of unlawful interference with international civil aviation.

3.1.14 Each Contracting State shall ensure that the appropriate authority arranges for the supporting facilities required by the security services at each airport serving international civil aviation.

3.1.15 Each Contracting State shall ensure that contingency plans are developed and resources made available to safeguard airports and ground facilities used in international civil aviation, against acts of unlawful interference.

3.1.16 Each Contracting State shall require the appropriate authority to ensure the development and implementation of training programmes to ensure the effectiveness of its national civil aviation security programme.

3.1.17 Each Contracting State shall require operators providing service from that State to implement a security programme appropriate to meet the requirements of the national civil aviation security programme of that State.

3.1.18 **Recommendation.—** *Each Contracting State should promote whenever possible research and development of new security equipment which will better satisfy international civil aviation security objectives.*

3.2 International co-operation

3.2.1 Each Contracting State shall co-operate with other States in order to adapt their respective national civil aviation security programmes as necessary.

3.2.1.1 **Recommendation.—** *Each Contracting State should make available to other States on request a written version of the appropriate parts of its national civil aviation security programme.*

3.2.1.2 **Recommendation.—** *Each Contracting State should include in its bilateral agreements on air transport a clause related to aviation security.*

3.2.2 Each Contracting State shall ensure that requests from other States for special security measures in respect of a specific flight or specified flights by operators of such other States, as far as may be practicable, are met.

3.2.3 Contracting States shall, as necessary, co-operate with each other in the development and exchange of information concerning training programmes.

3.2.4 **Recommendation.—** *Each Contracting State should co-operate with other States in the field of research and development of new security equipment which will better satisfy international civil aviation security objectives.*

CHAPTER 4. PREVENTIVE SECURITY MEASURES

4.1 General objectives of the measures

4.1.1 Each Contracting State shall establish measures to prevent weapons, explosives or any other dangerous devices which may be used to commit an act of unlawful interference, the carriage or bearing of which is not authorized, from being introduced, by any means whatsoever, on board an aircraft engaged in international civil aviation.

Note.— In applying this Standard, special attention must be paid to the threat posed by explosive devices concealed in, or using electric, electronic or battery-operated items carried as hand baggage and/or in checked baggage. Guidance on this matter is to be found in the Security Manual for Safeguarding Civil Aviation Against Acts of Unlawful Interference *(Doc 8973).*

4.1.2 **Recommendation.—** *Contracting States should ensure that the carriage of weapons on board aircraft, by law enforcement officers and other authorized persons, acting in the performance of their duties, requires special authorization in accordance with the laws of the States involved.*

4.1.2.1 **Recommendation.—** *Contracting States should ensure that the carriage of weapons in other cases is allowed only when an authorized and duly qualified person has determined that they are not loaded, if applicable, and then only if stowed in a place inaccessible to any person during flight time.*

4.1.2.2 **Recommendation.—** *Contracting States should ensure that the pilot-in-command is notified as to the number of armed persons and their seat location.*

4.1.3 Each Contracting State shall ensure that pre-flight checks of originating aircraft assigned to international flights include measures to discover suspicious objects or anomalies that could conceal weapons, explosives or any other dangerous devices.

4.1.4 Each Contracting State shall establish procedures, which include notification to the operator, for inspecting aircraft, when a well-founded suspicion exists that the aircraft may be the object of an act of unlawful interference, for concealed weapons, explosives or other dangerous devices.

4.1.5 Each Contracting State shall establish measures to safeguard aircraft when a well-founded suspicion exists that the aircraft may be attacked while on the ground and to provide as much prior notification as possible of the arrival of such aircraft to airport authorities.

4.1.6 Each Contracting State shall arrange for surveys and inspections of security measures.

4.2 Measures relating to passengers and their cabin baggage

4.2.1 Each Contracting State shall ensure that adequate measures are taken to control transfer and transit passengers and their cabin baggage to prevent unauthorized articles from being taken on board aircraft engaged in international civil aviation operations.

4.2.2 Each Contracting State shall ensure that there is no possibility of mixing or contact between passengers subjected to security control and other persons not subjected to such control after the security screening points at airports serving international civil aviation have been passed; if mixing or contact does take place, the passengers concerned and their cabin baggage shall be re-screened before boarding an aircraft.

4.2.3 Each Contracting State shall establish measures to ensure that the aircraft operator and the pilot-in-command are informed when passengers are obliged to travel because they have been the subject of judicial or administrative proceedings, in order that appropriate security measures can be taken.

4.2.4 **Recommendation.—** *Each Contracting State should require operators providing service from that State, to include in their security programmes, measures and procedures to ensure safety on board their aircraft when passengers are to be carried who are obliged to travel because they have been the subject of judicial or administrative proceedings.*

4.2.5 Each Contracting State shall require measures to be taken in respect of flights under an increased threat to ensure that disembarking passengers do not leave items on board the aircraft at transit stops on its airports.

4.3 Measures relating to checked baggage, cargo and other goods

4.3.1 Each Contracting State shall establish measures to ensure that operators when providing service from that State do not transport the baggage of passengers who are not on board the aircraft unless the baggage separated from passengers is subjected to other security control measures.

4.3.2 **Recommendation.—** *Each Contracting State should establish measures to ensure that checked baggage is subjected to screening before being placed on board aircraft.*

4.3.3 Each Contracting State shall establish measures to ensure that consignments checked-in as baggage by couriers for carriage on passenger flights are subjected to specific security controls in addition to those provided in 4.3.1.

4.3.4 Each Contracting State shall establish measures to ensure that baggage intended for carriage on passenger flights and originating from places other than airport check-in counters is protected from the point it is checked in until it is placed on board an aircraft.

4.3.5 Each Contracting State shall ensure the implementation of measures at airports serving international civil aviation to protect cargo, baggage, mail, stores and operator's supplies being moved within an airport and intended for carriage on an aircraft to safeguard such aircraft against an act of unlawful interference.

4.3.6 Each Contracting State shall establish measures to ensure that cargo, courier and express parcels and mail intended for carriage on passenger flights are subjected to appropriate security controls.

4.3.7 **Recommendation.—** *Each Contracting State should establish measures to ensure that operators do not accept consignments of cargo, courier and express parcels or mail for carriage on passenger flights unless the security of such consignments is accounted for by a known shipper or such consignments are subjected to other security controls to meet the requirements of 4.3.6.*

4.3.8 Each Contracting State shall require the establishment of secure storage areas at airports serving international civil aviation, where mishandled baggage may be held until forwarded, claimed or disposed of in accordance with local laws.

4.3.9 **Recommendation.—** *Each Contracting State should take the necessary measures to ensure that unidentified baggage is placed in a protected and isolated area until such time as it is ascertained that it does not contain any explosives or other dangerous device.*

4.4 Measures relating to access control

4.4.1 Each Contracting State shall establish procedures and identification systems to prevent unauthorized access by persons or vehicles to:

a) the air side of an airport serving international civil aviation; and

b) other areas important to the security of the airport.

4.4.2 Each Contracting State shall establish measures to ensure adequate supervision over the movement of persons to and from the aircraft and to prevent unauthorized access to aircraft.

4.5 Measures relating to airport design

Each Contracting State shall ensure that the architectural and infrastructure-related requirements necessary for the optimum implementation of international civil aviation security measures, are integrated into the design and construction of new facilities and alterations to existing facilities at airports.

CHAPTER 5. MANAGEMENT OF RESPONSE TO ACTS OF UNLAWFUL INTERFERENCE

5.1 Operational aspects of an act of unlawful interference

5.1.1 Each Contracting State shall take adequate measures for the safety of passengers and crew of an aircraft which is subjected to an act of unlawful interference until their journey can be continued.

5.1.2 Each Contracting State responsible for providing air traffic services for an aircraft which is the subject of an act of unlawful interference shall collect all pertinent information on the flight of that aircraft and transmit that information to all other States responsible for the Air Traffic Services units concerned, including those at the airport of known or presumed destination, so that timely and appropriate safeguarding action may be taken en route and at the aircraft's known, likely or possible destination.

5.1.3 **Recommendation.—** *Each Contracting State should ensure that information received as a consequence of action taken in accordance with 5.1.2 is distributed locally to the Air Traffic Services units concerned, the appropriate airport administrations, the operator and others concerned as soon as practicable.*

5.1.4 Each Contracting State shall provide such assistance to an aircraft subjected to an act of unlawful seizure, including the provision of navigation aids, air traffic services and permission to land as may be necessitated by the circumstances.

5.1.5 Each Contracting State shall take measures, as it may find practicable, to ensure that an aircraft subjected to an act of unlawful seizure which has landed in its territory is detained on the ground unless its departure is necessitated by the overriding duty to protect human life, recognizing the importance of consultations, wherever practicable, between the State where that aircraft has landed and the State of the operator of the aircraft.

5.2 Reports

5.2.1 **Recommendation.—** *Each Contracting State should exchange information with other States as considered appropriate, at the same time supplying such information to ICAO, related to plans, designs, equipment, methods and procedures for safeguarding international civil aviation against acts of unlawful interference.*

5.2.2 A Contracting State in which an aircraft subjected to an act of unlawful interference has landed shall notify by the most expeditious means the State of Registry of the aircraft and the State of the operator of the landing and shall similarly transmit by the most expeditious means all other relevant information to:

a) the two above-mentioned States;

b) each State whose citizens suffered fatalities or injuries;

c) each State whose citizens were detained as hostages;

d) each Contracting State whose citizens are known to be on board the aircraft; and

e) the International Civil Aviation Organization.

5.2.3 Each Contracting State concerned with an act of unlawful interference shall require its appropriate authority to re-evaluate security measures and procedures in respect of international flights which have been the subject of unlawful interference and take action necessary to remedy weaknesses so as to prevent recurrence.

5.2.4 Each Contracting State concerned with an act of unlawful interference shall provide ICAO with all pertinent information concerning the security aspects of the act of unlawful interference as soon as practicable after the act is resolved.

5.2.5 **Recommendation.—** *Each Contracting State should adopt measures to ensure that persons acting in an official capacity do not divulge confidential information concerning an act of unlawful interference if such information is likely to jeopardize the safety of international civil aviation.*

ATTACHMENT TO ANNEX 17

EXTRACTS FROM ANNEX 2 — RULES OF THE AIR

CHAPTER 3. GENERAL RULES

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3.7 Unlawful interference

An aircraft which is being subjected to unlawful interference shall endeavour to notify the appropriate ATS unit of this fact, any significant circumstances associated therewith and any deviation from the current flight plan necessitated by the circumstances, in order to enable the ATS unit to give priority to the aircraft and to minimize conflict with other aircraft.

Note 1.— Responsibility of ATS units in situations of unlawful interference is contained in Annex 11.

Note 2.— Guidance material for use when unlawful interference occurs and the aircraft is unable to notify an ATS unit of this fact is contained in Attachment B to this Annex.

Note 3.— Action to be taken by SSR equipped aircraft which are being subjected to unlawful interference is contained in Annex 11, the PANS-RAC (Doc 4444) and the PANS-OPS (Doc 8168).

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ATTACHMENT B. UNLAWFUL INTERFERENCE

1. General

The following procedures are intended as guidance for use by aircraft when unlawful interference occurs and the aircraft is unable to notify an ATS unit of this fact.

2. Procedures

2.1 Unless considerations aboard the aircraft dictate otherwise, the pilot-in-command should attempt to continue flying on the assigned track and at the assigned cruising level at least until able to notify an ATS unit or within radar coverage.

2.2 When an aircraft subjected to an act of unlawful interference must depart from its assigned track or its assigned cruising level without being able to make radiotelephony contact with ATS, the pilot-in-command should, whenever possible:

a) attempt to broadcast warnings on the VHF emergency frequency and other appropriate frequencies, unless considerations aboard the aircraft dictate otherwise. Other equipment such as on-board transponders, data links, etc., should also be used when it is advantageous to do so and circumstances permit; and

b) proceed in accordance with applicable special procedures for in-flight contingencies, where such procedures have been established and promulgated in Doc 7030 — *Regional Supplementary Procedures*; or

c) if no applicable regional procedures have been established, proceed at a level which differs from the cruising levels normally used for IFR flight in the area by 300 m (1 000 ft) if above FL 290 or by 150 m (500 ft) if below FL 290.

Note. — Action to be taken by an aircraft which is intercepted while being subject to an act of unlawful interference is prescribed in 3.8 of this Annex.

EXTRACTS FROM ANNEX 6 — OPERATION OF AIRCRAFT
PART I — INTERNATIONAL COMMERCIAL AIR TRANSPORT — AEROPLANES

CHAPTER 13. SECURITY*

13.1 Security of the flight crew compartment

Recommendation.— *In all aeroplanes the flight crew compartment door should be capable of being locked from within the compartment.*

13.2 Aeroplane search procedure checklist

An operator shall ensure that there is on board a checklist of the procedures to be followed in searching for a bomb in case of suspected sabotage. The checklist shall be supported by guidance on the course of action to be taken should a bomb or suspicious object be found.

13.3 Training programmes

13.3.1 An operator shall establish and maintain a training programme which enables crew members to act in the most appropriate manner to minimize the consequences of acts of unlawful interference.

13.3.2 An operator shall also establish and maintain a training programme to acquaint appropriate employees with preventive measures and techniques in relation to passengers, baggage, cargo, mail, equipment, stores and supplies intended for carriage on an aeroplane so that they contribute to the prevention of acts of sabotage or other forms of unlawful interference.

13.4 Reporting acts of unlawful interference

Following an act of unlawful interference the pilot-in-command shall submit, without delay, a report of such an act to the designated local authority.

* In the context of this Chapter, the word "security" is used in the sense of prevention of illicit acts against civil aviation.

EXTRACTS FROM ANNEX 9 — FACILITATION

CHAPTER 1. DEFINITIONS AND APPLICABILITY

A. Definitions

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Security equipment. Devices of a specialized nature for use, individually or as part of a system, in the prevention or detection of acts of unlawful interference with civil aviation and its facilities.

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CHAPTER 2. ENTRY AND DEPARTURE OF AIRCRAFT

A. General

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2.2 Contracting States shall make provision whereby procedures for the clearance of aircraft, including those normally applied for aviation security purposes, as well as those appropriate for narcotics control, will be applied and carried out in such a manner as to retain the advantage of speed inherent in air transport.

Note 1.— With respect to application of aviation security measures, attention is drawn to Annex 17 and to the ICAO Security Manual.

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CHAPTER 3. ENTRY AND DEPARTURE OF PERSONS AND THEIR BAGGAGE

A. General

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3.2 Contracting States shall make provision whereby the procedures for clearance of persons travelling by air, including those normally applied for aviation security purposes, as well as those appropriate for narcotics control, will be applied and carried out in such a manner as to retain the advantage of speed inherent in air transport.

Note 1.— With respect to application of aviation security measures, attention is drawn to Annex 17 and to the ICAO Security Manual.

Note 2.— With respect to application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

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C. Departure Requirements and Procedures

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3.29 **Recommended Practice.—** *Contracting States should, in conformity with their respective regulations, endeavour to reduce the documentation required to be produced by passengers departing from their territories to a valid passport or other acceptable form of identity document.*

Note.— It is not the intent of the above provision to discourage Contracting States, who wish to be more liberal, from accepting official documents of identity such as expired passports, national registration cards, seafarers' identity documents, alien resident permits, crew member certificates, etc. in lieu of a valid passport.

3.30 **Recommended Practice.—** *Contracting States should not require presentation of baggage of passengers departing from their territory except for aviation security measures, or in special circumstances.*

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

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CHAPTER 4. ENTRY AND DEPARTURE OF CARGO AND OTHER ARTICLES

A. General

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4.2 Contracting States shall make provisions whereby procedures for the clearance of goods carried by air and for the interchange of air cargo with surface transport, including those normally applied for aviation security purposes as well as those appropriate for narcotics control, will be applied and carried out in such a manner as to retain the advantage of speed inherent in air transport and to avoid delay.

Note 1.— With respect to application of aviation security measures, attention is drawn to Annex 17 and to the ICAO Security Manual.

Note 2.— With respect to application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

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C. Clearance of Export Cargo

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4.11 Contracting States shall make arrangements consistent with aviation security, as well as those appropriate for narcotics control, which permit operators to select and load cargo, including unaccompanied baggage, and stores on outbound aircraft up to the time of departure.

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4.13 Except for reasons of aviation security Contracting States shall not normally require physical examination of cargo, including unaccompanied baggage, to be exported by air.

Note.— This provision is not intended to prevent authorities from examining goods exported under certain conditions, e.g. under bond, licence or drawback, nor is it intended to preclude other essential examinations including any appropriate narcotics control measures.

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4.15 Contracting States shall permit cargo, including unaccompanied baggage which is to be exported by air, to be presented for clearance purposes at any approved customs office. Transfer from the first office to the air customs office of the airport where the cargo, including unaccompanied baggage, is to be laden on the aircraft, shall be effected in accordance with the procedure laid down in the laws and regulations of the State concerned. Such procedure shall be as simple as possible, making due allowance for aviation security requirements, and any appropriate narcotics control measures.

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G. Aircraft Equipment, Stores and Parts

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4.44 **Recommended Practice.—** *Ground equipment and security equipment imported into the territory of a Contracting State by an airline of another Contracting State for use within the limits of an international airport in connexion with the establishment or maintenance of an international service operated by that airline should be admitted free of customs duties and, as far as possible, other taxes and charges, subject to compliance with the regulations of the Contracting State concerned. Such regulations should not unreasonably interfere with the necessary use by the airline concerned of such ground equipment and security equipment.*

Note.— It is the intent of this provision that items such as the following should be admissible under the above provision, and it is not desired to discourage a Contracting State from allowing once-admitted items to be used by another foreign airline or at a location other than an international airport:

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e) Security equipment:

— weapon-detecting devices;

— explosives-detecting devices;

— intrusion-detecting devices.

f) Component parts for incorporation into security equipment.

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4.47 Contracting States shall establish procedures for airlines and/or operators of other Contracting States allowing the prompt entry into or departure from their territories of aircraft equipment, spare parts, ground, training and security equipment, whether or not they are free of customs duties and other taxes and charges, under the provisions of this Annex or any other arrangements. Contracting States shall grant prompt clearance for the importation and exportation of such goods upon completion of simplified documentary procedures by the airlines or operators concerned. These arrangements shall not extend to goods intended for general sale, food, beverages and tobacco.

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4.49 Contracting States shall allow the loan of aircraft equipment and spare parts and security equipment and spare parts between airlines, when these are used in connexion with the establishment or maintenance of scheduled international air services, without payment of customs duties or other taxes or charges subject only to control measures which may provide that repayment of the loan is normally to be accomplished by means of the return of articles that are qualitatively and technically similar and of the same origin, and in any event that no profit-making transaction is involved.

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CHAPTER 6. INTERNATIONAL AIRPORTS — FACILITIES AND SERVICES FOR TRAFFIC

A. General

6.1 Contracting States shall take all necessary steps to secure the co-operation of operators and airport administrations in ensuring that satisfactory facilities and services are provided for rapid handling and clearance of passengers, crew, baggage, cargo and mail at their international airports. Such facilities and services shall be flexible and capable of expansion to meet anticipated growth in traffic volume, or increased security measures during higher threat situations, while permitting appropriate narcotics control measures.

Note 1.— With respect to the application of aviation security measures, attention is drawn to the relevant specification in Annex 17, Chapter 2 [2.2.1].

Note 2.— With respect to the application of appropriate narcotics control measures, attention is drawn to the relevant ICAO publication (currently in preparation).

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B. Airport Traffic Flow Arrangements

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III. Outbound Passengers, Crew and Baggage

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6.21 **Recommended Practice.—** *In order to facilitate aircraft departure, Contracting States, in examining passengers as a security measure, or for purposes of narcotics control as appropriate, should, to the extent feasible, utilize specialized equipment in conducting such examinations so as to reduce materially the number of persons to be searched by other means.*

Note 1.— The use of radiological techniques for screening passengers should be avoided.

Note 2.— Privacy should be assured when a thorough physical search is to be carried out. If special rooms are not available, portable screens may be used for this purpose.

6.22 **Recommended Practice.—** *In order to facilitate aircraft departure, Contracting States, in examining baggage of passengers departing from their territory as a security measure, or for narcotics control purposes as appropriate, should, to the extent feasible, utilize specialized equipment in conducting such examinations so as to reduce materially the amount of baggage to be searched by other means.*

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V. Transit and Transfer of Passengers and Crew

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6.33 **Recommended Practice.—** *Contracting States should ensure that physical facilities at airports are provided, where the volume and nature of the traffic so require,* *whereby crew and passengers in direct transit on the same aircraft, or transferring to other flights, may remain temporarily without being subject to inspection formalities, except for aviation security measures, or in special circumstances.*

Note.— This provision is not intended to prevent the application of appropriate narcotics control measures.

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VII. Cargo and Mail Handling and Clearance Facilities

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6.44 **Recommended Practice.—** *Adequate space should be available in cargo terminals for storage and handling of air cargo, including building up and breaking down of pallet and container loads, located next to the customs area and easily accessible to authorized persons and vehicles from both the apron and the landside road. Such arrangements should take into account aviation security and appropriate narcotics control measures.*

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6.46 **Recommended Practice.—** *Cargo terminals should be equipped with storage facilities as appropriate for special cargo (e.g. valuable goods, perishable shipments, human remains, radioactive and other dangerous goods, as well as live animals). Those areas of cargo terminals in which cargo and mail are stored overnight or for extended periods prior to shipment by air should be protected against access by unauthorized persons.*

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CHAPTER 8. OTHER FACILITATION PROVISIONS

A. Bonds and Exemption from Requisition or Seizure

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8.2 **Recommended Practice.—** *The aircraft, ground equipment, security equipment, spare parts and technical supplies of an airline located in a Contracting State (other than the Contracting State in which such airline is established) for use in the operation of an international air service serving such Contracting State, should be exempt from the laws of such Contracting State authorizing the requisition or seizure of aircraft, equipment, parts or supplies for public use, without prejudice to the right of seizure for breaches of the laws of the Contracting State concerned.*

EXTRACTS FROM ANNEX 10 — AERONAUTICAL TELECOMMUNICATIONS, VOLUME 1

PART 1. EQUIPMENT AND SYSTEMS

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CHAPTER 2. RADIO NAVIGATION AIDS

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2.5. — Secondary Surveillance Radar (SSR)

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2.5.4.2.1 Code 7700 to provide recognition of an aircraft in an emergency.

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2.5.4.2.3 Code 7500 to provide recognition of an aircraft which is being subjected to unlawful interference.

2.5.4.3 Appropriate provisions shall be made in ground decoding equipment to ensure immediate recognition of Mode A codes 7500, 7600 and 7700.

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EXTRACTS FROM ANNEX 11 — AIR TRAFFIC SERVICES

CHAPTER 2. GENERAL

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2.20 Service to aircraft in the event of an emergency

2.20.1 An aircraft known or believed to be in a state of emergency, including being subjected to unlawful interference, shall be given maximum consideration, assistance and priority over other aircraft as may be necessitated by the circumstances.

Note.— To indicate that it is in a state of emergency, an aircraft equipped with an SSR transponder might operate the equipment as follows:

a) on Mode A, Code 7700; or

b) on Mode A, Code 7500, to indicate specifically that it is being subjected to unlawful interference.

2.20.2 When an occurrence of unlawful interference with an aircraft takes place or is suspected, ATS units shall attend promptly to requests by the aircraft. Information pertinent to the safe conduct of the flight shall continue to be transmitted and necessary action shall be taken to expedite the conduct of all phases of the flight, specially the safe landing of the aircraft.

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CHAPTER 5. ALERTING SERVICE

5.1 Application

5.1.1 Alerting service shall be provided

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c) to any aircraft known or believed to be the subject of unlawful interference.

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5.2 Notification of rescue co-ordination centres

5.2.1 Without prejudice to any other circumstances that may render such notification advisable, air traffic services units shall, except as prescribed in 5.5.1, notify rescue co-ordination centres immediately an aircraft is considered to be in a state of emergency in accordance with the following:

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b) *Alert phase* when:

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except when evidence exists that would allay apprehension as to the safety of the aircraft and its occupants, or when

4) an aircraft is known or believed to be the subject of unlawful interference.

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5.5 Information to the operator

5.5.1 When an area control or a flight information centre decides that an aircraft is in the uncertainty or the alert phase, it shall, when practicable, advise the operator prior to notifying the rescue co-ordination centre.

Note.— If an aircraft is in the distress phase, the rescue co-ordination centre has to be notified immediately in accordance with 5.2.1.

5.5.2 All information notified to the rescue co-ordination centre by an area control or flight information centre shall, whenever practicable, also be communicated, without delay, to the operator.

5.6 Information to aircraft operating in the vicinity of an aircraft in a state of emergency

5.6.1 When it has been established by an air traffic services unit that an aircraft is in a state of emergency, other aircraft known to be in the vicinity of the aircraft involved shall, except as provided in 5.6.2, be informed of the nature of the emergency as soon as practicable.

5.6.2 When an air traffic services unit knows or believes that an aircraft is being subjected to unlawful interference, no reference shall be made in ATS air-ground communications to the nature of the emergency unless it has first been referred to in communications from the aircraft involved and it is certain that such reference will not aggravate the situation.

EXTRACTS FROM ANNEX 13 — AIRCRAFT ACCIDENT INVESTIGATION

CHAPTER 5. INVESTIGATION

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ORGANIZATION AND CONDUCT OF THE INVESTIGATION

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RESPONSIBILITY OF THE STATE CONDUCTING THE INVESTIGATION

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Informing aviation security authorities

5.11 If, in the course of an investigation it becomes known, or it is suspected, that an act of unlawful interference was involved, the investigator-in-charge shall immediately initiate action to ensure that the aviation security authorities of the State(s) concerned are so informed.

EXTRACTS FROM ANNEX 14 — AERODROMES, VOLUME I — AERODROME DESIGN AND OPERATIONS

CHAPTER 3. PHYSICAL CHARACTERISTICS

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3.12 Isolated aircraft parking position

3.12.1 An isolated aircraft parking position shall be designated or the aerodrome control tower shall be advised of an area or areas suitable for the parking of an aircraft which is known or believed to be the subject of unlawful interference, or which for other reasons needs isolation from normal aerodrome activities.

3.12.2 **Recommendation.—** *The isolated aircraft parking position should be located at the maximum distance practicable and in any case never less than 100 m from other parking positions, buildings or public areas, etc. Care should be taken to ensure that the position is not located over underground utilities such as gas and aviation fuel and, to the extent feasible, electrical or communication cables.*

CHAPTER 5. VISUAL AIDS FOR NAVIGATION

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5.3 Lights

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5.3.21 Apron floodlighting
(see also 5.3.16.1 and 5.3.17.1)

Application

5.3.21.1 **Recommendation.—** *Apron floodlighting should be provided on an apron, and on a designated isolated aircraft parking position, intended to be used at night.*

Note 1.— The designation of an isolated aircraft parking position is specified in 3.12.

Note 2.— Guidance on apron floodlighting is given in the Aerodrome Design Manual, *Part 4.*

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CHAPTER 8. EQUIPMENT AND INSTALLATIONS

8.1 Secondary power supply

General

Application

8.1.1 **Recommendation.**— *A secondary power supply should be provided, capable of supplying the power requirements of at least the aerodrome facilities listed below:*

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e) essential security lighting, if provided in accordance with 8.5;

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8.4 Fencing

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8.4.2 **Recommendation.**— *A fence or other suitable barrier should be provided on an aerodrome to deter the inadvertent or premeditated access of an unauthorized person onto a non-public area of the aerodrome.*

Note 1.— This is intended to include the barring of sewers, ducts, tunnels, etc., where necessary to prevent access.

Note 2.— Special measures may be required to prevent the access of an unauthorized person to runways or taxiways which overpass public roads.

8.4.3 **Recommendation.**— *Suitable means of protection should be provided to deter the inadvertent or premeditated access of unauthorized persons into ground installations and facilities essential for the safety of civil aviation located off the aerodrome.*

Location

8.4.4 **Recommendation.**— *The fence or barrier should be located so as to separate the movement area and other facilities or zones on the aerodrome vital to the safe operation of aircraft from areas open to public access.*

8.4.5 **Recommendation.**— *When greater security is thought necessary, a cleared area should be provided on both sides of the fence or barrier to facilitate the work of patrols and to make trespassing more difficult. Consideration should be given to the provision of a perimeter road inside the aerodrome fencing for the use of both maintenance personnel and security patrols.*

8.5 Security lighting

Recommendation.— *At an aerodrome where it is deemed desirable for security reasons, a fence or other barrier provided for the protection of international civil aviation and its facilities should be illuminated at a minimum essential level. Consideration should be given to locating lights so that the ground area on both sides of the fence or barrier, particularly at access points, is illuminated.*

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CHAPTER 9. EMERGENCY AND OTHER SERVICES

9.1 Aerodrome emergency planning

General

Introductory Note.— Aerodrome emergency planning is the process of preparing an aerodrome to cope with an emergency occurring at the aerodrome or in its vicinity. The objective of aerodrome emergency planning is to minimize the effects of an emergency, particularly in respect of saving lives and maintaining aircraft operations. The aerodrome emergency plan sets forth the procedures for co-ordinating the response of different aerodrome agencies (or services) and of those agencies in the surrounding community that could be of assistance in responding to the emergency. Guidance material to assist the appropriate authority in establishing aerodrome emergency planning is given in the Airport Services Manual, *Part 7.*

9.1.1 An aerodrome emergency plan shall be established at an aerodrome, commensurate with the aircraft operations and other activities conducted at the aerodrome.

9.1.2 The aerodrome emergency plan shall provide for the co-ordination of the actions to be taken in an emergency occurring at an aerodrome or in its vicinity.

Note.— Examples of emergencies are: aircraft emergencies, sabotage including bomb threats, unlawfully seized aircraft, dangerous goods occurrences, building fires and natural disasters.

9.1.3 The plan shall co-ordinate the response or participation of all existing agencies which, in the opinion of the appropriate authority, could be of assistance in responding to an emergency.

Note.— Examples of agencies are:

- *on the aerodrome: air traffic control unit, rescue and fire fighting services, aerodrome administration, medical and ambulance services, aircraft operators, security services, and police;*
- *off the aerodrome: fire departments, police, medical and ambulance services, hospitals, military, and harbour patrol or coast guard.*

9.1.4 **Recommendation.**— *The plan should provide for co-operation and co-ordination with the rescue co-ordination centre, as necessary.*

9.1.5 **Recommendation.**— *The aerodrome emergency plan document should include at least the following:*

a) types of emergencies planned for;

b) agencies involved in the plan;

c) responsibility and role of each agency, the emergency operations centre and the command post, for each type of emergency;

d) information on names and telephone numbers of offices or people to be contacted in the case of a particular emergency; and

e) a grid map of the aerodrome and its immediate vicinity.

Emergency operations centre and command post

9.1.6 **Recommendation.**— *A fixed emergency operations centre and a mobile command post should be available for use during an emergency.*

9.1.7 **Recommendation.**— *The emergency operations centre should be a part of the aerodrome facilities and should be responsible for the over-all co-ordination and general direction of the response to an emergency.*

9.1.8 **Recommendation.**— *The command post should be a facility capable of being moved rapidly to the site of an emergency, when required, and should undertake the local co-ordination of those agencies responding to the emergency.*

9.1.9 **Recommendation.**— *A person should be assigned to assume control of the emergency operations centre and, when appropriate, another person the command post.*

Communication system

9.1.10 **Recommendation.**— *Adequate communication systems linking the command post and the emergency operations centre with each other and with the participating agencies should be provided in accordance with the plan and consistent with the particular requirements of the aerodrome.*

Aerodrome emergency exercise

9.1.11 The plan shall contain procedures for periodic testing of the adequacy of the plan and for reviewing the results in order to improve its effectiveness.

Note.— The plan includes all participating agencies and associated equipment.

9.1.12 The plan shall be tested by conducting:

a) a full-scale aerodrome emergency exercise at intervals not exceeding two years; and

b) partial emergency exercises in the intervening year to ensure that any deficiencies found during the full-scale aerodrome emergency exercise have been corrected; and

reviewed thereafter, or after an actual emergency, so as to correct any deficiency found during such exercises or actual emergency.

Note.— The purpose of a full-scale exercise is to ensure the adequacy of the plan to cope with different types of emergencies. The purpose of a partial exercise is to ensure the adequacy of the response to individual participating agencies and components of the plan, such as the communications system.

1/4/93

EXTRACTS FROM THE PROCEDURES FOR AIR NAVIGATION SERVICES — RULES OF THE AIR AND AIR TRAFFIC SERVICES (DOC 4444)

PART III - AREA CONTROL SERVICE

SEPARATION OF AIRCRAFT IN THE PROVISION OF AREA CONTROL SERVICE

1. General Provisions for the Separation of Controlled Traffic

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1.3 Larger separations than the specified minima should be applied whenever wake turbulence or exceptional circumstances such as unlawful interference call for extra precautions. This should be done with due regard to all relevant factors so as to avoid impeding the flow of air traffic by the application of excessive separations.

Note 1.- Unlawful interference with an aircraft constitutes a case of exceptional circumstances which might require the application of separations larger than the specified minima, between the aircraft being subjected to unlawful interference and other aircraft.

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EMERGENCY AND COMMUNICATION FAILURE

16. Emergency Procedures

16.1 General

16.1.1 The various circumstances surrounding each emergency situation preclude the establishment of exact detailed procedures to be followed. The procedures outlined herein are intended as a general guide to air traffic services personnel. Air traffic control units shall maintain full and complete co-ordination, and personnel shall use their best judgement in handling emergency situations.

Note.- To indicate that it is in a state of emergency, an aircraft equipped with an SSR transponder might operate the equipment as follows:

(a) on Mode A, Code 7700; or
(b) on Mode A, Code 7500, to indicate specifically that it is being subjected to unlawful interference.

16.2 Priority

16.2.1 An aircraft known or believed to be in a state of emergency, including being subjected to unlawful interference, shall be given priority over other aircraft.

16.3 Unlawful interference

16.3.1 Air traffic services personnel shall be prepared to recognize any indication of the occurrence of unlawful interference with an aircraft.

16.3.2 Whenever unlawful interference with an aircraft is suspected, and where automatic distinct display of SSR Mode A Code 7500 and Code 7700 is not provided, the radar controller shall attempt to verify his suspicion by setting the SSR decoder to Mode A Code 7500 and thereafter to Code 7700.

Note.- An aircraft equipped with SSR transponder is expected to operate the transponder on Mode A Code 7500 to indicate specifically that it is the subject of unlawful interference. The aircraft may operate the transponder on Mode A Code 7700, to indicate that it is threatened by grave and imminent danger, and requires immediate assistance.

16.3.3 Whenever unlawful interference with an aircraft is known or suspected, ATS units shall promptly attend to requests by or to anticipated needs of the aircraft, including requests for relevant information relating to air navigation facilities, procedures and services along the route of flight and at any aerodrome of intended landing, and shall take such action as is necessary to expedite the conduct of all phases of the flight.

16.3.3.1 ATS units shall also:

(a) transmit, and continue to transmit, information pertinent to the safe conduct of the flight, without expecting a reply from the aircraft;

(b) monitor and plot the progress of the flight with the means available, and co-ordinate transfer of control with adjacent ATS units without requiring transmissions or other responses from the aircraft, unless communication with the aircraft remains normal;

(c) inform and continue to keep informed, appropriate ATS units, including those in adjacent FIRs, which may be concerned with the progress of the flight;

Note.- In applying this provision, account must be taken of all the factors which may affect the progress of the flight, including fuel endurance and the possibility of sudden changes in route and destination. The objective is to provide, as far in advance as is practicable in the circumstances, each ATS unit with appropriate information as to the expected or possible penetration of the aircraft into its area of responsibility.

(d) notify:

(i) the operator or his designated representative;

(ii) the appropriate rescue co-ordination centre in accordance with appropriate alerting procedures;

(iii) the designated security authority;

Note.- It is assumed that the designated security authority and/or the operator will in turn notify other parties concerned in accordance with pre-established procedures.

(e) relay appropriate messages, relating to the circumstances associated with the unlawful interference, between the aircraft and designated authorities.

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PART V.- AERODROME CONTROL SERVICE

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CONTROL OF AERODROME TRAFFIC

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10. Control of Taxiing Aircraft

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Note.- See Figure V-4.

10.4 An aircraft known or believed to be the subject of unlawful interference or which for other reasons needs isolation from normal aerodrome activities shall be cleared to the designated isolated parking position. Where such an isolated parking position has not been designated, or if the designated position is not available, the aircraft shall be cleared to a position within the area or areas selected by prior agreement with the aerodrome authority. The taxi clearance shall specify the taxi route to be followed to the parking position. This route shall be selected with a view to minimizing any security risks to the public, other aircraft and installations at the aerodrome.

Note.- See Annex 14, Volume I, Chapter 3.

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EXTRACTS FROM THE PROCEDURES FOR AIR NAVIGATION SERVICES — AIRCRAFT OPERATIONS (DOC 8168), VOLUME I

PART VIII.- SECONDARY SURVEILLANCE RADAR (SSR) TRANSPONDER OPERATING PROCEDURES

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CHAPTER 1.- OPERATION OF TRANSPONDERS

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1.3 EMERGENCY PROCEDURES

1.3.1 The pilot of an aircraft encountering a state of emergency shall set the transponder to Mode A Code 7700 except when previously directed by ATC to operate the transponder on a specified code. In the latter case he shall maintain the specified code unless otherwise advised by ATC.

1.3.2 Notwithstanding the procedures at 1.3.1, a pilot may select Mode A Code 7700 whenever he has specific reason to believe that this would be the best course of action.

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1.5 UNLAWFUL INTERFERENCE WITH AIRCRAFT IN FLIGHT

1.5.1 Should an aircraft in flight be subjected to unlawful interference, the pilot-in-command shall endeavour to set the transponder to Mode A Code 7500 to give indication of the situation unless circumstances warrant the use of Code 7700.

1.5.2 When a pilot has selected Mode A Code 7500 and is subsequently requested to confirm his code by ATC in accordance with 1.1.4 he shall, according to circumstances either confirm this or not reply at all.

Note.- The absence of a reply from the pilot will be taken by ATC as an indication that the use of Code 7500 is not due to an inadvertent false code selection.

— END —

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

THE SAFE TRANSPORT OF DANGEROUS GOODS BY AIR

ANNEX 18

TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION

SECOND EDITION — JULY 1989

This edition incorporates all amendments adopted by the Council prior to 25 February 1989 and supersedes on 16 November 1989 all previous editions of Annex 18.

For information regarding the applicability of Standards and Recommended Practices, *see* Foreword and the relevant clauses in each Chapter.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Bulletin* and in the monthly *Supplement to the Catalogue of ICAO Publications*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No.	Date Applicable	Date entered	Entered by
1-4	Incorporated in this Edition		

CORRIGENDA			
No.	Date of issue	Date entered	Entered by

TABLE OF CONTENTS

FOREWORD

Historical background

The material in this Annex was developed by the Air Navigation Commission in response to a need expressed by Contracting States for an internationally agreed set of provisions governing the safe transport of dangerous goods by air. In order to assist in achieving compatibility with the regulations covering the transport of dangerous goods by other modes of transport, the provisions of this Annex are based on the Recommendations of the United Nations Committee of Experts on the Transport of Dangerous Goods and the Regulations for the Safe Transport of Radioactive Materials of the International Atomic Energy Agency.

Relationship with the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284)

The provisions of Annex 18 govern the international transport of dangerous goods by air. The broad provisions of this Annex are amplified by the detailed specifications of the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284).

Action by Contracting States

Notification of differences. The attention of Contracting States is drawn to the obligation imposed by Article 38 of the Convention by which Contracting States are required to notify the Organization of any differences between their national regulations and practices and the International Standards contained in this Annex and any amendments thereto. Contracting States are invited to extend such notification to any differences from the Recommended Practices contained in this Annex, and any amendments thereto, when the notification of such differences is important for the safety of air navigation. Further, Contracting States are invited to keep the Organization currently informed of any differences which may subsequently occur, or of the withdrawal of any differences previously notified. A specific request for notification of differences will be sent to Contracting States immediately after the adoption of each amendment to this Annex.

The attention of States is also drawn to the provisions of Annex 15 related to the publication of differences between their national regulations and practices and the related ICAO Standards and Recommended Practices through the Aeronautical Information Service, in addition to the obligation of States under Article 38 of the Convention.

In the specific case of 2.2.1 of this Annex, it should be noted that States are expected to file a difference only if they are unable to accept the binding nature of the Technical Instructions. Variations from the detailed provisions of the Technical Instructions are to be reported to ICAO for publication in that document as required by 2.5 of this Annex. Such detailed variations from the Technical Instructions will not be published with any other differences in a Supplement to this Annex and are not expected to be published under the provisions of Annex 15.

Promulgation of information. The establishment and withdrawal of any changes to facilities, services and procedures affecting aircraft operations provided in accordance with the Standards specified in this Annex should be notified and take effect in accordance with the provisions of Annex 15.

Status of Annex components

An Annex is made up of the following component parts, not all of which, however, are necessarily found in every Annex; they have the status indicated:

1.— *Material comprising the Annex proper:*

a) *Standards* and *Recommended Practices* adopted by the Council under the provisions of the Convention. They are defined as follows:

Standard: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38.

Recommended Practice: Any specification for physical characteristics, configuration, matériel, performance, personnel or procedure, the uniform application of which is recognized as desirable in the interest of safety, regularity or efficiency of international air navigation, and to which Contracting States will endeavour to conform in accordance with the Convention.

b) *Appendices* comprising material grouped separately for convenience but forming part of the Standards and Recommended Practices adopted by the Council.

c) *Definitions* of terms used in the Standards and Recommended Practices which are not self-explanatory in that they do not have accepted dictionary meanings. A definition does not have independent status but is an essential part of each Standard and Recommended Practice in which the term is used, since a change in the meaning of the term would affect the specification.

d) *Tables* and *Figures* which add to or illustrate a Standard or Recommended Practice and which are referred to therein, form part of the associated Standard or Recommended Practice and have the same status.

2.— *Material approved by the Council for publication in association with the Standards and Recommended Practices:*

a) *Forewords* comprising historical and explanatory material based on the action of the Council and including an explanation of the obligations of States with regard to the application of the Standards and Recommended Practices ensuing from the Convention and the Resolution of Adoption.

b) *Introductions* comprising explanatory material introduced at the beginning of parts, chapters or sections of the Annex to assist in the understanding of the application of the text.

c) *Notes* included in the text, where appropriate, to give factual information or references bearing on the Standards or Recommended Practices in question, but not constituting part of the Standards or Recommended Practices.

d) *Attachments* comprising material supplementary to the Standards and Recommended Practices, or included as a guide to their application.

Selection of language

This Annex has been adopted in four languages — English, French, Russian and Spanish. Each Contracting State is requested to select one of those texts for the purpose of national implementation and for other effects provided for in the Convention, either through direct use or through translation into its own national language, and to notify the Organization accordingly.

Editorial practices

The following practice has been adhered to in order to indicate at a glance the status of each statement: *Standards* have been printed in light face roman; *Recommended Practices* have been printed in light face italics, the status being indicated by the prefix **Recommendation**; *Notes* have been printed in light face italics, the status being indicated by the prefix *Note*.

It will be noted that in the English text the following practice has been adhered to when writing the specifications: Standards employ the operative verb "shall" while Recommended Practices employ the operative verb "should"

Any reference to a portion of this document, which is identified by a number and/or title, includes all subdivisions of that portion.

Table A. Amendments to Annex 18

Amendment	*Source(s)*	*Subject(s)*	*Adopted Effective Applicable*
1st Edition	Air Navigation Commission Study		26 June 1981 1 January 1983 1 January 1984
1	Sixth Meeting of the Dangerous Goods Panel	Miscellaneous amendments for alignment with Recommendations of the UN Committee of Experts and IAEA.	26 November 1982 26 March 1983 1 January 1984
2	Fifth, Sixth and Seventh Meetings of the Dangerous Goods Panel	Improved definitions for overpack and unit load device. Definitions of package and packaging aligned with Recommendations of the UN Committee of Experts. Addition of a paragraph covering surface transport to or from aerodromes. The requirement to provide information to the pilot-in-command revised to indicate when this information should be given.	1 June 1983 1 October 1983 1 January 1984
3	Eighth Meeting of the Dangerous Goods Panel	Clarification of the circumstances when exemptions may be granted. Clarification of the segregation requirements of poisons or infectious substances from animals or foodstuffs.	25 March 1985 29 July 1985 1 January 1986
4 (2nd Edition)	Eleventh Meeting of the Dangerous Goods Panel	General simplification of the provisions of Annex 18 through the removal of technical detail. Miscellaneous amendments to various provisions.	24 February 1989 23 July 1989 16 November 1989

16/11/89

INTERNATIONAL STANDARDS AND RECOMMENDED PRACTICES

CHAPTER 1. DEFINITIONS

When the following terms are used in this Annex they have the following meanings:

Cargo aircraft. Any aircraft, other than a passenger aircraft, which is carrying goods or property.

Consignment. One or more packages of dangerous goods accepted by an operator from one shipper at one time and at one address, receipted for in one lot and moving to one consignee at one destination address.

Crew member. A person assigned by an operator to duty on an aircraft during flight time.

Dangerous goods. Articles or substances which are capable of posing significant risk to health, safety or property when transported by air/

Note.— Dangerous goods are classified in Chapter 3.

Dangerous goods accident. An occurrence associated with and related to the transport of dangerous goods by air which results in fatal or serious injury to a person or major property damage.

Dangerous goods incident. An occurrence, other than a dangerous goods accident, associated with and related to the transport of dangerous goods by air, not necessarily occurring on board an aircraft, which results in injury to a person, property damage, fire, breakage, spillage, leakage of fluid or radiation or other evidence that the integrity of the packaging has not been maintained. Any occurrence relating to the transport of dangerous goods which seriously jeopardizes the aircraft or its occupants is also deemed to constitute a dangerous goods incident.

Exception. A provision in this Annex which excludes a specific item of dangerous goods from the requirements normally applicable to that item.

Exemption. An authorization issued by an appropriate national authority providing relief from the provisions of this Annex.

Flammable. Note.— The word flammable has the same meaning as inflammable in the English language.

Flight crew member. A licensed crew member charged with duties essential to the operation of an aircraft during flight time.

Incompatible. Describing dangerous goods which, if mixed, would be liable to cause a dangerous evolution of heat or gas or produce a corrosive substance.

Operator. A person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Overpack. An enclosure used by a single shipper to contain one or more packages and to form one handling unit for convenience of handling and stowage.

Note.— A unit load device is not included in this definition.

Package. The complete product of the packing operation consisting of the packaging and its contents prepared for transport.

Packaging. Receptacles and any other components or materials necessary for the receptacle to perform its containment function and to ensure compliance with the packing requirements of this Annex.

Packing. The art and operation by which articles or substances are enveloped in wrappings and/or enclosed in packagings or otherwise secured.

Passenger aircraft. An aircraft that carries any person other than a crew member, an operator's employee in an official capacity, an authorized representative of an appropriate national authority or a person accompanying a consignment or other cargo.

Pilot-in-command. The pilot responsible for the operation and safety of the aircraft during flight time.

Proper shipping name. The name to be used to describe a particular article or substance in all shipping documents and notifications and, where appropriate, on packagings.

Serious injury. An injury which is sustained by a person in an accident and which:

a) requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; or

b) results in a fracture of any bone (except simple fractures of fingers, toes or nose); or

c) involves lacerations which cause severe haemorrhage, nerve, muscle or tendon damage; or

d) involves injury to any internal organ; or

e) involves second or third degree burns, or any burns affecting more than 5 per cent of the body surface; or

f) involves verified exposure to infectious substances or injurious radiation.

State of Origin. The State in the territory of which the cargo was first loaded on an aircraft.

State of the Operator. The State in which the operator has his principal place of business or, if he has no such place of business, his permanent residence.

UN number. The four-digit number assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods to identify a substance or a particular group of substances.

Unit load device. Any type of freight container, aircraft container, aircraft pallet with a net, or aircraft pallet with a net over an igloo.

Note.— An overpack is not included in this definition.

CHAPTER 2. APPLICABILITY

2.1. General applicability

The Standards and Recommended Practices of this Annex shall be applicable to all international operations of civil aircraft. In cases of extreme urgency or when other forms of transport are inappropriate or full compliance with the prescribed requirements is contrary to the public interest, the States concerned may grant exemptions from these provisions provided that in such cases every effort shall be made to achieve an over-all level of safety in transport which is equivalent to the level of safety provided by these provisions.

Note 1.— The States concerned are the States of Origin, transit, overflight and destination of the consignment and the State of the Operator.

Note 2.— Refer to 4.2 for dangerous goods normally forbidden for which States may grant an exemption.

Note 3.— Refer to 4.3 for dangerous goods forbidden for transport by air under any circumstances.

Note 4.— It is not intended that this Annex be interpreted as requiring an operator to transport a particular article or substance or as preventing an operator from adopting special requirements on the transport of a particular article or substance.

2.2 Dangerous Goods Technical Instructions

2.2.1 Each Contracting State shall take the necessary measures to achieve compliance with the detailed provisions contained in the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284), approved, issued and amended in accordance with the procedure established by the ICAO Council.

2.2.2 **Recommendation.**— *Each Contracting State should inform ICAO of difficulties encountered in the application of the Technical Instructions and of any amendments which it would be desirable to make to them.*

2.3 Domestic civil aircraft operations

Recommendation.— *In the interests of safety and of minimizing interruptions to the international transport of dangerous goods, Contracting States should also take the necessary measures to achieve compliance with the Annex and the Technical Instructions for domestic civil aircraft operations.*

2.4 Exceptions

2.4.1 Articles and substances which would otherwise be classed as dangerous goods but which are required to be aboard the aircraft in accordance with the pertinent airworthiness requirements and operating regulations, or for those specialized purposes identified in the Technical Instructions, shall be excepted from the provisions of this Annex.

2.4.2 Where articles and substances intended as replacements for those described in 2.4.1 are carried on an aircraft, they shall be transported in accordance with the provisions of this Annex except as permitted in the Technical Instructions.

2.4.3 Articles and substances intended for the personal use of passengers and crew members shall be excepted from the provisions of this Annex to the extent specified in the Technical Instructions.

2.5 Notification of variations from the Technical Instructions

2.5.1 Where a Contracting State adopts different provisions from those specified in the Technical Instructions, it shall notify ICAO promptly of such State variations for publication in the Technical Instructions.

Note.— Contracting States are expected to notify a difference to the provisions of 2.2.1 under Article 38 of the Convention only if they are unable to accept the binding nature of the Technical Instructions. Where States have adopted different provisions from those specified in the Technical Instructions, they are expected to be reported only under the provisions of 2.5.

2.5.2 **Recommendation.**— *The State of the Operator should take the necessary measures to ensure that when an operator adopts more restrictive requirements than those specified in the Technical Instructions, the notification of such operator variations is made to ICAO for publication in the Technical Instructions.*

2.6 Surface transport

Recommendation.— *States should make provisions to enable dangerous goods intended for air transport and prepared in accordance with the ICAO Technical Instructions to be accepted for surface transport to or from aerodromes.*

16/11/89

CHAPTER 3. CLASSIFICATION

The classification of an article or substance shall be in accordance with the provisions of the Technical Instructions.

Note.— The detailed definitions of the classes of dangerous goods are contained in the Technical Instructions. These classes identify the potential risks associated with the transport of dangerous goods by air and are those recommended by the United Nations Committee of Experts on the Transport of Dangerous Goods.

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CHAPTER 4. LIMITATION ON THE TRANSPORT OF DANGEROUS GOODS BY AIR

4.1 Dangerous goods permitted for transport by air

The transport of dangerous goods by air shall be forbidden except as established in this Annex and the detailed specifications and procedures provided in the Technical Instructions.

4.2 Dangerous goods forbidden for transport by air unless exempted

The dangerous goods described hereunder shall be forbidden on aircraft unless exempted by the States concerned under the provisions of 2.1 or unless the provisions of the Technical Instructions indicate they may be transported under an approval issued by the State of Origin:

a) articles and substances that are identified in the Technical Instructions as being forbidden for transport in normal circumstances; and

b) infected live animals.

4.3 Dangerous goods forbidden for transport by air under any circumstances

Articles and substances that are specifically identified by name or by generic description in the Technical Instructions as being forbidden for transport by air under any circumstances shall not be carried on any aircraft.

CHAPTER 5. PACKING

5.1 General requirements

Dangerous goods shall be packed in accordance with the provisions of this chapter and as provided for in the Technical Instructions.

5.2 Packagings

5.2.1 Packagings used for the transport of dangerous goods by air shall be of good quality and shall be constructed and securely closed so as to prevent leakage which might be caused in normal conditions of transport, by changes in temperature, humidity or pressure, or by vibration.

5.2.2 Packagings shall be suitable for the contents. Packagings in direct contact with dangerous goods shall be resistant to any chemical or other action of such goods.

5.2.3 Packagings shall meet the material and construction specifications in the Technical Instructions.

5.2.4 Packagings shall be tested in accordance with the provisions of the Technical Instructions.

5.2.5 Packagings for which retention of a liquid is a basic function, shall be capable of withstanding, without leaking, the pressure stated in the Technical Instructions.

5.2.6 Inner packagings shall be so packed, secured or cushioned as to prevent their breakage or leakage and to control their movement within the outer packaging(s) during normal conditions of air transport. Cushioning and absorbent materials shall not react dangerously with the contents of the receptacles.

5.2.7 No receptacle shall be re-used until it has been inspected and found free from corrosion or other damage. Where a receptacle is re-used, all necessary measures shall be taken to prevent contamination of subsequent contents.

5.2.8 If, because of the nature of their former contents, uncleaned empty receptacles may present a hazard, they shall be tightly closed and treated according to the hazard they constitute.

5.2.9 No harmful quantity of a dangerous substance shall adhere to the outside of packages.

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CHAPTER 6. LABELLING AND MARKING

6.1 Labels

Unless otherwise provided for in the Technical Instructions, each package of dangerous goods shall be labelled with the appropriate labels and in accordance with the provisions set forth in those Instructions.

6.2 Markings

6.2.1 Unless otherwise provided for in the Technical Instructions, each package of dangerous goods shall be marked with the proper shipping name of its contents and, when assigned, the UN number and such other markings as may be specified in those Instructions.

6.2.2 Specification markings on packagings

Unless otherwise provided for in the Technical Instructions, each packaging manufactured to a specification contained in those Instructions shall be so marked in accordance with the appropriate provisions of those Instructions and no packaging shall be marked with a packaging specification marking unless it meets the appropriate packaging specification contained in those Instructions.

6.3 Languages to be used for markings

Recommendation.— *In addition to the languages required by the State of Origin and pending the development and adoption of a more suitable form of expression for universal use, English should be used for the markings related to dangerous goods.*

CHAPTER 7. SHIPPER'S RESPONSIBILITIES

7.1 General requirements

Before a person offers any package or overpack of dangerous goods for transport by air, that person shall ensure that the dangerous goods are not forbidden for transport by air and are properly classified, packed, marked, labelled and accompanied by a properly executed dangerous goods transport document, as specified in this Annex and the Technical Instructions.

7.2 Dangerous goods transport document

7.2.1 Unless otherwise provided for in the Technical Instructions, the person who offers dangerous goods for transport by air shall complete, sign and provide to the operator a dangerous goods transport document, which shall contain the information required by those Instructions.

7.2.2 The transport document shall bear a declaration signed by the person who offers dangerous goods for transport indicating that the dangerous goods are fully and accurately described by their proper shipping names and that they are classified, packed, marked, labelled, and in proper condition for transport by air in accordance with the relevant regulations.

7.3 Languages to be used

Recommendation.— *In addition to the languages which may be required by the State of Origin and pending the development and adoption of a more suitable form of expression for universal use, English should be used for the dangerous goods transport document.*

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CHAPTER 8. OPERATOR'S RESPONSIBILITIES

8.1 Acceptance for transport

An operator shall not accept dangerous goods for transport by air:

a) unless the dangerous goods are accompanied by a completed dangerous goods transport document, except where the Technical Instructions indicate that such a document is not required; and

b) until the package, overpack or freight container containing the dangerous goods has been inspected in accordance with the acceptance procedures contained in the Technical Instructions.

Note 1.— See Chapter 12 concerning the reporting of dangerous goods accidents and incidents.

Note 2.— Special provisions relating to the acceptance of overpacks are contained in the Technical Instructions.

8.2 Acceptance checklist

An operator shall develop and use an acceptance checklist as an aid to compliance with the provisions of 8.1.

8.3 Inspection for damage or leakage

8.3.1 Packages and overpacks containing dangerous goods and freight containers containing radioactive materials shall be inspected for evidence of leakage or damage before loading on an aircraft or into a unit load device. Leaking or damaged packages, overpacks or freight containers shall not be loaded on an aircraft.

8.3.2 A unit load device shall not be loaded aboard an aircraft unless the device has been inspected and found free from any evidence of leakage from, or damage to, any dangerous goods contained therein.

8.3.3 Where any package of dangerous goods loaded on an aircraft appears to be damaged or leaking, the operator shall remove such package from the aircraft, or arrange for its removal by an appropriate authority or organization, and thereafter shall ensure that the remainder of the consignment is in a proper condition for transport by air and that no other package has been contaminated.

8.3.4 Packages or overpacks containing dangerous goods and freight containers containing radioactive materials shall be inspected for signs of damage or leakage upon unloading from the aircraft or unit load device. If evidence of damage or leakage is found, the area where the dangerous goods or unit load device were stowed on the aircraft shall be inspected for damage or contamination.

8.4 Loading restrictions in passenger cabin or on flight deck

Dangerous goods shall not be carried in an aircraft cabin occupied by passengers or on the flight deck of an aircraft, except in circumstances permitted by the provisions of the Technical Instructions.

8.5 Removal of contamination

8.5.1 Any hazardous contamination found on an aircraft as a result of leakage or damage to dangerous goods shall be removed without delay.

8.5.2 An aircraft which has been contaminated by radioactive materials shall immediately be taken out of service and not returned to service until the radiation level at any accessible surface and the non-fixed contamination are not more than the values specified in the Technical Instructions.

8.6 Separation and segregation

8.6.1 Packages containing dangerous goods which might react dangerously one with another shall not be stowed on an aircraft next to each other or in a position that would allow interaction between them in the event of leakage.

8.6.2 Packages of poisons and infectious substances shall be stowed on an aircraft in accordance with the provisions of the Technical Instructions.

8.6.3 Packages of radioactive materials shall be stowed on an aircraft so that they are separated from persons, live animals and undeveloped film, in accordance with the provisions in the Technical Instructions.

8.7 Securing of dangerous goods cargo loads

When dangerous goods subject to the provisions contained herein are loaded in an aircraft, the operator shall protect the dangerous goods from being damaged, and shall secure such goods in the aircraft in such a manner that will prevent any movement in flight which would change the orientation of the packages. For packages containing radioactive materials, the securing shall be adequate to ensure that the separation requirements of 8.6.3 are met at all times.

8.8 Loading on cargo aircraft

Except as otherwise provided in the Technical Instructions, packages of dangerous goods bearing the "Cargo aircraft only" label shall be loaded in such a manner that a crew member or other authorized person can see, handle and, where size and weight permit, separate such packages from other cargo in flight.

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CHAPTER 9. PROVISION OF INFORMATION

9.1 Information to pilot-in-command

The operator of an aircraft in which dangerous goods are to be carried shall provide the pilot-in-command as early as practicable before departure of the aircraft with written information as specified in the Technical Instructions.

9.2 Information and instructions to flight crew members

The operator shall provide such information in the Operations Manual as will enable the flight crew to carry out its responsibilities with regard to the transport of dangerous goods and shall provide instructions as to the action to be taken in the event of emergencies arising involving dangerous goods.

9.3 Information to passengers

Operators shall ensure that information is promulgated in such a manner that passengers are warned as to the types of goods which they are forbidden from transporting aboard an aircraft as checked baggage or carry-on articles.

9.4 Information to other persons

Operators, shippers or other organizations involved in the transport of dangerous goods by air shall provide such information to their personnel as will enable them to carry out their responsibilities with regard to the transport of dangerous goods and shall provide instructions as to the action to be taken in the event of emergencies arising involving dangerous goods.

9.5 Information from pilot-in-command to aerodrome authorities

Recommendation.— *If an in-flight emergency occurs the pilot-in-command should inform the appropriate air traffic services unit, for the information of aerodrome authorities, of any dangerous goods on board. If the situation permits, the information should include the proper shipping names, class, subsidiary risks for which labels are required, the compatibility group for Class 1 and the quantity and location aboard the aircraft of the dangerous goods.*

9.6 Information in the event of an aircraft accident or incident

9.6.1 The operator of an aircraft carrying dangerous goods which is involved in an aircraft accident shall, as soon as possible, inform the State in which the aircraft accident occurred of the dangerous goods carried, together with their proper shipping names, class, subsidiary risks for which labels are required, the compatibility group for Class 1 and the quantity and location on board the aircraft.

9.6.2 **Recommendation.—** *The operator of an aircraft carrying dangerous goods which is involved in an aircraft incident should, on request from the State in which the incident occurred, provide that State with information required to minimize the hazards created by any damage to the dangerous goods carried.*

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CHAPTER 10. ESTABLISHMENT OF TRAINING PROGRAMMES

Dangerous goods training programmes shall be established and updated as provided for in the Technical Instructions.

CHAPTER 11. COMPLIANCE

11.1 Inspection systems

Each Contracting State shall establish inspection, surveillance and enforcement procedures with a view to achieving compliance with its dangerous goods regulations.

Note.— It is envisaged that these procedures would include provisions for the inspection of both documents and cargo and operators' practices as well as providing a method for the investigation of alleged violations (see 11.3).

11.2 Co-operation between States

Recommendation.— *Each Contracting State should co-operate with other States in exchanging any available information concerning violations of dangerous goods regulations, with the aim of eliminating such violations.*

11.3 Penalties

Recommendation.— *Each Contracting State should take such measures as it may deem appropriate to achieve compliance with its dangerous goods regulations including the prescription of appropriate penalties for violations.*

11.4 Dangerous goods by mail

Recommendation.— *Each Contracting State should establish procedures with a view to controlling the introduction of dangerous goods into air transport through its postal services.*

Note.— International procedures for controlling the introduction of dangerous goods into air transport through the postal services have been established by the Universal Postal Union.

CHAPTER 12. DANGEROUS GOODS ACCIDENT AND INCIDENT REPORTING

12.1 With the aim of preventing the recurrence of dangerous goods accidents and incidents, each Contracting State shall establish procedures for investigating and compiling information concerning such accidents and incidents which occur in its territory and which involve the transport of dangerous goods originating in or destined for another State. Reports on such accidents and incidents shall be made in accordance with the detailed provisions of the Technical Instructions.

12.2 **Recommendation.—** *With the aim of preventing the recurrence of dangerous goods accidents and incidents, each Contracting State should establish procedures for investigating and compiling information concerning such accidents and incidents which occur in its territory other than those described in 12.1. Reports on such accidents and incidents should be made in accordance with the detailed provisions of the Technical Instructions.*

— END —

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