International Civil Aviation Organization

SIXTH MEETING OF SPECTRUM REVIEW WORKING GROUP (SRWG/6)

Video Teleconference, 1 – 3 March 2022

Agenda Item 6: Review the regional guidance material

DRAFT OF ASIA PACIFIC REGIONAL AERONAUTICAL RADIO FREQUENCY MANAGEMENT GUIDANCE MATERIAL

(Presented by China)

SUMMARY

This paper presents the second edition of the draft of Asia Pacific Regional Aeronautical Radio Frequency Management Guidance Material.

The guidance provided in ATTACHMENT includes objective, scope, institutional framework, spectrum management and procedure of APAC region, air-ground communication and radio navigation aid frequency management information.

1. INTRODUCTION

1.1 The fourth meeting of the spectrum review working group (SRWG/4) considered the development of the regional guidance material on aeronautical frequency spectrum management in a shared way by States.

1.2 The first draft of Asia Pacific Regional Aeronautical Radio Frequency Management Guidance Material was submitted at the fifth meeting of the spectrum review working group (SRWG/5), which includes the prime objectives and scope in chapter 1, institutional framework, spectrum management and procedure for coordination of APAC Region in chapter 2, air-ground communication frequency management of HF and VHF COM in chapter 3.

2. DISCUSSION

2.1. Based on ANNEX 10, Handbook on Radio Frequency Spectrum Requirements for Civil Aviation（DOC9718）, the conference conclusions of APAC Regional office , and referring to EUR Frequency Management Manual (EUR DOC 011), the content of radio navigation aid frequency management was introduced to this manuscript for the first time，including the frequency band and channel spacing, designated operational coverage (DOC), necessary field strength, frequency assignment principle and protection criteria, etc.

2.2. The issues need attention are shown as follows:

2.2.1. The minimum coordination distance for radio navigation facilities

To ensure that the navigation facility has an assignable frequency and avoid harmful interference from/to the other navigation facilities with the same or adjacent frequency, before the formal assignment, States/Administrations should coordinate with the Regional Office for all frequency that may affect the use of the other frequency assignments coordinated through the ICAO mechanism.

In order to improve the working efficiency, it is necessary to determine the minimum coordination distance. Referring to the document EUR DOC 011, the minimum coordination distance established by European and North Atlantic Office is 150 NM for ILS, 400-500 NM for VOR, 500 NM for GBAS/VDB and 400-500 NM for DME.

However, it can be seen from DOC 9718, Volume 2 that the minimum geographical separation distance of the facility is determined by DOC, EIRP, protection ratio (D / U), path loss and other factors. Therefore, it is difficult to determine a fixed value for the minimum coordination distance which is not specified in this manuscript.

2.2.2. The minimum separation distance for Localizer and Glide Path

According to Attachment C to Annex 10, Volume 1, the minimum separation distances of Localizer and Glide Path are shown in the table below:

	Frequency separation	Minimum separation between second facility and the protection point of the first facility km (NM)	
		List A	List B
Localizer	Co-channel	148(80)	148(80)
	50kHz	37(20)	9(5)
	100kHz	9(5)	0
	150kHz	0	0
	200kHz	0	0
Glide path	Co-channel	93(50)	93(50)
	150kHz	20(11)	2(1)
	300kHz	2(1)	0
	450kHz	0	0
	600kHz	0	0

List A refers to the use of localizer receivers designed for 100 kHz channel spacing coupled with glide path receivers designed for 300 kHz channel spacing.

List B refers to the use of localizer receivers designed for 50 kHz channel spacing coupled with glide path receivers designed for 150 kHz channel spacing.

Note 1. The above figures are based on the assumption of protection points for the localizer at 46 km (25 NM) distance and 1900 m (6250 ft) height and for the ILS glide path at 18.5 km (10 NM) distance and 760 m (2500 ft) height.

Note 2. States, in applying the separations shown in the table, have to recognize the necessity to site the ILS and VOR facilities in a manner which will preclude the possibility of airborne receiver error due to overloading by high unwanted signal levels when the aircraft is in the initial and final approach phases.

Note 3. States, in applying the separations shown in the table, have to recognize the necessity to site the ILS glide path facilities in a manner which will preclude the possibility of erroneous glide path indications due to reception of adjacent channel signals when the desired signal ceases to radiate for any reason while the aircraft is in the final approach phase.

From DOC 9718, Volume 2, through the calculation based on EIRP of navigation facilities, D / U ratio and ITU-R propagation curve, it can be found that the geographical separation distance between two facilities with the same or adjacent frequencies channel will be greater than the recommended value in above table. For example, when two Localizers' EIRP=17dBW，DOC=25/6250(25NM,6250ft)，their separation distance will be 137NM for co-channel, greater than 105NM（80NM+DOR25NM））。

At present, the standard values in above table are still used in frequency assignment planning in Europe. And so is in China mainland where these facilities have operated well for decades, and no report of harmful interference to airborne receivers has been received.

The above two calculation methods are retained in the manuscript. However, we recommend the adoption of annex 10 standards in the Asia/Pacific region.

2.2.3. The minimum separation distance for adjacent channel of Localizer and VOR

According to Annex 10, Volume 1, Appendix C, 3.5.3.2, Protection of the VOR system is effectively obtained without geographical separation of the facilities. However, in the case of:

a) a localizer receiver designed for 100 kHz channel spacing and used in an area where nav aid assignments are spaced at 100 kHz, the protection of the ILS system requires that a VOR having an ERP of 17 dBW (50 W) be at least 9.3 km (5 NM) from the ILS protection point;

b) a localizer receiver designed for 100 kHz channel spacing and used in an area where assignments are spaced at 50 kHz, the protection of the ILS system requires that a VOR having an ERP of 17 dBW (50 W) be at least 79.6 km (43 NM) from the ILS protection point.

In other words, for the localizer receiver designed for 50 kHz channel spacing, there is no protection distance requirement from the adjacent VOR channel. However, according to the requirements of DOC 9718, Volume 2, in this case, the protection requirements of D/U=-34dB need to be met at the edge of each facility. For example, the geographical distance between Localizer and 50kHz adjacent channel VOR needs to be 44 NM (Localizer DOR25NM+path loss19NM).

The protection requirements of DOC 9718 are introduced in this manuscript, and relevant comparative research will be further discussed in our future study.

2.2.4. Influence of Aircraft Contribution Factor on the Calculation of GBAS Protection Ratio

According to DOC 9718, Volume 2, With the view to protect the desired VDB signals in space, an airborne contribution factor has been added. This airborne contribution factor compensates for antenna gain variations in the horizontal plane (between the direction of the desired versus the undesired transmitter) and on-board transmission line loss variation (between the frequency of the desired and the undesired signal. The airborne contribution factor can be calculated with 15 + Min (6, 6 x Frequency Offset (in kHz) /1000) with a maximum frequency offset of 1000 kHz.

If the above method is adopted, the protection ratio for co-channel shall be increased from 26dB to 41dB. When the Frequency Offset of undesired channel is 1MHz, the protection ratio needs to be increased from -46dB to -25dB. This will lead to an increase in the geographical protection distance for GBAS/VDB facilities.

As a result, the relevant contents are pending in this manuscript, and further research will be studied in the future.

2.2.5. Criteria for Identifications coordination

This document provide the overview of the requirements have to be taken into account for identifications, such as the number of characters, special character, and the coordination through regional office. But the duplication criteria of identifications cannot be determined in this manuscript.

States/Administrations are invited to make recommendations on the criteria for identifications coordination.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper and the **ATTACHMEN**T;

b) focus on the contents of 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5 sections;

c) propose that ICAO APAC regional office could forward the refined draft after meeting discussion to States/Administrations for further comments; and

d) discuss any relevant matter as appropriate.

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ATTACHMENT to WP/06 of SRWG/6

Asia/Pacific Regional Aeronautical Radio Frequency Management Guidance Material

Draft (Second Edition)

International Civil Aviation Organization

AMENDMENTS

Amendments are announced in the supplements to the *Publications Catalogue*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS, CORRIGENDA AND ADDENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA / ADDENDA		
No.	Date	Entered by

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GLOSSARY

SYMBOLS AND UNITS

ABBREVIATIONS

CNS	Communication, Navigation and Surveillance
DME	Distance Measuring Equipment
DVOR	Doppler VHF Omni-Directional Range
ICAO	The International Civil Aviation Organization
ITU	International Telecommunication Union
ILS	Instrument Landing System
SARPs	Standards and Recommended Practices
VHF	Very High Frequency

DEFINITIONS

1. The explanation to the type of service/functions

ACC-L	Area control service for flights up to FL 250
ACC-SR-I	Surveillance radar area control service up to FL 250
ACC-SR-U	Surveillance radar area control service up to FL 450
ACC-U	Area control service for flights up to FL 450
AD	Within limits of aerodrome
AFIS	Aerodrome flight information services
APP-L	Approach control service for flights below FL120
APP-I	Approach control service for flights below FL 250
APP-PAR	Precision approach radar service up to FL 40
APP-SR-I	Surveillance radar approach control service up to FL 250
APP-SR-L	Surveillance radar approach control service up to FL 120
APP-SR-LU	Surveillance radar approach control service up to FL 450
APP-U	Approach control service for flights up to FL 450
ATIS	Automatic terminal information service
CD	Clearance delivery
DF	Direction finding
ER	Requirement to utilize extended range technique, RCAG or repeater stations
RCAG	Remote controlled air-ground communication
FIR	Flight information region
FIS-L	Flight information service for flights up to FL 250
FIS-U	Flight information service for flights between FL 250 and FL 450
RCAG	Remote controlled air-ground communication
SMC	Surface movement control up to limits of aerodrome
TWR	Aerodrome control service
VOLMET	VOLMET broadcasts

2. Specific terms related to frequency management

- Allocation (of a frequency band): Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radio astronomy service under specified conditions. This term shall also be applied to the frequency band concerned.

- Allotment (of a radio frequency or radio frequency channel): Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space radiocommunication service in one or more identified countries or geographical areas and under specified conditions.

- Assignment (of a radio frequency or radio frequency channel): Authorization given by an administration for a radio station to use a radio frequency or radio frequency channel under specified conditions.

Chapter 1

INTRODUCTION

This guidance material has been developed under a recommendation from the fourth meeting of the spectrum review working group (SRWG/4) of APANPIRG which was held via video conferencing from 09 to 10 June 2020. It is for States/Administrations in the APAC region to implement the frequency assignments in a coordinated manner with ANSP, CAA and national frequency Authorities to satisfy future operational needs or the introduction of new technologies, with emphasis on communication and navigation systems.

1.1 OBJECTIVE

1.1.1 Aeronautical services are recognized internationally to be prime users of radio frequencies. [Doc 9718 I chapter 1 1.2] The civil aviation community must accordingly develop and present, as necessary, its agreed policies and its quantified and qualified statements of requirement for radio frequency spectrum to ensure the continuing availability of adequate radio spectrum and, ultimately, the ongoing viability of air navigation services throughout the world. [Doc 9718 I chapter 1 1.4]

1.1.2 For the APAC Region, the Secretariat is developing, with the support of ICAO contracting states, material to support frequency assignment planning in the APAC Region.

1.1.3 In accordance with above, the prime objectives of this document are:

a) to provide background information on the APAC region's spectrum management institutional framework. [Doc 9718 volume 1 2.3.d]

b) to provide a convenient record for important frequency management material, such as the criteria applied in the planning of radio frequency assignments. [Doc 9718 1 2.3.c]

c) to provide updated frequency assignment planning criteria to secure [be sure] that aeronautical radio communication and navigation systems are protected from harmful interference on a uniform basis. [Doc 9718 II Background and purpose]

1.2 SCOPE

1.2.1 This guidance material describes general reference in aeronautical frequency management of APAC region, including the introduction and relationships between the main participants, overview of the framework and process of aeronautical spectrum management, etc.

1.2.2 This document is suitable for national authorities, telecommunication authorities (or telecommunication administrations), ATCs, aerodromes, and airlines which will management and use aeronautical frequencies.

Chapter 2

BACKGROUND

2.1 Institutional framework

2.1.1 ITU

2.1.1.1 International Telecommunication Union (ITU) as a specialized agency in the field of telecommunications, embraces all aspects of telecommunications, whether by line or by radio transmission, has authority to set standards for systems, technical parameters and procedures. [Doc 9718 volume 1 3.1]

Note: However, other specialized agencies, such as ICAO, would not be barred from any kind of work touching upon aeronautical telecommunications including standardization activities.

2.1.1.2 A prime and highly important area for aviation concerns the regulation and use of the radio frequency spectrum for which ITU is the international body. [Doc 9718 volume 1 3.1] In addition, the agreements made under its auspices for these matters and incorporated in the Final Acts of World Radio communication Conferences (WRCs) which are held every four years. [Doc 9718 volume 1 3.2]

2.1.1.3 The internationally agreed regulation of the radio frequency spectrum is provided through the ITU Radio Regulations (RR), [Doc 9718 volume 1 3.3] which include allocations, provisions on licensing, interference resolution, safety and distress procedures and other aspects. Within the Radio Regulations, the finite useable radio spectrum, from approximately 8.3 kHz to 275 GHz, is allocated to user services in response to their recognized demands, and among three ITU world Regions in accordance with the major regional spectrum requirements for these services in the relevant region. [Doc 9718 volume 1 3.3]

2.1.2 ICAO

2.1.2.1 Pursuant to the provisions in Art 37 of the Convention on International Civil Aviation, ICAO develops Standards and Recommended Practices (SARPs) for Communication, (radio) Navigation and Surveillance (CNS) systems. These standards include technical characteristics and protection requirements to secure interference free operation of these systems and are incorporated in Annex 10.

2.1.2.2 In addition to the material in Anne 10, on a Regional level, Air Navigation Plans have been developed. These ANPs contain, based on Regional Air Navigation Agreements, provisions that States have agreed to apply on the use of aeronautical radio communication, navigation and surveillance systems, including material relevant to frequency assignment planning.

2.1.2.3 In order to provide for more detailed guidance material on the provisions in Annex 10 for CNS systems, ICAO has developed Doc 9718. Doc 9718 is (currently) published in two parts:

- Volume I which contains material relevant to the allocation and use of aeronautical frequency bands by the ITU.
- Volume II which contains material relevant to the frequency assignment planning for CNS systems.

2.1.2.4 ICAO coordinates the input to ITU discussions on aeronautical radio frequency spectrum matters. The necessary activity to support these ITU-generated functions exists at two levels: [Doc 9718 volume 1 5.3]

(a) At the worldwide level, through the work of the Air Navigation Commission, with the assistance of the FSMP (and communication divisional meetings or air navigation conferences, as required), to prepare the coordinated ICAO policies, spectrum estimates and technical inputs for ITU conferences and ITU-R study groups. The ICAO spectrum strategy, policy statements and the ICAO Position for WRCs are approved by the Council; and

(b) At the regional level, by the ICAO Regional Offices, through coordination of frequency assignment plans with states/administrations, using agreed ICAO planning criteria. This activity is supported by the Regional Planning and Implementation Groups (PIRGs).

2.1.3 National and regional authorities

2.1.3.1 Within ITU Member States, the telecommunication authorities (or telecommunication administrations) normally control and operate the mechanism which develops the national proposals for amending the Radio Regulations (RR) for submission to the ITU WRCs. [Doc 9718 volume 1 3.4]

2.1.3.2 National and regional preparatory committees function is the coordination medium to which the aviation requirements, either ICAO or regional official coordinated or nationally derived, are presented by the national aviation authorities for consideration. [Modify from Doc 9718 volume 1 3.4]

2.1.3.3 It is essential that aeronautical participation in these national and regional activities be ensured in order to support and defend aviation requirements. [Doc 9718 volume 1 3.4]

2.1.4 Relationship between ITU RR and other material and ICAO SARPS

2.1.4.1 Aviation services are recognized important users of radio spectrum to create safe and expeditious conditions to support air operations. The aeronautical mobile (route) service (AM(R)S), the aeronautical radio navigation service (ARNS) and their satellite service counterparts are important components in the mobile and radio determination families of users with (normally) exclusive allocations made on a worldwide basis to ensure global harmonization. Worldwide allocations enable international standardization of equipment and systems to support safe and global air traffic. ITU Radio Regulations (RR) are used as the framework for the relevant ICAO Annexes and the Standards and Recommended Practices (SARPs) contained therein. [Doc 9718 volume 1 3.5]

2.1.4.2 ICAO is recognized internationally as the competent international body to coordinate a worldwide policy for the operational use of the specified systems. Furthermore, the ICAO Annexes contain procedures for regular and emergency communications that are specifically developed for aviation purposes, taking account of the operational conditions. These procedures supplement the basic requirements of the Radio Regulations for procedures in aeronautical communications. [Doc 9718 volume 1 4.4.3]

2.1.4.3 The Radio Regulations and ICAO SARPs together thus form a complementary set of regulatory provisions without any overlap. The Radio Regulations must evolve within the general telecommunications environment with its many and diverse users of the radio frequency spectrum, while the ICAO SARPs respond to the operational safety aspects of air navigation and are developed and agreed by aviation within the ICAO organizational framework. [Doc 9718 volume 1 4.4.4]

2.2 Spectrum coordination and management

2.2.1 General

2.2.1.1 In using frequency bands for radio services, Members shall bear in mind that radio frequencies are limited natural resources and that they must be used rationally, efficiently and economically, in conformity with the provisions of these regulations of Radio Regulations, Annex 10 to the ICAO Convention and national and regional planning. [RR 0.3]

2.2.1.2 Frequency assignment should ensure that stations of a secondary service shall not cause harmful interference to stations of primary services to which frequencies are already assigned or to which frequencies may be assigned at a later date. [RR 5.29]

2.2.1.3 Any new assignment or any change of frequency or other basic characteristic of an existing assignment shall be made in such a way as to avoid causing harmful interference to services rendered by stations using frequencies assigned in accordance with this guidance material. [RR 4.3]

2.2.1.4 Frequency assignment should ensure the availability and protection from harmful interference of the frequencies provided for distress and safety purposes. [RR 0.7]

2.2.2 Frequency coordination and registration [doc 9718 volume 1 4.5]

2.2.2.1 The coordination and registration of frequency assignments is the prerogative of the ITU and must be performed in accordance with procedures laid down in the Radio Regulations. Frequencies are registered in the Master International Frequency Register (MIFR) maintained at ITU Headquarters in Geneva.

2.2.2.2 In exclusive aeronautical bands, actual (day-to-day) coordination of frequency assignments is being undertaken by ICAO, through the ICAO Regional Offices.

2.2.2.3 To support this coordination, the ICAO Regional Offices have developed the necessary procedures, including the relevant frequency assignment planning criteria. Coordination of frequency assignments is taking place (in most cases) with the national civil aviation authorities.

2.2.2.4 Although in some cases aeronautical frequency assignments, notably those in HF and LF/MF bands, are registered by the countries operating these services, other frequency assignments, particularly those in bands above 100 MHz, tend to be recorded only in national registers or in the ICAO Regional Air Navigation Plans. Because of this, de facto, the ICAO frequency register within ICAO.

2.2.2.5 However, it does not dispense with the more general requirement for the coordination of a frequency assignment within the ITU and the registration of this frequency assignment in the MIFR, if international protection of that assignment is necessary.

2.2.2.6 Coordination and registration of frequency assignments in the HF bands (between 2850 kHz and 22000 kHz) is only taking place through the ITU. However, ICAO is considering developing, in parallel, a relevant ICAO list of HF frequency assignments.

2.2.2.7 Coordination and registration of frequency assignments for radar stations and on-board autonomous radio navigation systems is however NOT being coordinated through ICAO.

2.2.2.8 List of frequency bands coordinated by ICAO is given in Table 1

Table 2.1 List of frequency bands

Symbols	Frequency range	Facility
LF/MF	190 – 495 kHz and 505 – 526.5 kHz	NDB and locator
VHF	108 – 117.975 MHz 117.975 – 137 MHz	ILS localizer (below 112 MHz), VOR and GBAS Air-ground communications
UHF	328.6 – 335.4 MHz 960 – 1215 MHz	ILS glide path DME

2.2.3 Procedure of Coordination for aeronautical frequency in APAC Region

2.2.3.1 The ICAO Third Asia/Pacific Regional Air Navigation (ASIA/PAC/3 RAN) Meeting in 1993 agreed that The ICAO APAC Regional Office would continue to maintain its frequency selection and coordination role, including the maintenance and promulgation of Frequency List Nos.1, 2 and 3 in a timely and periodic manner.

Note: with the successful implementation of Frequency Finder, there was no more Frequency List No. 3 published by the ICAO APAC Regional Office after the 29th Edition in January 2016, replaced by the up-to-date database in Frequency Finder.

Note: Frequency Finder is the ICAO aeronautical radio frequency management tool for VHF COM and NAV frequency assignments.

2.2.3.2 The Thirty-first Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/31) in 2020 agreed that the database in Frequency Finder is visible to all Frequency Finder users. And the maintenance and promulgation of Frequency List Nos. 1 and 2 are still being conducted by the Regional Office in a timely and periodic manner. It proposes to request States/Administrations to update specific characteristics for NAV facilities in the Frequency List No. 2 as well as to secure that the information in the Frequency Lists is up-to-date.

2.2.3.3 The updated Frequency Lists of Nos. 1 and 2 are published under – CNS More Documents through secure portal of ICAO APAC website webpage, or download from the database of the Frequency Finder.

2.2.3.4 Currently, States/Administrations can submit to the Regional Office their requests for new or modified frequency assignments in any format (e.g. letter, email). [SRWG4 WP2 2.3]

(a) The administrative aspects of the frequency coordination can be improved by States/Administrations using Frequency Finder to generate electronic submissions for new or modified frequency assignments. This option permits States/Administrations to check a selected frequency to satisfy any operational need and to check the compatibility of this (proposed) frequency with other frequency assignments in the Frequency List No.3. It greatly facilitates the final coordination that is performed by the ICAO Regional Office. The electronic submission(s), in the format of an Excel file, can be sent to the ICAO Regional Office through email.

(b) The second option for States/Administrations to submit to the Regional Office requests for registering new or modified frequency assignments, also by electronic means, through a locally generated Excel file that follows the template as in **Appendix A**.

(c) The third option is for States/Administrations to submit to the Regional Office requests for new of modified frequency assignment by letter. The preferred format of the characteristics of these submissions is in **Appendix B**.

Chapter 3

AIR-GROUND COMMUNICATION FREQUENCY MANAGEMENT

3.1 HF Air-ground Communication Frequency bands

3.1.1 HF bands (between 2850 kHz and 22 000 kHz) coordination is recommended to be carried out between States. Coordination and registration of HF frequencies is undertaken by the ITU, through the Radio Regulatory Authorities in each country. ICAO does not coordinate assignments for HF frequencies. [SRWG/1 wp04 2.3] ICAO is considering developing, in parallel, a relevant ICAO list of HF frequency assignments. [9718 volume 1 4.5.4] Pre-coordination of HF frequencies could be arranged through the ICAO ASIA/PAC Office in Bangkok. However, national radio regulator is required to develop a proposal for the required assignments. Such proposals should be based on the provisions of Appendix 27 to the ITU Radio Regulations, together with the information contained in the ITU International Frequency List (ILS) taking into consideration the protection requirements for HF as contained in Appendix 27. [SRWG/1 wp04]

3.1.2 Appendix 27 to the Radio Regulations (RR) contains the frequency allotment plan for the AM(R)S in the HF bands. This appendix contains the plan for HF frequency allotments to major world air route areas and to regional and domestic air route areas as well as VOLMET areas. It also includes worldwide frequency allotments, which are for the use of aircraft operating agencies for AOC, to be assigned in accordance with RR 27/217. [DOC9718 volume 1 4.2.6]

3.1.3 The technical characteristics for HF aviation equipment in Appendix 27 of the Radio Regulations, since they form part of the Radio Regulations, enjoy the same status as compulsory treaty obligations. [DOC9718 volume 1 4.6]

3.2 VHF Air-ground Communication Frequency bands

3.2.1 General allotment of frequency band 117.975 – 137.000 MHz shall be as shown in Table 3.1.

Table 3.1 Allotment table

Block allotment frequencies (MHz)	**Worldwide utilization**	**Remarks**
118.000 –121.450 inclusive	International and National Aeronautical Mobile Services	Specific international allotments will be determined in the light of regional agreement.
121.500	Emergency frequency	
121.550 –121.9917inclusive	International and National Aerodrome Surface Communications	Reserved for national allotments
122.000 –123.050 inclusive	National Aeronautical Mobile Services	Reserved for national allotments
123.100	Auxiliary frequency SAR	
123.150 –123.6917inclusive	National Aeronautical Mobile Services	Reserved for national allotments
123.450	Air-to-air communications	Reserved for air-to-air communication
123.700 –129.6917 inclusive	International and National Aeronautical Mobile Services	Specific international allotments will be determined in the light of regional agreement.
129.700 –130.8917 inclusive	National Aeronautical Mobile Services	Reserved for national allotments but may be used in whole or in part, subject to regional agreement,

130.900 –136.875 inclusive	International and National Aeronautical Mobile Services	Specific international allotments will be determined in light of regional agreement.
136.900 –136.975 inclusive	International and National Aeronautical Mobile Services	Reserved for VHF air-ground data link communications.

3.2.2 In accordance with the provisions of Annex 10, the emergency channel (121.500 MHz) shall be used only for genuine emergency purposes, and where a requirement is established for the use of a frequency auxiliary to 121.500 MHz, the frequency 123.100 MHz shall be used,

3.2.3 Common signalling channels for VDL

3.2.3.1 The frequency 136.975 MHz is reserved on a worldwide basis to provide a common signaling channel (CSC) to the VHF digital link Mode 2 (VDL Mode 2).

3.2.3.2 In areas where VDL Mode 4 is implemented, the frequencies 136.925 MHz and 113.250 MHz shall be provided as common signaling channels (CSCs) to the VHF digital link Mode 4 (VDL Mode 4).

3.2.4 In the frequency band 117.975 – 137.000 MHz, the frequencies used for National Aeronautical Mobile Services, unless worldwide or regionally allotted to this specific purpose, shall be so deployed that no harmful interference is caused to facilities in the International Aeronautical Mobile Services.

3.2.5 Minimum separation between assignable frequencies in the aeronautical mobile (R) service shall be 8.33 kHz . Requirements for mandatory carriage of equipment specifically designed for 8.33 kHz channel spacing shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation timescales for the carriage of equipment, including the appropriate lead time. (See Annex 10, Volume V, 4.1.2.2, 4.1.2.3). APAC region has agreed to base frequency assignment planning on 25 kHz frequency separation. The APAC frequency allotment plans as in Table 3.2.

Table 3.2 APAC Regional frequency allotment plans

Function	**Frequencies/Bands(MHz)**
TWR	118.000 118.025 118.050 118.075 118.100 118.125 118.150 118.175 118.200 118.225 118.250 118.275 118.300 118.325 118.350 118.375 118.400 118.425 118.450 118.475 118.500 118.525 118.550 118.575 118.600 118.625 118.650 118.675 118.700 118.725 118.750 118.775 118.800 118.825 118.850 118.875 124.300 124.325 124.350 124.375
SMC	**121.550 121.575** 121.600 121.625 121.650 121.675 121.700 121.725 121.750 121.775 121.800 121.825 121.850 121.875 121.900 121.925 121.950 121.975
APP-PAR	119.500 119.525 119.550 119.575 119.600 119.625 119.650 119.675 119.800 119.825 119.850 119.875 119.900 119.925 119.950 119.975
APP-L, APP-I, APP/DF I, APP/SR-	119.000 119.025 119.050 119.075 119.100 119.125 119.150 119.175 119.200 119.225 119.250 119.275 119.400 119.425 119.450 119.475 119.700 119.725 119.750 119.775 120.000 120.025 120.050 120.075 120.200 120.225 120.250 120.275

	120.400 120.425 120.450 120.475 120.600 120.625 120.650 120.675 120.800 120.825 120.850 120.875 121.000 121.025 121.050 121.075 121.100 121.125 121.150 121.175 121.200 121.225 121.250 121.275 121.400 **121.425 121.450** 123.800 123.825 123.850 123.875 124.000 124.025 124.050 124.075 124.700 124.725 124.750 124.775 125.100 125.125 125.150 125.175 125.500 125.525 125.550 125.575 126.500 126.525 126.550 126.575 127.700 127.725 127.750 127.775 127.900 127.925 127.950 127.975
APP-U	120.300 120.325 120.350 120.375 121.300 121.325 121.350 121.375 124.200 124.225 124.250 124.275 124.400 124.425 124.450 124.475 124.600 124.625 124.650 124.675 124.800 124.825 124.850 124.875 125.000 125.025 125.050 125.075 125.200 125.225 125.250 125.275 125.400 125.425 125.450 125.475 125.600 125.625 125.650 125.675 125.800 125.825 125.850 125.875 126.000 126.025 126.050 126.075 126.300 126.325 126.350 126.375
ACC-L or ACC/SR-L	126.100 126.125 126.150 126.175 127.500 127.525 127.550 127.575 128.300 128.325 128.350 128.375 128.700 128.725 128.750 128.775
ACC-U ACC-LU	118.900 118.925 118.950 118.975 119.300 119.325 119.350 119.375 120.500 120.525 120.550 120.575 120.700 120.725 120.750 120.775 120.900 120.925 120.950 120.975 123.700 123.725 123.750 123.775 124.500 124.525 124.550 124.575 125.300 125.325 125.350 125.375 125.700 125.725 125.750 125.775 125.900 125.925 125.950 125.975 128.100 128.125 128.150 128.175 132.100 132.125 132.150 132.175 132.200 132.225 132.250 132.275 132.300 132.325 132.350 132.375 132.400 132.425 132.450 132.475 132.500 132.525 132.550 132.575 132.600 132.625 132.650 132.675 132.700 132.725 132.750 132.775 132.800 132.825 132.850 132.875 132.900 132.925 132.950 132.975 133.000 133.025 133.050 133.075 133.100 133.125 133.150 133.175

	133.200 133.225 133.250 133.275 133.300 133.325 133.350 133.375 133.400 133.425 133.450 133.475 133.500 133.525 133.550 133.575 133.600 133.625 133.650 133.675 133.700 133.725 133.750 133.775 133.800 133.825 133.850 133.875 133.900 133.925 133.950 133.975 134.000 134.025 134.050 134.075 134.100 134.125 134.150 134.175 134.200 134.225 134.250 134.275 134.300 134.325 134.350 134.375 134.400 134.425 134.450 134.475 134.500
FIS - LU	120.100 120.125 120.150 120.175 123.900 123.925 123.950 123.975 124.100 124.125 124.150 124.175 124.900 124.925 124.950 124.975 126.700 126.725 126.750 126.775 126.900 126.925 126.950 126.975 127.100 127.125 127.150 127.175 127.300 127.325 127.350 127.375 128.500 128.525 128.550 128.575
FIS-U (GPS)	134.600 134.625 134.650 134.675 134.700 134.725 134.750 134.775 134.800 134.825 134.850 134.875 134.900 134.925 134.950 134.975 135.000 135.025 135.050 135.075 135.100 135.125 135.150 135.175 135.200 135.225 135.250 135.275 135.300 135.325 135.350 135.375 135.400 135.425 135.450 135.475 135.500 135.525 135.550 135.575 135.600 135.625 135.650 135.675 135.700 135.725 135.750 135.775 135.800
AOC	128.900 128.925 128.950 128.975 129.000 129.025 129.050 129.075 129.100 129.125 129.150 129.175 129.200 129.225 129.250 129.275 129.300 129.325 129.350 129.375 129.400 129.425 129.450 129.475 129.500 129.525 129.550 129.575 129.600 129.625 129.650 129.675 129.700 129.725 129.750 129.775 129.800 129.825 129.850 129.875 129.900 129.925 129.950 129.975 130.000 130.025 130.050 130.075 130.100 130.125 130.150 130.175 130.200 130.225 130.250 130.275 130.300 130.325 130.350 130.375 130.400 130.425 130.450 130.475 130.500 130.525 130.550 130.575 130.600 130.625 130.650 130.675

	130.700 130.725 130.750 130.775 130.800 130.825 130.850 130.875 130.900 130.925 130.950 130.975 131.000 131.025 131.050 131.075 131.100 131.125 131.150 131.175 131.200 131.225 131.250 131.275 131.300 131.325 131.350 131.375 131.400 131.425 131.450 131.475 131.500 131.525 131.550 131.575 131.600 131.625 131.650 131.675 131.700 131.725 131.750 131.775 131.800 131.825 131.850 131.875 131.900 131.925 131.950 131.975 132.000 132.025
VOLMET/ATIS	126.200 126.225 126.250 126.275 126.400 126.425 126.450 126.475 126.600 126.625 126.650 126.675 126.800 126.825 126.850 126.875 127.000 127.025 127.050 127.075 127.200 127.225 127.250 127.275 127.400 127.425 127.450 127.475 127.600 127.625 127.650 127.675 127.800 127.825 127.850 127.875 128.000 128.025 128.050 128.075 128.200 128.225 128.250 128.275 128.400 128.425 128.450 128.475 128.600 128.625 128.650 128.675 128.800 128.825 128.850 128.875
DATA LINK	136.900 136.925 136.950 136.975
AIR-TO-AIR	123.450

3.2.6 Frequencies should be assigned to all VHF Aeronautical Mobile Service (AMS) facilities in accordance with the principles laid out in Annex 10, Volume V and ICAO Handbook on Radio Frequency Spectrum Requirements for Civil Aviation (Doc 9718) Volumes I and II, and take into account:

(a) agreed geographical separation criteria based on 25 kHz or 8.33 kHz interleaving between channels;

(b) agreed geographical separation criteria for the implementation of VDL services;

(c) the need for maximum economy in frequency demands and in radio spectrum utilization; and

(d) a deployment of frequencies which ensures that international services are planned to be free of interference from other services using the same band. [APAC ANP VOLII 2.41]

3.2.7 The priority order to be followed in the assignment of frequencies to service is:

(a) ATS channels serving international services (ACC, APP, TWR, FIS);

(b) ATS channels serving national purposes;

(c) channels serving international VOLMET services;

(d) channels serving ATIS and PAR; and

(e) channels used for other than ATS purposes. [APAC ANP VOLII 2.42]

3.2.8 The criteria used for frequency assignment planning for VHF AMS facilities serving international requirements should, to the extent practicable, also be used to satisfy the need for national VHF AMS facilities. [APAC ANP VOLII 2.43]

3.2.9 Special provisions should be made, by agreement between the States concerned, for the sharing and the application of reduced protection of non-ATS frequencies in the national sub-bands, so as to obtain a more economical use of the available frequency spectrum consistent with operational requirements. [APAC ANP VOLII 2.44]

3.2.10 States should ensure that no air/ground frequency is utilized outside its designated operational coverage and that the stated operational requirements for coverage of a given frequency can be met for the transmission sites concerned, taking into account terrain configuration. [APAC ANP VOLII 2.45]

3.2.11 The criteria of Geographical separation used for Co-channel VHF assignments [DOC9614,AISA/PAC/ 03]

[Note: to be further revised]

Table 3.3 The criteria of Geographical separation used for Co-channel VHF assignments

AIR - GROUND COMMUNICATION FOR	SYMBOL	SERVICE RANGE NM	SERVICE HEIGHT m/ft	CO-CHANNEL SEPARATION NM
Aerodrome Control	TWR	25	1200/4000	175[1]
Surface Movement Control	SMC	limits of aerodrome	Surface	50[1]
Approach Control (upper)	APP-U	150	13700/45000	820[1]
Approach Control (intermediate)	APP-I	75	7600/25000	550[1]
Approach Control (lower)	APP-L	50	3650/12000	370[1]
Area Control or Flight Information (upper)	ACC-U or FIS-U	Specified area plus 50 NM	13700/45000 or 19800/65000 [3]	520[2] 630[2]
Area Control (lower)	ACC-L or ACC-SR-L	Specified area plus 50 NM	7600/25000	500[2]
Area Control or Flight Information (extended range)	ACC - ER or FIS - ER	to be specified	13700/45000 or 19800/65000[3]	1000[1] 1200[1]
VOLMET/ATIS	VOLMET or ATIS	omni - directional	13700/45000 or 19800/65000[3]	520[1] 600[1]

1 Distance between stations
2 Distance between limits of service areas
3 If required for SST operations

Chapter 4

RADIO NAVIGATION AID FREQUENCY MANAGEMENT

4.1 Non-Directional Radio Beacons (NDB)

[To be inserted]

4.2 Instrument Landing System (ILS)

4.2.1 Frequency band and channel spacing

4.2.1.1 Frequency band –The Localizer is operating in the frequency band 108 – 112 MHz. This band is also used for VOR and GBAS/VDB systems. Localizers cannot be assigned a frequency allotted for a VOR and vice versa. The Glide Path is operating in the frequency band 328.6 – 335.4 MHz. The Localizer and Glide Path frequencies are paired as shown in Appendix D. [DOC 9718, V2, 3.3.1.1]

4.2.1.2 Channel spacing 100 kHz – The channel spacing for the Localizer is 100 kHz and for the Glide Path is 300 kHz. The Localizer operates on odd 100 kHz channels in the VHF band. [DOC 9718, V2, 3.3.1.2]

4.2.1.3 Channel spacing 50 kHz – The use of 50 kHz channels for the localizer (and 150 kHz for the glide path) is permitted as stipulated in Annex 10, Volume V, paragraph 4.2.2.1. [DOC 9718, V2, 3.3.1.3]

Note: Such use shall not cause harmful interference to ILS receivers not capable of tuning to these (50/150 kHz) channels and is subject to the condition that the operational service to international operators using airborne equipment designed for 100 kHz channel spacing (150 kHz for the Glide Path) is not derogated.[DOC 9718 V2, 3.3.1.3]

4.2.1.4 When the ILS is associated with a DME, the DME channels must be selected as Appendix D. Further guidance on DME frequency assignment planning, including the ILS/DME channel pairing, is in section 4.5.

4.2.2 Designated Operational Coverage (DOC)

4.2.2.1 The horizontal Designated Operational Coverage of the Localizer and Glide Path is shown in Figure 4-1. The DOC can be extended (optional) with a range of 10 NM outside the clearance sector of the Localizer as promulgated by States/Administrations. [DOC 9718, V2, 3.2.1]

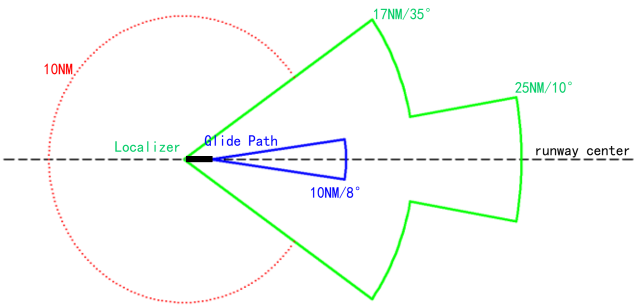


Figure 4-1. DOC of the ILS Localizer and Glide Path

4.2.2.2 The maximum protection height of the localizer DOC is 6250 ft and for the Glide Path 2500 ft. This height is relative to the elevation of the Localizer transmitter. [DOC 9718 V2, 3.2.2]

4.2.2.3 States/Administrations may modify the coverage to meet specific operational requirements. Unless a (modified) DOC has been provided, the standard DOC as in paragraph 4.2.2.1 is used in the frequency assignment ~~[coordination]~~ planning process. [DOC 9718 V2, 3.2.3]

4.2.2.4 When the ILS is associated with a DME, the DOC of the DME is typically the same as for the Localizer. However, States/Administrations may require the associated DME to provide coverage in a larger area. [DOC 9718 V2, 3.2.4]

Note: In practice, many frequency assignments for a DME, associated with an ILS, have a DOC of 10.000 ft/100 NM. Frequency assignment planning criterias for DME are in section 4.5.

4.2.3 [PFD limit] The minimum field strength for a Localizer is 40 µV/m (or 32 dBµV/m or - 116 dBW) throughout the DOC. For a Glide Path the minimum field strength is 400 µV/m (or 52 dBµV/m or - 106 dBW). [DOC 9718 Vol2, 3.2.4.2]

4.2.4 ILS serving both ends of the same runway. [DOC 9718, V2, 3.2.7]

To alleviate frequency congestion problems at locations where two separate ILS facilities serve opposite ends of the same runway or different runways at the same airport, the assignment of identical ILS localizer and glide path paired frequencies should be permitted provided that:

a) the operational circumstances permit;
b) each localizer is assigned a different identification signal; and
c) arrangements are made whereby the localizer and glide path not in operational use cannot radiate.

Note: The Standards in Annex 10, Volume I, 3.1.2.7.2 and 3.1.3.9, specify the equipment arrangements to be made.

4.2.5 [Facility Code] Information on the planning of identifications can be found in section 4.6.

4.2.6 A compatibility assessment for potential interference that can be caused by FM broadcasting stations operating in the frequency band 87 – 108 MHz is necessary before a Localizer frequency can be put into operational use. The FM immunity performance requirements for Localizer receivers are contained in Annex 10, Volume I, paragraph 3.1.4. Additional information on the process to assess compatibility with FM broadcast stations is in Recommendation ITU-R SM.1009. [DOC 9718, V2, 3.6]

4.2.7 Frequency Assignment Planning Principles

4.2.7.1 When the main direction of radiation of the ILS system is not known, for frequency assignment planning purposes, the coverage is assumed to be omnidirectional. The localizer coverage is originated from the location of the Localizer; the Glide Path coverage is originated from the location of the Glide Path. [DOC 9718 Vol2, 3.2.5]

4.2.7.2 The criteria must be applied in respect of each localizer installation, in the sense that while of two localizers, the first may not cause interference to the use of the second, nevertheless the second may cause interference to the use of the first. [Annex 10, ATT C 2.6.1]

4.2.7.3 The DOC for the Localizer is much larger than that for the Glide Path. When a localizer frequency has been assigned, the associated Glide Path frequency is automatically protected from harmful interference from other co-channel ILS facilities. However, when non-co-channel Localizer frequency has been assigned, a separate adjacent channel compatibility assessment is necessary for the Glide Path frequency with regard to other nearby ILS facilities operating on adjacent Glide Path frequencies. Therefore, the frequency assignment planning for Localizer and Glide Path has to be performed separately. [DOC 9718, V2, 3.3.1.5]

4.2.7.4 In so far as the wanted and unwanted carriers may produce a heterodyne note, the protection ratio ensures that the instrumentation is not affected. However, in cases where a voice facility is used, the heterodyne note may interfere with this facility. [DOC 9718 V2, 3.2.6]

4.2.8 Protection criteria for a desired Localizer and an undesired Localizer or VOR and a desired Glide path and an undesired Glide Path.

4.2.8.1 The minimum required separation distances between the desired ILS system and potentially interfering ILS systems are based on the assumption that protection against interference is afforded to the desired signal from the undesired signal is 20 dB. This corresponds to a disturbance of not more than 15 microamperes at the limit of the service distance of the ILS. [DOC 9718, V2, 3.4.1]

4.2.8.2 In order to protect receivers designed for 50 kHz channel spacing of LOC, minimum separations are chosen in order to provide the following minimum D/U ratios within the DOC as in Table 4.1.

Table 4.1 Minimum D/U ratio for 50 kHz Channel Localizer receivers

Δf (kHz)	D/U (dB)
0	20
50	-34
100	-46
≥ 150	-50

4.2.8.3 In order to protect receivers designed for 100 kHz channel spacing of LOC, minimum separations are chosen in order to provide the following minimum D/U ratios within the DOC as in Table 4.2.

Table 4.2 Minimum D/U ratio for 100 kHz Channel Localizer receivers

Δf (kHz)	D/U (dB)
0	20
50	-7
100	-46
≥ 150	-50

4.2.8.4 In order to protect receivers designed for 150 kHz spacing of Glide Path, minimum separations are chosen in order to provide the following minimum D/U ratios within the DOC as in Table 4.3.

Table 4.3 Minimum D/U ratio for 150 kHz Channel Glide Path receivers

Δf (kHz)	D/U (dB)
0	20
150	-20
≥ 300	-40

4.2.8.5 In order to protect receivers designed for 300 kHz spacing of Glide Path, minimum separations are chosen in order to provide the following minimum D/U ratios within the DOC as in Table 4.4.

Table 4.4 Minimum D/U ratio for 300 kHz Channel Glide Path receivers

Δf (kHz)	D/U (dB)
0	20
150	0
300	-20
≥ 450	-40

4.2.8.6 In Regions where both 100 kHz and 50 kHz Localizer channels are being used (300 kHz and 150 kHz channels for the Glide Path), the protection of the Localizer is based on receivers designed for 100 kHz channel spacing.

4.2.8.7 In the above cases, when the frequency offset is greater than 150 kHz for the Localizer and 450 kHz for the Glide path, practical experience has shown that freedom of using such frequencies can be applied.

4.2.9 Protection criteria for a desired Localizer and an undesired GBAS/VDB

4.2.9.1 The (assumed) minimum D/U ratios to protect Localizer receivers designed for 50 kHz channel spacing from interference that can be caused by GBAS/VDB signals are as in Table 4.5.

Table 4.5 Assumed D/U ratios to protect the Localizer from GBAS/VDB

Δf (frequency offset)	D/U
0 co-frequency	26 dB
+/- 25 kHz	0 dB
+/- 50 kHz	-34 dB
+/- 75 kHz	-46 dB
+/- 100 kHz	-65 dB

Note 1: The geographical separation between a GBAS and a Localizer facility must consider the performance of Localizer receivers, including co-channel and adjacent channel rejection of VDB signals. Since existing Localizer receivers were not specifically designed to reject VDB transmissions, desired-to-undesired (D/U) signal ratios for co-channel and adjacent channel rejection of the VDB were determined empirically for VOR receivers designed for 50 kHz channel spacing.

Note 2: No protection criteria for compatibility assessment between GBAS/VDB and Localizer receivers designed for 100 kHz channel spacing have been developed yet.

4.2.9.2 When the frequency separation between the Localizer and the GBAS/VDB facility is 100 kHz or greater, no compatibility assessment is required.

4.2.10 Geographical separation distances calculations examples.

4.2.10.1 Separation distance between co-channel Localizers.
(Source: DOC 9718, Vol 2, 3.7)

LOC (1) DOC = 25/6250 (25 NM, 6250ft). 50 W (EIRP = 17 dBW)
LOC (2) DOC = 25/6250 (25 NM, 6250ft). 50 W (EIRP = 17 dBW)

a) Both LOCs operate on the same frequency, D/U = 20 dB, The LOC antenna height is assumed 6 ft.

b) The minimum received desired power is minus 116 dBW at the edge of the DOC.

c) The EIRP of the undesired Localizer is 17 dBW, the required transmission loss between the location of the undesired Localizer and the edge of DOC of the desired Localizer, L = 17 - (- 116) + 20 = 153 dB.

d) The ITU-R propagation curve for the antenna heights h1 = 6250 ft and h2 is 6 ft for 5% of the time shows that this transmission loss is achieved at a distance of 112 NM.

e) The minimum station-to-station separation distance is 112+25 = 137 NM. vice versa (because of the same EIRP and DOC)

4.2.10.2 Separation distances between (desired) Localizer and (undesired) adjacent frequency VOR
(*Source: DOC 9718, Vol 2, 3.8*)

[*Note: to be further studied.*
According to ANN 10. Vol 1, if a localizer receiver designed for 50 kHz channel spacing, then there is no separation distance between LOC and adj-channel VOR in 50 kHz channel spacing.]

LOC DOC = 25/6250 (25 NM, 6250ft). 50 W (EIRP = 17 dBW)
VOR DOC = 100/25000 (100 NM, 25000ft). 100 W (EIRP = 20 dBW),
The VOR antenna height is assumed 20 ft.

a) The minimum received desired power at the aircraft, assuming an isotropic antenna is - 116 dBW.

b) The Localizer protection ratio for interference from adjacent frequency VOR facilities assumed -34dB (50 kHz channel spacing).

c) The ERIP of the undesired VOR is 20 dBW, the required transmission loss between the location of the undesired VOR and the edge of DOC of the desired Localizer, L = 20 - (- 116) + (- 34) = 102 dB.

d) The ITU-R propagation curve for the antenna heights h1 = 6250 ft and h2 is 20 ft for 5% of the time shows that this transmission loss is achieved at a distance of 19 NM.

e) Once compatibility between a desired Localizer and an undesired Localizer or VOR facility has been assessed, a second compatibility assessment is necessary to secure that no interference is caused to the "undesired" facilities by the desired Localizer. Separation distances between (desired) VOR and (undesired) adjacent frequency Localizer are in section 4.3.10.

4.2.11 Table of required Localizer and Glide Path separation distances as Table 4.6.
(*Source: Annex 10, Vol 1, Table C-3.*)

[*Note: to be further studied.*
The values contend in this table are less than the separation distances calculated showing in section 4.2.10.
The NSP has proposed to remove this table from Annex 10.]

Table 4.6 Required distance separations

	Frequency separation	Minimum separation between second facility and the protection point of the first facility km (NM)	
		List A	List B
Localizer	Co-channel	148(80)	148(80)
	50kHz	37(20)	9(5)
	100kHz	9(5)	0
	150kHz	0	0
	200kHz	0	0
Glide path	Co-channel	93(50)	93(50)
	150kHz	20(11)	2(1)

	300kHz 450kHz 600kHz	2(1) 0 0	0 0 0

List A refers to the use of localizer receivers designed for 100 kHz channel spacing coupled with glide path receivers designed for 300 kHz channel spacing.

List B refers to the use of localizer receivers designed for 50 kHz channel spacing coupled with glide path receivers designed for 150 kHz channel spacing.

Note 4. The above figures are based on the assumption of protection points for the localizer at 46 km (25 NM) distance and 1900 m (6250 ft) height and for the ILS glide path at 18.5 km (10 NM) distance and 760 m (2500 ft) height.

Note 5. States, in applying the separations shown in the table, have to recognize the necessity to site the ILS and VOR facilities in a manner which will preclude the possibility of airborne receiver error due to overloading by high unwanted signal levels when the aircraft is in the initial and final approach phases.

Note 6. States, in applying the separations shown in the table, have to recognize the necessity to site the ILS glide path facilities in a manner which will preclude the possibility of erroneous glide path indications due to reception of adjacent channel signals when the desired signal ceases to radiate for any reason while the aircraft is in the final approach phase.

4.2.11.1 The application of the figures given in Table 4.6 will only be correct within the limitations set by the assumptions. If more precise determination of separation distances is required in areas of frequency congestion, this may be determined for each facility from appropriate propagation curves, taking into account the particular directivity factors, radiated power characteristics and the operational requirements as to coverage. Where reduced separation distances are determined by taking into account directivity, etc., flight measurements at the ILS protection point and at all points on the approach path should be made wherever possible to ensure that a protection ratio of at least 20 dB is achieved in practice. [Annex 10, ATT C 2.6.7]

4.3 VHF Omnidirectional Range (VOR)

4.3.1 Frequency band and channel spacing

4.3.1.1 VOR is operating in the frequency band 108 – 117.975 MHz. Within band 108 – 111.975MHz, frequencies ending in either even tenths or even tenths plus a twentieth of a megahertz are used only by VOR that should no harmful adjacent channel interference to ILS. [DOC 9718, 4.3.1.1 and ANN10, V5, 4.2.1]

4.3.1.2 The channel spacing is 100 kHz. The use of 50 kHz VOR channels is permitted as stipulated in Annex 10, Volume V, paragraph 4.2.3.1.

Note: The use of 50 kHz VOR channels shall not cause harmful interference to VOR receivers not capable of tuning to these channels and the operational service to international operators using airborne 100 kHz equipment is not derogated. [DOC 9718, 4.3.1.2]

4.3.1.3 The frequency 113.250 is reserved as common signalling channel for VDL Mode 4 (Annex 10, Volume V, paragraph 4.1.3.3.2).

4.3.1.4 VOR facilities are often associated with DME facilities. The associated DME channels shall be selected in Appendix D. Further guidance on DME frequency assignment planning, including the VOR/DME channel pairing, is in section 4.5.

Note: A separate compatibility assessment for the DME facilities associated with a VOR facility is required in all cases.

4.3.2 [DOC] The designated operational coverage (DOC) of the VOR is determined through the operational requirement as promulgated by States/Administrations. In many cases the DOC is circular and can typically vary from 25 NM to approximately 200 NM and the protected altitude up to between 10 000 feet and 60 000 feet. Protection from harmful interference is only provided within the DOC. [DOC 9718 Vol2, 4.2.1]

Note: When the VOR is associated with a DME, the DOC of the DME is typically the same as for the VOR.

4.3.3 [PFD limit] The field strength or power density in space of VOR signals required should be 90 microvolts per metre (39 dBμV/m) or minus 107 dBW/m^2 (or - 110 dBW at 118 MHz). [ANN10, V1, 3.3.4.2 and DOC 9718 4.2.2.1]

4.3.4 [With FM] A compatibility assessment for potential interference that can be caused by FM broadcasting stations operating in the frequency band 87 – 108 MHz is necessary. The FM immunity performance requirements for VOR receivers are contained in Annex 10, Volume I, paragraph 3.3.8. Additional information on the process to assess compatibility with FM broadcast stations is in Recommendation ITU-R SM.1009.

4.3.5 [Facility Code] Information on the planning of identifications can be found in section 4.6.

4.3.6 Protection criteria for a desired VOR and an undesired VOR or Localizer

4.3.6.1 Localizer and VOR facilities cannot operate on the same frequency. Adjacent channel compatibility with an (undesired) Localizer is assessed in the same way as adjacent channel interference from a VOR assessed. [DOC 9718, Vol 2, 4.3.4.2]

4.3.6.2 The protection of VOR facilities operating on the same frequency is based on a desired to undesired (D/U) signal ratio of 20dB. This corresponds to a bearing error of less than 1 degree due to unwanted signals. [DOC 9718, Vol 2, 4.4.1]

4.3.6.3 When the undesired frequency is off-set from the desired frequency, the minimum D/U ratio for receivers designed for 100 kHz channel spacing is shown in Table 4.7, and for receivers designed for 50 kHz channel spacing is shown in Table 4.8 below. [DOC 9718, Vol 2, 4.4.1]

Table 4.7 Minimum D/U ratios for 100 kHz channel receivers

ΔF (kHz)	D/U (dB)
0	20
50	-7
100	-46
≥ 150	-50

Table 4.8 Minimum D/U ratios for 50 kHz channel receivers

ΔF (kHz)	D/U (dB)
0	20
50	-34
100	-46
≥ 150	-50

4.3.6.4 Where both 100 kHz and 50 kHz VOR channels are being used, the protection of the VOR is based on receivers designed for 100 kHz channel spacing.

4.3.7 Protection criteria for a desired VOR and an undesired GBAS/VDB

4.3.7.1 The (assumed) minimum D/U ratios to protect VOR receivers designed for 50 kHz channel spacing from interference that can be caused by GBAS/VDB signals are as in Table 4.9.

Table 4.9 D/U ratios to protect VOR from GBAS/VDB

Δf (frequency offset)	**D/U**
0 – co-frequency	26 dB
+/- 25 kHz	0 dB
+/- 50 kHz	-34 dB
+/- 75 kHz	-46 dB
+/- 100 kHz	-65 dB

Note: No protection criteria for VOR receivers designed for 100 kHz channel spacing, with GBAS/VDB have been developed yet.

4.3.7.2 When the frequency separation between the VDB station and a VOR station is 100 kHz or greater no compatibility assessment is required.

4.3.8 Consideration of VOR harmonics of the 9960Hz sub-carrier.

[*Note: to be further studied*]

4.3.8.1 With regard to the emission of harmonics of the VOR sub-carrier 9960 Hz, frequency assignment planning is based on the assumption that the VOR facilities comply with the provisions in Annex 10, Volume I, Chapter 3, paragraphs 3.3.2.2 and 3.3.5.7 and Volume V, Chapter 4, paragraph 4.2.4

4.3.8.2 States/Administrations that operate VOR facilities that do not comply with these provisions are requested to inform ICAO accordingly. In this case the frequency coordination will take this into account.

4.3.9 Sectorized coverage

4.3.9.1 Application of the calculation methods described above may produce incorrect results if sectorization (key-holing) is used. Figure 4-2 can be used to explain the problem:

4.3.9.2 Consider A to be the desired VOR facility and B the undesired one. The “Critical Point” is most exposed to interference from facility B because it is the point of the DOC of facility A which is nearest to transmitter B.

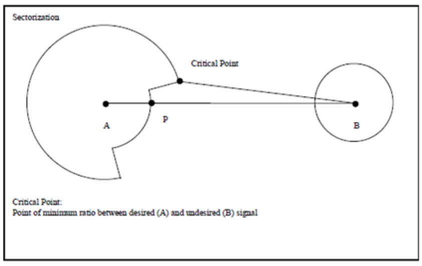


Figure 4-2 Geometry for determining the test points

4.3.10 Geographical separation distances calculations examples.

4.3.10.1 Separation distance between (desired) VOR and (undesired) VOR.

VOR (1) DOC = 25/100 (25 NM, 10 000ft). 100 W (EIRP = 20 dBW)
VOR (2) DOC = 100/450 (100 NM, 45 000 ft. 400W (EIRP = 26 dBW)
Both VOR (1) and VOR (2) operate on the same frequency (50 kHz channel spacing), D/U = 20 dB (re. Table 4.8). The minimum received desired power is minus 110 dBW at the edge of the DOC. The VOR antenna height is assumed 20 ft.

Step 1: Compatibility of VOR (1) with VOR (2).

The minimum required transmission loss L from the location of VOR (2) to the edge of the DOC of VOR (1). L = 26 (dBW) + 110 (dBW) + 20 (dB) = 156 dB.
The ITU-R propagation table for (20ft/10 000 ft) (5% of the time) show this transmission loss is obtained at a distance of 156 NM.
The minimum station-to-station separation distance is 156 + 25 = 181 NM.

Step 2: Compatibility of VOR (2) with VOR (1).

The minimum required transmission loss L from the location of VOR (1) to the edge of the DOC of VOR (2). L = 20 (dBW) + 110 (dBW) + 20 (dB) = 150 dB.
The ITU-R propagation table for 20ft/45 000 ft (5% of the time) shows this transmission loss is obtained at a distance of 272 NM.
The minimum station-to-station separation distance is 272+100 = 372 NM

Step 3: The minimum geographical (station to station) separation distance between VOR1 and VOR 2 is the largest, i.e. 372 NM.

4.3.10.2 Table 4.10 to Table 4.12 present the co- and adjacent frequency separation distance between the edge of the DOC of the (desired) VOR and the location of the (undesired) VOR or ILS-Localizer.
The calculation results are based on:

- The minimum received desired power is minus 110 dBW.
- D/U ratios are as per Table 4.7 and Table 4.8.
- Tx = EIRP of undesired facility (calculations for 17 dBW, 20 dBW and 30 dBW).
- L = the minimum required transmission loss

- D is established with the ITU-R propagation curve for 108 MHz and 5% of the time. Antenna height of the desired aircraft receiver is as indicated in the column Remarks and the antenna height of the undesired facility is 20ft above ground.

Table 4.10 Minimum separation distances between desired VOR and undesired VOR or LOC

ΔF (kHz)	**D/U (dB)**	**Tx = 17 dBW**		**Tx = 20 dBW**		**Tx=30 dBW**		**Remarks**
		L (dB)	**D (NM)**	**L (dB)**	**D (NM)**	**L (dB)**	**D (NM)**	**Desired VOR at 45000 ft**
0	20	147	268	150	271	160	284	50/100 kHz receiver
50	-7	120	134	123	174	133	231	100 kHz receiver
50	-34	93	5	96	11	106	43	50 kHz receiver
100	-46	81	<0.5	84	<0.5	94	7	50/100 kHz receiver
150	-50	77	<0.5	80	<0.5	90	<0.5	50/100 kHz receiver

Table 4.11 Minimum separation distances between desired VOR and undesired VOR or LOC

ΔF (kHz)	**D/U (dB)**	**Tx = 17 dBW**		**Tx = 20 dBW**		**Tx=30 dBW**		**Remarks**
		L (dB)	**D (NM)**	**L (dB)**	**D (NM)**	**L (dB)**	**D (NM)**	**Desired VOR at 25000 ft**
0	20	147	208	150	212	160	225	50/100 kHz receiver
50	-7	120	115	123	131	133	175	100 kHz receiver
50	-34	93	9	96	13	106	42	50 kHz receiver
100	-46	81	<0.5	84	<0.5	94	10	50/100 kHz receiver
150	-50	77	<0.5	80	<0.5	90	5	50/100 kHz receiver

Table 4.12 Minimum separation distances between desired VOR and undesired VOR or LOC

ΔF (kHz)	**D/U (dB)**	**Tx = 17 dBW**		**Tx = 100 W**		**Tx=30 dBW**		**Remarks**
		L (dB)	**D (NM)**	**L (dB)**	**D (NM)**	**L (dB)**	**D (NM)**	**Desired VOR at 10000 ft**
0	20	147	143	150	147	160	161	50/100 kHz receiver
50	-7	120	71	123	82	133	115	100 kHz receiver
50	-34	93	10	96	14	106	29	50 kHz receiver
100	-46	81	1	84	3	94	11	50/100 kHz receiver
150	-50	77	<0.5	80	1	90	7	50/100 kHz receiver

Note: The separation distances are between the edge of coverage for a desired VOR and the location of an undesired VOR (or Localizer) facility. The EIRP of the undesired VOR (or Localizer) is as specified in column "Tx".

4.3.10.3 Separation distance between (desired) VOR and (undesired) co-channel GBAS/VDB.

VOR DOC = 200/450 (200 NM / 45 000 ft)
VDB DOC = 23/10 000 (23NM / 10 000ft), EIRP = 17 dBW.

a) The minimum received desired power is minus 110 dBW.
b) D/U = 26 dB (co-frequency)
c) The required transmission loss between the location of the undesired GBAS/VDB and the edge of DOC of the desired VOR, L = 17 (dBW) +26(dB) +– (-110dBW) = 153 dB.
d) With the ITU-R propagation curve for a VOR receiver at 45 000 ft and VDB antenna height of 45 ft; for 5% of the time, the separation distance is 284 NM.
e) This separation distance is measured from the edge of coverage of the desired VOR to the location of the undesired VDB station. The station-to-station separation is 284 + 200 = 484 NM.
f) Once compatibility between a desired facility and an undesired facility has been assessed, a second compatibility assessment is necessary to secure that no interference is caused to the "undesired" facilities by the desired facility. Separation distances between (desired) GBAS/VDB and (undesired) VOR are in section 4.3.11.

4.3.10.4 Table 4.13 presents the co- and adjacent frequency separation distance between the edge of the DOC of the (desired) VOR and the location of the (undesired) GBAS/VDB station.

The calculation results are based on:

- The minimum received desired power is minus 110 dBW.
- D/U ratios are as per Table 4.9..

- The (undesired) GBAS/VDB EIRP = 17dBW (typically), antenna is assumed at 45ft above local terrain.
- The ITU-R P.528-4 propagation curves for 5% of the time were used.

Table 4.13 Distance between the edge of the DOC of the desired VOR (50 kHz receiver) from GBAS/VDB

VOR - Height (ft)	**Co-frequency** **D/U = 26 dB** **L = 153 dB**	**1st adj freq.** **(+/-25 kHz)** **D/U = 0 dB** **L = 126 dB**	**2nd adj freq.** **(+/- 50 kHz)** **D/U = - 34 dB** **L = 92 dB**	**3rd adj freq.** **(+/-75 kHz)** **D/U = -46 dB** **L = 87 dB**	**4th adj freq.** **(+/- 100 kHz)** **D/U = -65 dB** **L = 61 dB**
5 000	127 NM	80 NM	9 NM	5 NM	Frequency assignment planning freedom
10 000	161 NM	111 NM	8 NM	5 NM	
15 000	186 NM	135 NM	8 NM	4 NM	
20 000	206 NM	155 NM	8 NM	3 NM	
25 000	225 NM	172 NM	8 NM	2 NM	
30 000	242 NM	189 NM	7 NM	Frequency assignment planning freedom	
35 000	237 NM	203 NM	6 NM		
40 000	271 NM	217 NM	5 NM		
45 000	284 NM	228 NM	3 NM		
50 000	297 NM	242 NM	Planning freedom		
60 000	320 NM	264 NM			

Note 1: With minimum separation distances less than 0.5 NM frequency assignment planning freedom is assumed.

Note 2: Separation distances ≤ 5 NM may be considered as operational insignificant

4.4 Ground Based Augmentation System (GBAS)

4.4.1 [Frequency band and channel spacing] The GNSS ground-based augmentation system (GBAS) VHF data broadcast (VDB) frequency band is 108 to 117.975MHz. The lowest assignable frequency is 108.025 MHz and the highest assignable frequency is 117.950 MHz – channel spacing is 25 kHz.

4.4.2 Designated Operational Coverage (DOC)

4.4.2.1 The DOC of the GBAS/VDB to provide the approach service is as shown in Figure 4-3.

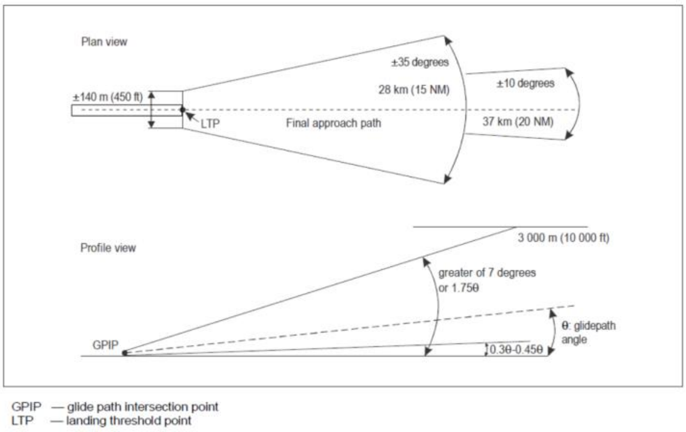


Figure 4-3 Minimum required DOC of GBAS

4.4.2.2 Typically, the DOC for GBAS/VDB facilities is referenced to the location and the elevation of the threshold of the runway. However, it is recommended to use an omnidirectional coverage that extends to 23 NM from the runway threshold and up to a level of 10, 000 ft above runway threshold. [DOC 9718, Vol 2, 6.2]

4.4.2.3 The vertical coverage is limited by a plane that extends from the glide path interception point with an angle of 0.3 times the Glide Path angle. The upper limit of coverage is 10000 ft that follows the Earth curvature. [DOC 9718, Vol 2, 6.2]

4.4.2.4 When GBAS supports multiple approaches, use of a single omnidirectional VDB may be considered, if geographically feasible. In this case, frequency coordination should include all GBAS coverage areas. [DOC 9718, Vol 2, 6.2]

4.4.2.5 Figure 4-3 presents the minimum approach DOC, States/Administrations may specify different (larger) DOC areas. More information on establishing the DOC is in Annex 10, Volume I, Attachment D, paragraph 7.3. [DOC 9718, Vol 2, 6.2]

4.4.3 [PFD limit] For frequency assignment planning purposes, it is assumed the field strength of the desired corresponds to the minimum field strength, as defined in Annex10, Volume I, throughout the designated operational coverage. The minimum field strength is 215 µV/m (-99dBW/m2) which is equivalent to a power level at the aircraft antenna output of -102dBW with an ideal isotropic antenna (for the horizontal component of the GBAS/VDB signal). The maximum field strength is (SIS max) 0.879 V/m (-27dBW/m2 or -29dBW). [DOC 9718, Vol 2, 6.3.4]

4.4.4 GBAS/VDB positioning service ERIP

4.4.4.1 The ERIP for the GBAS/VDB when providing the approach service is typically 17dBW (50 W). [DOC 9718, Vol 2, 6.2.4.1]

4.4.4.2 The EIRP for the GBAS/VDB when providing the positioning service is in Table 4.14. [DOC 9718, Vol 2, 6.2.4.2]

Table 4.14 Typical EIRP for GBAS/VDB positioning service
(source: Annex 10, Vol. I, Att. D table D-3)

Range (NM)	EIRP(dBW)	EIRP (W)
50	14	25
100	20	100
150	23	200
200	26	400

Note: The EIRP of a GBAS/VDB system shall be provided as Peak Envelope Power. Since MOPS specify the output power to be measured as mean power over a bit-sequence in the preamble, care must be taken that the PEP are used for calculation. [EUR 011, 4.1.10]

4.4.5 For use in civil aviation, the GBAS signal is horizontally polarized. This reduces significantly the minimum separation distances between vertically polarized signals such as are used in VHF COM systems, VDL Mode 2 and VDL Mode 4. The value for cross polarization isolation between horizontal and vertical polarization assumed to be 10 dB (Re. Annex 10, V1, Attachment D, 7.2.4).

4.4.6 [With FM] The risk of interference from FM broadcasting stations in the band 87 – 108 MHz caused by unwanted emissions into the aeronautical band or generated in the airborne receiver should be taken into account. The relevant Recommendation for GBAS is ITU-R SM.1841. [EUR 011, 4.1.4]

4.4.7 [Facility code] Information on the planning of identifications can be found in section 4.6.

4.4.8 GBAS Data Selector and Time Slot Planning Criteria

[*Note: to be further studied*]

4.4.8.1 Reference path data selectors and reference station data selectors (RPDS and RSDS) assignments are to be controlled to avoid duplicate use of channel numbers within the protection region for the data broadcast frequency. Therefore, the GBAS service provider has to ensure that an RPDS and RSDS are assigned only once on a given frequency within radio range of a particular GBAS ground subsystem. Assignments of RPDS and RSDS are to be managed along with assignments of frequency and time slots for the VHF data broadcast.

4.4.8.2 Time slot co-ordination among GBAS VDB systems operating on the same frequency will not be used initially, i.e. all 8 time slots (A – H) are assigned to a station together with the VDB frequency. Since Annex 10 provides in Table D-3. Typical GBAS/GBAS frequency assignment criteria the following note:

Note: No geographic transmitter restrictions are expected between co-frequency, adjacent time slots provided the undesired VDB transmitting antenna is located at least 200 m from areas where the desired signal is at minimum field strength.
Reuse of a frequency is possible if the limitations in the note are observed.

4.4.8.3 Reference path data selectors (RPDS) and reference station data selectors (RSDS) must not be duplicated within the protection region of a given frequency. As long as time slot co-ordination is not used to share frequencies, as indicated above, RPDS and RSDS (0 to 48) compatibility is automatically established via frequency co-ordination, i.e. all 49 data selectors are available together with the assigned VDB frequency.

Note: More information on the use and coordination of the RPDS and RSDS is in Annex 10, Volume I, Appendix B, section 3.6.5.7. Further guidance on this is necessary.

4.4.8.4 The relative assignment of slots to a GBAS ground subsystem can impact performance in instances where messages in multiple slots need to be received by the airborne subsystem prior to processing. This will occur when using linked messages and/or for a GAST D ground subsystem where correction data is contained in both the Type 1 and Type 11 messages. In these cases slot assignments for all MT 1 and 11 should be adjacent to avoid unnecessary latency and complexity of design. Non-adjacent assignments may, depending on the design of the ground subsystem, result in a lack of time for the ground subsystem to process fault detections, render some slot combinations unusable and thus result in lower efficiency of spectrum use.

4.4.9 Protection requirements

4.4.9.1 Protection requirements for GBAS/VDB receivers.

(a) The GBAS/VDB receiver shall be capable to achieve a message failure rate of not more than one failed message per 1000 data messages. The D/U ratios in Table 4.15 will meet this requirement.

Table 4.15 Co- and adjacent channel protection requirements for GBAS/VDB receivers

Frequency offset	**VDB/VDB**	**VDB/VOR**	**VDB/ILS**	**VDB/VHF-COM**
Co-frequency	26 dB	26 dB	26 dB	n/a
+/- 25 kHz	-18 dB	0 dB	0 dB	n/a
+/- 50 kHz	-43 dB	-34 dB	-34 dB	-32 dB
+/- 75 kHz – +/- 975 kHz	-46 dB	-46 dB	-46 dB	-44 dB
+/- 100 kHz	-46 dB	-46 dB	-46 dB	
≥ 1000 kHz	-46 dB	-60 dB	-60 dB	

4.4.9.2 Airborne Contribution Factor

[Note: to be further studied]

(a) With the view to protect the desired VDB signals in space, an airborne contribution factor has been added. This airborne contribution factor compensates for antenna gain variations in the horizontal plane (between the directions of the desired versus the undesired transmitter) and on-board transmission line loss variation (between the frequency of the desired and the undesired signal. The airborne contribution factor can be calculated with 15 + Min (6, 6 x Frequency Offset (in kHz) /1000) with a maximum frequency offset of 1000 kHz.

(b) Table 4.16 contains the protection ratios that are to be observed in frequency assignment planning to protect a desired GBAS/VDB from interference that can be caused by an undesired GBAS/VDB, VOR or ILS or VHF COM facility.

Table 4.16 Co- and adjacent channel protection requirements for GBAS/VDB; signal-in-space

Frequency offset	**VDB/VDB**	**VDB/VOR**	**VDB/ILS**	**VDB/VHF-COM**
Co-frequency	41 dB	41 dB	41 dB	n/a
25 kHz	-3 dB	15 dB	15 dB	n/a
50 kHz	-27 dB	-18 dB	-18 dB	
75 kHz	-30 dB	-30 dB	-30 dB	
100 kHz				
975 kHz	-25 dB	-25 dB	--25 dB	
≥ 1000 kHz	-25 dB	-39 dB	-39 dB	

4.4.9.3 Compatibility criteria to protect ILS-Localizer and VOR signals from interference that can be caused by GBAS/VDB signals are in section 4.2 and 4.3 respectively.

4.4.9.4 Interference from VDL Mode 4 signals. (to be added as and when implemented)

4.4.9.5 Interference from VHF-COM signals

(a) On-board compatibility – No frequency assignment planning constraints have been identified to secure the compatibility between the on-board transmission of VHF-COM signals and the reception of GBAS/VDB signals on the same aircraft.

(b) Air-to-air interference can be expected as in Table 4.17.

Table 4.17 Minimum separation distances between aircraft

ΔF (kHz)	D/U	10dBW		14 dBW		17dBW		20 dBW	
		L (dB)	D(NM)	L (dB)	D(NM)	L (dB)	D(NM)	L (dB)	D(NM)
50	-34 dB	78	< 1	82	1.5	85	3	88	4.5
75	-39 dB	73	< 1	77	< 1	80	< 1	83	2
100	-42 dB	70	< 1	76	< 1	77	< 1	80	1
125	-46 dB	66	< 1	70	< 1	79	< 1	76	< 1

(c) The minimum separation distances as in Table 4.17 were calculated assuming isotropic antennas on board the desired and the undesired aircraft. Taking into account that the effect of the actual antenna diagram of the VHF-COM and the GBAS/VDB antenna as well as the transient effect of air-to-air interference, at a frequency separation greater than 100 kHz no air-to-air interference is expected

Note: An aircraft EIRP. of 20 dBW (100 W) is not normally used. For aircraft EIRP. of 17dBW (50 W) or less, a minimum frequency separation between the aircraft VHF-COM and the GBAS/VDB receiver of 50 [58.3] kHz may be recommended.

(d) At short distances, as shown in Table 4.17, interference from a VHF-Ground facility can be expected when the EIRP of the ground station is between 14 dBW (25W) to 20 dBW (100W). Maintaining a minimum frequency separation of 100 kHz between the assigned GBAS/VDB and VHF-COM frequency would avoid such interference. One option is to ensure in the frequency assignment planning process that a guard band of 100 kHz is introduced which would exclude the frequencies between 117.900 – 117.975 MHz to be used for GBAS/VDB.

Note: This condition seems to be extremely conservative. Taking into account the actual antenna diagram and the geography of short distances to the (interfering) VHF COM station, is may be sufficient to only exclude the frequency 117.950 MHz from being assigned to a GBAS/VDB station.

4.4.10 Geographical separation distances calculation examples

4.4.10.1 Separation distance between GBAS/VDB and GBAS/VDB.

VDB (1) DOC = 23/100 (23 NM, 10 000ft). 50W (EIRP = 17 dBW)
VDB (2) DOC = 23/100 (23 NM, 10 000ft). 50W (EIRP = 17 dBW)
Both VDB (1) and VDB (2) operate on the same frequency, D/U = 41 dB (SIS; re. paragraph 4.4.10.2(b) and Table 4.16)
The minimum received desired power is minus 102 dBW at the edge of the DOC.
ITU-R aeronautical propagation curve for 112 MHz, h1 = 45 ft, h2 = 10.000 ft; 5% of the time.

The required transmission loss between the undesired GBAS/VDB station and the edge of coverage of the desired GBAS/VDB station L = Tx -Pd + D/U = 17 (dBW) + 102 (dBW) +41 (dB) = 160 dB

With the ITU-R aeronautical propagation curve for 112 MHz and 5% of the time, the height of the (undesired) VDB 45 ft and the height of the (desired) aircraft receiver at 10000 ft. The minimum required transmission loss of 160 dB is obtained with a separation distance of 213 NM. This is the minimum separation distance between an undesired VDB transmitter and an aircraft at the edge of coverage of the (desired) VDB facility. The station-to-station separation distance is 213 + 23 = 236 NM.

With the method as described above, Table 4.18 with GBAS vs GBAS separation distances was developed for the desired GBAS facility providing the approach service.

These separation criteria do not allow for the use of a second VDB frequency within the DOC of the desired VDB even for a frequency separation greater than 1 MHz. For the use of a second VDB frequency a more detailed analysis is necessary.

Note: Guidelines for the detailed analysis are being developed.

Table 4.18 Minimum separation distances between desired and undesired GBAS stations

Frequency offset	D/U (dB)	L (dB)	Distance from DOC of desired station to undesired station	Distance between GBAS stations
Δf = 0 (Co- frequency)	41	160	213 NM	236 NM
Δf = 25 kHz	-3	116	81 NM	104 NM
Δf = 50 kHz	-27	92	9 NM	32 NM
Δf = 75 kHz – 975 kHz	-30 to -25	89 to 94	6 to 11 NM	29 to 33 NM
Δf ≥ 1000 kHz	-25	94	11 NM	33 NM

4.4.10.2 Separation distance between (desired) GBAS/VDB and (undesired) VOR or ILS-Localizer.

(a) The parameters used in the calculations below are:

The minimum received desired power (Pd) is minus 102 dBW.
D/U is as in Table 4.16.
Tx = 17 dBW, 27 dBW and 30 dBW respectively (EIRP of undesired VOR or Localizer)
Height of the antenna of the (undesired) VOR is 20 ft above local terrain.
Height of the antenna of the (undesired) Localizer) is 6 ft above local terrain.
Height of the (desired) VDB aircraft is 10.000 ft.
ITU-R aeronautical propagation curves (Recommendation P.528-4) for 112 MHz, 5% of the time
L=Tx-Pd+D/U

(b) Separation distances between a (desired) VDB and an (undesired) VOR or Localizer. The EIRP for the undesired VOR or Localizer is 17 dBW.

Table 4.19 Minimum separation distances between the DOC of the desired GBAS station and the location of the undesired VOR / Localizer

D/U (dB)	**L(dB); 5%**	**VOR (17 dBW) Distance (NM)**	**Localizer (17dBW) Distance (NM)**
41 (Δf = 0)	160	160	146
15 (Δf = 25)	134	118	36
-18 (Δf = 50)	101	21	14
-30 (Δf = 75)	89	6	6
-25 (Δf = 975)	94	11	8
-39 (Δf ≥ 1000)	80	1	1

(c) Separation distances between a (desired) VDB and an (undesired) VOR or Localizer. The EIRP for the undesired VOR or Localizer is 27 dBW.

Table 4.20 Minimum separation distances between the DOC of the desired GBAS station and the location of the undesired VOR or Localizer

D/U (dB)	**L(dB); 5%**	**VOR (27 dBW) Distance (NM)**	**Localizer (27 dBW) Distance (NM)**
41 (Δf = 0)	170	243	171
15 (Δf = 25)	144	138	121
-18 (Δf = 50)	111	43	25
-30 (Δf = 75)	99	18	12
-25 (Δf = 975)	104	26	17
-39 (Δf ≥ 1000)	90	7	6

(d) Separation distances between a (desired) VDB and an (undesired) VOR or Localizer. The e.i.r.p for the undesired VOR or Localizer is 30 dBW.

Table 4.21 Minimum separation distances between the DOC of the desired GBAS station and the location of the undesired VOR or Localizer

D/U (dB)	L(dB); 5%	VOR (30 dBW) Distance (NM)	Localizer (30 dBW) Distance (NM)
41 (Δf = 0)	173	260	209
15 (Δf = 25)	147	143	129
-18 (Δf = 50)	114	51	29
-30 (Δf = 75)	103	24	16
-25 (Δf = 975)	107	31	20
-39 (Δf ≥ 1000)	93	10	7

4.5 Distance Measuring Equipment (DME)

4.5.1 Frequency band and channel spacing

4.5.1.1 The DME operates on paired interrogation and reply frequencies (each combination of these frequencies is a "channel") in the frequency band 960 – 1215 MHz. A number of these channels are in turn paired with ILS or VOR frequencies. The DME channelling arrangement is shown in Appendix D. [DOC 9718, V2, 5.3.1]

Note: The frequency band 960 – 1215 MHz is also used for TACAN. TACAN operates with the same channeling scheme as the DME and can be paired with a VOR (VOR/TAC). From the frequency assignment planning point of view TACAN is equivalent to DME.

4.5.1.2 The spacing between DME channels is 1 MHz. DME X and Y channels with the same channel number use the same interrogator frequency but with different pulse coding. The reply frequency for the X and Y channel is different as well as the pulse coding. The Y channels reuse the reply frequencies within the interrogation frequency block (1025 – 1150 MHz).

4.5.2 [DOC] The Designated Operational Coverage (DOC) of the DME is normally as promulgated by States/Administrations. When the DME is associated with an ILS or a VOR, the DOC of the DME is normally not less than the DOC of the ILS or VOR. [DOC 9718, 5.2.1]

4.5.3 [PFD limit] The peak equivalent isotopically radiated power shall not be less than that required to ensure a peak pulse power density of minus 89 dBW/m^2 under all operational weather conditions at any point within coverage. Minus 111 dBW at the antenna corresponds to a power flux density of minus 89 dBW/m^2 at the mid-band frequency.

4.5.4 [Facility code] Information on the planning of identifications can be found in section 4.6.

4.5.5 Protection requirements

Notes: For frequency planning purposes,
1) There is no difference between DME/N and DME/P.
2) TACAN facilities are treated in the same way as DME stations.
3) No criteria are defined for DME/W and DME/Z.

4.5.5.1 The necessary desired to undesired (D/U) signal ratios needed to protect the desired transponder reply signal at an airborne receiver from the various co-frequency/adjacent frequency, same code/different code, undesired transponder reply signal combinations that may exist. [ANN 10, V1, Attachment C, 7.1.8.1]

4.5.5.2 The prerequisite for any D/U calculation to be valid is that the minimum signal of the (desired) DME (-111dBW) at the aircraft antenna is achieved at all points throughout the coverage.

4.5.5.3 In making an assignment, each DME facility must be treated as the desired source with the other acting as the undesired. If both satisfy their unique D/U requirement, then the channel assignment may be made. This "reverse" check is necessary if the DME facilities being considered radiate with different EIRP or have a different DOC. [DOC 9718, Vol 2, 5.7.7.1]

4.5.5.4 To each X or Y DME channel corresponds a specific reply frequency within the band 960 - 1215 MHz. X and Y DME channels do not have reply frequencies in common. Hence, for the protection of the desired transponder replies from other co-channel transponder replies, it is sufficient to consider only DME facilities with the same channel designation (including the pulse code). However, for DME facilities operating on Y channels, the reply frequency may be the same as the interrogator frequency of another DME X facility. [DOC 9718, Vol 2, 5.7.1.3]

4.5.5.5 For co-channel assignments, the D/U signal ratio should be at least 8 dB throughout the service volume. [ANN10, V1, ATT D, 7.1.8.2]

4.5.5.6 For Adjacent frequency assignments, the minimum required D/U ratio within the operational service volume shall be in accordance with the values given in Table 4.22. [ANN10, V1, ATT D, 7.1.8.2]

The following values are assumed for the adjacent-channel emissions of the transponder (P_u):
200 mW (-7 dBW) on the first adjacent frequency;
2 mW (-27 dBW) on the second adjacent frequency.

Table 4.22 Protection ratio D/U (dB)

Type of assignment	A	B
Co-frequency: Same pulse code	 8	 8

Different pulse code	8	-43
First adjacent frequency: Same pulse code Different pulse code	 - (P_u - 1) - (P_u + 7)	 -42 -75
Second adjacent frequency: Same pulse code Different pulse code	 - (P_u + 19) - (P_u + 27)	 -75 -75

Note 1: The D/U ratios in column A protect those DME/N interrogators operating on X or Y channels. Column A applies to decoder rejection of 6 microseconds.

Note 2: The D/U ratios in column B protect those DME/N or DME/P interrogators utilizing discrimination in conformance with 3.5.5.3.4.2 and 3.5.5.3.4.3 of Chapter 3, Annex 10, Volume I and providing a decoder rejection conforming to 3.5.5.3.5 of Chapter 3. Annex 10, Volume I

Note 3: Pu is the peak effective radiated power of the undesired signal in dBW.

Note 4: The frequency protection requirement is dependent upon the antenna patterns of the desired and undesired facility and the EIRP of the undesired facility.

Note 5: In assessing adjacent channel protection, the magnitude of D/U ratio in column A should not exceed the magnitude of the value in column B.

4.5.5.7 Separation requirement for DME reply frequencies which are separated by 63 MHz. The channel assignment plan for DME is such that the transponder reply frequency for each Y channel is the same as the interrogation frequency of another DME channel. When the reply frequency of one DME matches the interrogation frequency of a second DME, a minimum separation distance of 15 NM (28km) between these (ground) facilities would be required, in general.

4.5.6 Sectorized DOC of the DME [DOC 9718, Vol 2,, 5.11]

Similar to VOR (as described in section 4.3), the DME DOC many be sectorized (instead of circular). In this case, compatibility of the DME with other DME assignments needs to be assured at the critical point which is the closest point of the DOC of the desired DME (with sectorized DOC) and any potential interfering DME transponder.

4.5.7 Use of directional antenna [DOC 9718, Vol 2, 5.12]

4.5.7.1 When omnidirectional DOC is not required, the use of a DME with directional antenna is encouraged, subject to the proviso that the operational requirements for the service to be provided by this facility are met. In Particular, they are useful for the replacement of ILS marker beacons. The directional DME could provide a means to mitigate frequency congestion.

4.5.7.2 The compatibility of DMEs with directional antennas can be examined basically along the same lines as those developed for omnidirectional DME. However, because of the variable antenna gain of a DME with directional antenna, the value of the quantity K (EIRP of the desired minus the EIRP of the undesired facility) in the above formulas depends in general on the position of the airborne receiver. It is noted in particular that because of the orientation of a DME with directional antenna, the minimum D/U value is not necessarily attained along the direct line connecting desired and undesired facilities, as opposed to the case of compatibility between omnidirectional DME.

4.5.7.3 In the presence of at least one DME with directional antenna, the following method should be applied. At first an appropriate number of points is selected along the edge of the DOC of the desired DME, regardless of the type of its antenna. Subsequently at all such points the required D/U criteria are checked. Compatibility is ensured if at all such points the required D/U criteria are met.

4.5.8 Separation distance calculation examples between DMEs.

DME (1) DOC = 200/45000 (200 NM, 45 000ft). EIRP = 40 dBW
DME (2) DOC = 200/45000 (200 NM, 45 000ft). EIRP = 40 dBW

4.5.8.1 Co-channel geographical separation distance

a) Both DME (1) and DME (2) operate on the same frequency, D/U = 8 dB (re. Table 4.22). The minimum received desired power is minus 111 dBW at the edge of the DOC. The DME antenna height is assumed 20 ft.

b) The minimum required transmission loss L from the location of undesired DME to the edge of the DOC of desired DME. L = 40 (dBW) + 111 (dBW) + 8 (dB) = 159 dB.

c) ITU-R propagation curve for 1080 MHz, h1 = 20 ft and h2 = 45 000 ft and 5% of the time shows that the required transmission loss of 159 dB is obtained at a separation distance (to the edge of coverage of the desired DME) of 137 NM.

d) The minimum station-to-station separation distance is 137+ 200 = 237 NM, vice versa because of the same EIRP and DOC).

4.5.8.2 First adjacent channel (1MHz)

a) When considering the co-channel interference that can be caused by the out-of-band emissions for a DME, the D/U ratio is 8dB. On the first adjacent channel the undesired signal has a signal level of 7dBW.

b) The minimum received desired power is minus 111 dBW. The minimum required transmission loss L from the location of undesired DME to the edge of the DOC of desired DME. L = -7 – (-111) + 8 dB =-112dB

c) D= 10 NM using the ITU-R 5% curve for h1 = 20 ft and h2 =45 000 ft. D is measured from the edge of the desired facility to the location of the undesired (first adjacent channel) DME ground station.

d) The minimum station-to-station separation distance is 10 + 200 = 210 NM, vice versa (because of the same EIRP and DOC).

4.6 Identifications of Radio Navigation Aids

To be inserted.

4.6.1 Identifications of navigation aids shall be so composed, if possible, as to facilitate association with the name of the point in plain language. The Table 4.23 provides an overview of the requirements which have to be taken into account for identifications.

Table 4.23 The requirements have to be taken into account for identifications

Facility	Identification	Remarks
NDB and Locator	2 or 3 letters of the International Morse Code.	
ILS	2 or 3 letters of the International Morse Code which may be preceded by the letter I.	Transmitted by the localizer.
ILS/DME	ILS: 2 or 3 letters of the International Morse Code which may be preceded by the letter I. DME: Identical to associated ILS.	Associated DME identification signal.
VOR	2 or 3 letters of the International Morse Code.	
VOR/DME	VOR: 2 or 3 letters of the International Morse Code. DME: Identical to associated VOR.	Associated DME identification signal.
DME	Letters and numerals of the International Morse Code.	Independent DME identification signal for stand-alone DME facility.
GBAS	4 characters	

4.6.2 The identification TST is reserved for radio navigation facilities on test and should not be used for other purposes.

4.6.3 Duplication of the same identification of a navigation aid should, as far as possible, be avoided in the State [Region] and shall not be duplicated within [1100 km (600 NM)] of the location of the radio navigation aid concerned, except as noted hereunder. [ANN 11, APP 2, 2.2.2]

Note: Due to these provisions, an aircraft at the maximum flight level will never be within radio line-of-sight of more than one radio navigation facility using a specific identification.

[Note: TBD]

4.6.4 The provisions of 4.6.3 above do not apply when two radio navigation aids operating in different bands of the frequency spectrum are situated at the same location, their radio identifications are normally the same.

4.6.5 States/Administrations' requirements for identifications shall be notified to the Regional Offices for coordination.

Appendix A

TEMPLATE FOR AN EXCEL OR WORD FILE THAT CAN BE USED FOR ELECTRONIC SUBMISSION OF ONE (OR MORE) NEW OR MODIFIED FREQUENCY ASSIGNMENTS FOR NAV SYSTEMS TO THE REGIONAL OFFICE

Essential characteristics should to be included in the submission to the Regional Office:

Country	
Location	
Latitude	
Longitude	
Frequency	
Channel	
VHFDOC	
VHFPwr	
DMEDOC	
DMEPwr	
Cat	
Remarks	
TRD	

In the table, the following format should be used:

Country Country name as per ICAO directory
Location Name of the location of the NAV facility
Latitude Latitude in the format xxDyy'zz'' (e.g. 32D44'55'')
Longitude Longitude in the format xxxDyy'zz'' (e.g.054D55'56'')
Facility Select one of the following facilities

- ILS
- ILS/DME
- VOR
- VOR/DME
- DME
- TACAN
- GBAS

Frequency xxx.yyy (e.g. 109.200 or 113.450) [MHz]
A frequency can be proposed by a State or selected by the Regional Office and is subject to a compatibility assessment with or frequency assignments in the COM list 2
Channel DME channel (e.g. 36X or 45Y)
VHFDOC xxx/yyy e.g. 200/250 xxx is the range of the coverage (e.g. 200 is 200 NM)
yyy is the height (FL) of the coverage (e.g. 250 is FL 250 or 25000ft)

DMEDOC xxx/yyy e.g. 200/250 xxx is the range of the DME coverage (e.g. 200 is 200 NM)
yyy is the height (FL) of the DME coverage (e.g. 250 is FL 250 or 25000ft)

Remarks Optional, as provided by the State
Cat Category; either ICAO or NAT
VHFPwr As provided by the State
DMEPwr As provided by the State
Note: The values for VHFPwr and DMEPwr are for the effective isotopically radiated power (e.i.r.p) of the relevant facility. In the absence of such information, the following values are assumed in the frequency assignment planning process:

ILS/Localizer	30 dBW	
ILS/DME	27 dBW (e.i.r.p for the associated DME)	
VOR	Range <50 NM	e.i.r.p 17 dBW
	Range 50 – 100 NM	e.i.r.p 20 dBW
	Range 100 – 150 NM	e.i.r.p 23 dBW
	Range > 150 NM	e.i.r.p 30 dBW
VOR/DME	Range <50 NM	e.i.r.p 27 dBW (landing DME)
	Range 150 -150 NM	e.i.r.p 30 dBW (terminal DME
	Rnage >150 NM	e.i.r.p 37 dBW (en route DME)
DME only	as for DME associated with VOR.	

The e.i.r.p values for DME apply also for TACAN facilities

TRD Runway azimuth

Appendix B

PREFERRED FORMAT OF THE CHARACTERISTICS OF SUBMISSIONS

Reference of submission:

Date:

Subject: Application for xx, at xx (location name)

Contact information of the civil aviation authority of States

Suggested basic information of a submission:

Function of the proposed assignments,

Details of the facility: Manufacturer & Model (if possible),

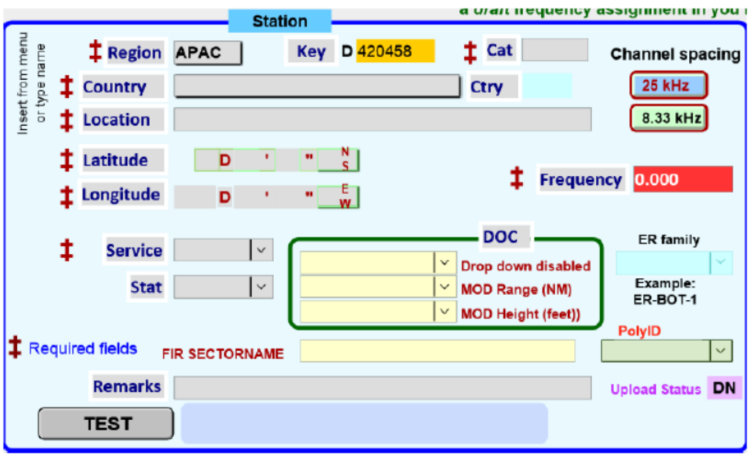
Frequency Range (if request RO for proposal) or proposed frequency,

Transmit Power or DOC

Latitude/Longitude:

Minimum information required with reference to the following screenshot:

Country, Location, Latitude/Longitudes, Service.



Appendix C

GENERIC CALCULATION METHOD FOR GEOGRAPHICAL SEPARATION DISTANCES

a. For the calculation of minimum separation distances with a (desired) facility and an (undesired) facility the generic model as described in Chapter 1 of DOC 9718 has been established.

b. To establish minimum geographical separation distances between a desired facility and an undesired facility, the following parameters are used:

a) The minimum received desired power Pd of the desired facility (dBW).
b) D/U ratio. The prerequisite for any D/U calculation to be valid is that the minimal receive power is achieved at all points throughout the coverage.
c) ERIP of the undesired facility Tx (dBW).
d) Designated operational range of the desired facility.
e) ITU-R aeronautical propagation curve for 5% of the time.

c. The generic method establishes the minimum geographical separation distance between the edge of the DOC of the desired facility and undesired facility. This distance provides for the transmission loss (attenuation) of the undesired signal to a level that meets the D/U requirement for the desired signal, $L = Tx - Pd + D/U$. This distance is obtained with using the relevant (frequency) ITU propagation curve applicable for the maximum height of the DOC of the desired facility and the site elevation of the undesired facility.

d. When the minimum distance from the edge of coverage from the desired facility to the undesired facility has been established, the station-to-station separation distance can be obtained by adding the DOR to the minimum distance from the edge of coverage to the undesired facility.

e. These steps need to be undertaken in the reverse direction whereby the desired facility becomes the undesired facility and the undesired facility becomes the desired facility. The maximum distance between the two processes determine the minimum separation between the two facilities.

Appendix D

PAIRING OF ILS/VOR/DME CHANNELS

Source: Annex 10, Volume 1, Table A			DME parameters					
			Interrogation				Reply	
				Pulse codes				
Channel pairing					DME/P mode			
DME channel number	VHF frequency MHz	GS frequency MHz	Frequency MHz	DME/N µs	Initial approach µs	Final approach µs	Frequency MHz	Pulse codes µs
* 1X	–	–	1 025	12	–	–	962	12
** 1Y	–	–	1 025	36	–	–	1 088	30
* 2X	–	–	1 026	12	–	–	963	12
** 2Y	–	–	1 026	36	–	–	1 089	30
* 3X	–	–	1 027	12	–	–	964	12
** 3Y	–	–	1 027	36	–	–	1 090	30
* 4X	–	–	1 028	12	–	–	965	12
** 4Y	–	–	1 028	36	–	–	1 091	30
* 5X	–	–	1 029	12	–	–	966	12
** 5Y	–	–	1 029	36	–	–	1 092	30
* 6X	–	–	1 030	12	–	–	967	12
** 6Y	–	–	1 030	36	–	–	1 093	30
* 7X	–	–	1 031	12	–	–	968	12
** 7Y	–	–	1 031	36	–	–	1 094	30
* 8X	–	–	1 032	12	–	–	969	12
** 8Y	–	–	1 032	36	–	–	1 095	30
* 9X	–	–	1 033	12	–	–	970	12
** 9Y	–	–	1 033	36	–	–	1 096	30
* 10X	–	–	1 034	12	–	–	971	12
** 10Y	–	–	1 034	36	–	–	1 097	30
* 11X	–	–	1 035	12	–	–	972	12
** 11Y	–	–	1 035	36	–	–	1 098	30
* 12X	–	–	1 036	12	–	–	973	12
** 12Y	–	–	1 036	36	–	–	1 099	30
* 13X	–	–	1 037	12	–	–	974	12
** 13Y	–	–	1 037	36	–	–	1 100	30
* 14X	–	–	1 038	12	–	–	975	12
** 14Y	–	–	1 038	36	–	–	1 101	30

*	15X	–	–	1 039	12	–	–	976	12
**	15Y	–	–	1 039	36	–	–	1 102	30
*	16X	–	–	1 040	12	–	–	977	12
**	16Y	–	–	1 040	36	–	–	1 103	30
?	17X	108		1 041	12	–	–	978	12
	17Y	108.05		1 041	36	36	42	1 104	30
	18X	108.1	334.7	1 042	12	12	18	979	12
	18Y	108.15	334.55	1 042	36	36	42	1 105	30
	19X	108.2		1 043	12	–	–	980	12
	19Y	108.25		1 043	36	36	42	1 106	30
	20X	108.3	334.1	1 044	12	12	18	981	12
	20Y	108.35	333.95	1 044	36	36	42	1 107	30
	21X	108.4		1 045	12	–	–	982	12
	21Y	108.45		1 045	36	36	42	1 108	30
	22X	108.5	329.9	1 046	12	12	18	983	12
	22Y	108.55	329.75	1 046	36	36	42	1 109	30
	23X	108.6		1 047	12	–	–	984	12
	23Y	108.65		1 047	36	36	42	1 110	30
	24X	108.7	330.5	1 048	12	12	18	985	12
	24Y	108.75	330.35	1 048	36	36	42	1 111	30
	25X	108.8		1 049	12	–	–	986	12
	25Y	108.85		1 049	36	36	42	1 112	30
	26X	108.9	329.3	1 050	12	12	18	987	12
	26Y	108.95	329.15	1 050	36	36	42	1 113	30
	27X	109		1 051	12	–	–	988	12
	27Y	109.05		1 051	36	36	42	1 114	30
	28X	109.1	331.4	1 052	12	12	18	989	12
	28Y	109.15	331.25	1 052	36	36	42	1 115	30
	29X	109.2		1 053	12	–	–	990	12
	29Y	109.25		1 053	36	36	42	1 116	30
	30X	109.3	332.0	1 054	12	12	18	991	12
	30Y	109.35	331.85	1 054	36	36	42	1 117	30
	31X	109.4		1 055	12	–	–	992	12
	31Y	109.45		1 055	36	36	42	1 118	30

32X	109.5	332.6	1 056	12	12	18	993	12
32Y	109.55	332.45	1 056	36	36	42	1 119	30
33X	109.6		1 057	12	–	–	994	12
33Y	109.65		1 057	36	36	42	1 120	30
34X	109.7	333.2	1 058	12	12	18	995	12
34Y	109.75	333.05	1 058	36	36	42	1 121	30
35X	109.8		1 059	12	–	–	996	12
35Y	109.85		1 059	36	36	42	1 122	30
36X	109.9	333.8	1 060	12	12	18	997	12
36Y	109.95	333.65	1 060	36	36	42	1 123	30
37X	110		1 061	12	–	–	998	12
37Y	110.05		1 061	36	36	42	1 124	30
38X	110.1	334.4	1 062	12	12	18	999	12
38Y	110.15	334.25	1 062	36	36	42	1 125	30
39X	110.2		1 063	12	–	–	1 000	12
39Y	110.25		1 063	36	36	42	1 126	30
40X	110.3	335.0	1 064	12	12	18	1 001	12
40Y	110.35	334.85	1 064	36	36	42	1 127	30
41X	110.4		1 065	12	–	–	1 002	12
41Y	110.45		1 065	36	36	42	1 128	30
42X	110.5	329.6	1 066	12	12	18	1 003	12
42Y	110.55	329.45	1 066	36	36	42	1 129	30
43X	110.6		1 067	12	–	–	1 004	12
43Y	110.65		1 067	36	36	42	1 130	30
44X	110.7	330.2	1 068	12	12	18	1 005	12
44Y	110.75	330.05	1 068	36	36	42	1 131	30
45X	110.8		1 069	12	–	–	1 006	12
45Y	110.85		1 069	36	36	42	1 132	30
46X	110.9	330.8	1 070	12	12	18	1 007	12
46Y	110.95	330.65	1 070	36	36	42	1 133	30
47X	111		1 071	12	–	–	1 008	12
47Y	111.05		1 071	36	36	42	1 134	30
48X	111.1	331.7	1 072	12	12	18	1 009	12

	48Y	111.15	331.55	1 072	36	36	42	1 135	30
	49X	111.2		1 073	12	–	–	1 010	12
	49Y	111.25		1 073	36	36	42	1 136	30
	50X	111.3	332.3	1 074	12	12	18	1 011	12
	50Y	111.35	332.15	1 074	36	36	42	1 137	30
	51X	111.4		1 075	12	–	–	1 012	12
	51Y	111.45		1 075	36	36	42	1 138	30
	52X	111.5	332.9	1 076	12	12	18	1 013	12
	52Y	111.55	332.75	1 076	36	36	42	1 139	30
	53X	111.6		1 077	12	–	–	1 014	12
	53Y	111.65		1 077	36	36	42	1 140	30
	54X	111.7	333.5	1 078	12	12	18	1 015	12
	54Y	111.75	333.35	1 078	36	36	42	1 141	30
	55X	111.8		1 079	12	–	–	1 016	12
	55Y	111.85		1 079	36	36	42	1 142	30
	56X	111.9	331.1	1 080	12	12	18	1 017	12
	56Y	111.95	330.95	1 080	36	36	42	1 143	30
	57X	112		1 081	12	–	–	1 018	12
	57Y	112.05		1 081	36	–	–	1 144	30
	58X	112.1		1 082	12	–	–	1 019	12
	58Y	112.15		1 082	36	–	–	1 145	30
	59X	112.2		1 083	12	–	–	1 020	12
	59Y	112.25		1 083	36	–	–	1 146	30
**	60X	–		1 084	12	–	–	1 021	12
**	60Y	–		1 084	36	–	–	1 147	30
**	61X	–		1 085	12	–	–	1 022	12
**	61Y	–		1 085	36	–	–	1 148	30
**	62X	–		1 086	12	–	–	1 023	12
**	62Y	–		1 086	36	–	–	1 149	30
**	63X	–		1 087	12	–	–	1 024	12
**	63Y	–		1 087	36	–	–	1 150	30
**	64X	–		1 088	12	–	–	1 151	12
**	64Y	–		1 088	36	–	–	1 025	30

**	65X	–	1 089	12	–	–	1 152	12
**	65Y	–	1 089	36	–	–	1 026	30
**	66X	–	1 090	12	–	–	1 153	12
**	66Y	–	1 090	36	–	–	1 027	30
**	67X	–	1 091	12	–	–	1 154	12
**	67Y	–	1 091	36	–	–	1 028	30
**	68X	–	1 092	12	–	–	1 155	12
**	68Y	–	1 092	36	–	–	1 029	30
**	69X	–	1 093	12	–	–	1 156	12
**	69Y	–	1 093	36	–	–	1 030	30
	70X	112.3	1 094	12	–	–	1 157	12
**	70Y	112.35	1 094	36	–	–	1 031	30
	71X	112.4	1 095	12	–	–	1 158	12
**	71Y	112.45	1 095	36	–	–	1 032	30
	72X	112.5	1 096	12	–	–	1 159	12
**	72Y	112.55	1 096	36	–	–	1 033	30
	73X	112.6	1 097	12	–	–	1 160	12
**	73Y	112.65	1 097	36	–	–	1 034	30
	74X	112.7	1 098	12	–	–	1 161	12
**	74Y	112.75	1 098	36	–	–	1 035	30
	75X	112.8	1 099	12	–	–	1 162	12
**	75Y	112.85	1 099	36	–	–	1 036	30
	76X	112.9	1 100	12	–	–	1 163	12
**	76Y	112.95	1 100	36	–	–	1 037	30
	77X	113	1 101	12	–	–	1 164	12
**	77Y	113.05	1 101	36	–	–	1 038	30
	78X	113.1	1 102	12	–	–	1 165	12
**	78Y	113.15	1 102	36	–	–	1 039	30
	79X	113.2	1 103	12	–	–	1 166	12
**	79Y	113.25	1 103	36	–	–	1 040	30
	80X	113.3	1 104	12	–	–	1 167	12
	80Y	113.35	1 104	36	36	42	1 041	30
	81X	113.4	1 105	12	–	–	1 168	12
	81Y	113.45	1 105	36	36	42	1 042	30

82X	113.5	1 106	12	–	–	1 169	12
82Y	113.55	1 106	36	36	42	1 043	30
83X	113.6	1 107	12	–	–	1 170	12
83Y	113.65	1 107	36	36	42	1 044	30
84X	113.7	1 108	12	–	–	1 171	12
84Y	113.75	1 108	36	36	42	1 045	30
85X	113.8	1 109	12	–	–	1 172	12
85Y	113.85	1 109	36	36	42	1 046	30
86X	113.9	1 110	12	–	–	1 173	12
86Y	113.95	1 110	36	36	42	1 047	30
87X	114	1 111	12	–	–	1 174	12
87Y	114.05	1 111	36	36	42	1 048	30
88X	114.1	1 112	12	–	–	1 175	12
88Y	114.15	1 112	36	36	42	1 049	30
89X	114.2	1 113	12	–	–	1 176	12
89Y	114.25	1 113	36	36	42	1 050	30
90X	114.3	1 114	12	–	–	1 177	12
90Y	114.35	1 114	36	36	42	1 051	30
91X	114.4	1 115	12	–	–	1 178	12
91Y	114.45	1 115	36	36	42	1 052	30
92X	114.5	1 116	12	–	–	1 179	12
92Y	114.55	1 116	36	36	42	1 053	30
93X	114.6	1 117	12	–	–	1 180	12
93Y	114.65	1 117	36	36	42	1 054	30
94X	114.7	1 118	12	–	–	1 181	12
94Y	114.75	1 118	36	36	42	1 055	30
95X	114.8	1 119	12	–	–	1 182	12
95Y	114.85	1 119	36	36	42	1 056	30
96X	114.9	1 120	12	–	–	1 183	12
96Y	114.95	1 120	36	36	42	1 057	30
97X	115	1 121	12	–	–	1 184	12
97Y	115.05	1 121	36	36	42	1 058	30
98X	115.1	1 122	12	–	–	1 185	12

98Y	115.15	1 122	36	36	42	1 059	30
99X	115.2	1 123	12	–	–	1 186	12
99Y	115.25	1 123	36	36	42	1 060	30
100X	115.3	1 124	12	–	–	1 187	12
100Y	115.35	1 124	36	36	42	1 061	30
101X	115.4	1 125	12	–	–	1 188	12
101Y	115.45	1 125	36	36	42	1 062	30
102X	115.5	1 126	12	–	–	1 189	12
102Y	115.55	1 126	36	36	42	1 063	30
103X	115.6	1 127	12	–	–	1 190	12
103Y	115.65	1 127	36	36	42	1 064	30
104X	115.7	1 128	12	–	–	1 191	12
104Y	115.75	1 128	36	36	42	1 065	30
105X	115.8	1 129	12	–	–	1 192	12
105Y	115.85	1 129	36	36	42	1 066	30
106X	115.9	1 130	12	–	–	1 193	12
106Y	115.95	1 130	36	36	42	1 067	30
107X	116	1 131	12	–	–	1 194	12
107Y	116.05	1 131	36	36	42	1 068	30
108X	116.1	1 132	12	–	–	1 195	12
108Y	116.15	1 132	36	36	42	1 069	30
109X	116.2	1 133	12	–	–	1 196	12
109Y	116.25	1 133	36	36	42	1 070	30
110X	116.3	1 134	12	–	–	1 197	12
110Y	116.35	1 134	36	36	42	1 071	30
111X	116.4	1 135	12	–	–	1 198	12
111Y	116.45	1 135	36	36	42	1 072	30
112X	116.5	1 136	12	–	–	1 199	12
112Y	116.55	1 136	36	36	42	1 073	30
113X	116.6	1 137	12	–	–	1 200	12
113Y	116.65	1 137	36	36	42	1 074	30
114X	116.7	1 138	12	–	–	1 201	12
114Y	116.75	1 138	36	36	42	1 075	30

	115X	116.8	1 139	12	–	–	1 202	12
	115Y	116.85	1 139	36	36	42	1 076	30
	116X	116.9	1 140	12	–	–	1 203	12
	116Y	116.95	1 140	36	36	42	1 077	30
	117X	117	1 141	12	–	–	1 204	12
	117Y	117.05	1 141	36	36	42	1 078	30
	118X	117.1	1 142	12	–	–	1 205	12
	118Y	117.15	1 142	36	36	42	1 079	30
	119X	117.2	1 143	12	–	–	1 206	12
	119Y	117.25	1 143	36	36	42	1 080	30
	120X	117.3	1 144	12	–	–	1 207	12
	120Y	117.35	1 144	36	–	–	1 081	30
	121X	117.4	1 145	12	–	–	1 208	12
	121Y	117.45	1 145	36	–	–	1 082	30
	122X	117.5	1 146	12	–	–	1 209	12
	122Y	117.55	1 146	36	–	–	1 083	30
	123X	117.6	1 147	12	–	–	1 210	12
	123Y	117.65	1 147	36	–	–	1 084	30
	124X	117.7	1 148	12	–	–	1 211	12
**	124Y	117.75	1 148	36	–	–	1 085	30
	125X	117.8	1 149	12	–	–	1 212	12
**	125Y	117.85	1 149	36	–	–	1 086	30
	126X	117.9	1 150	12	–	–	1 213	12
**	126Y	117.95	1 150	36	–	–	1 087	30

* These channels are reserved exclusively for national allotments.

** These channels may be used for national allotment on a secondary basis.

The primary reason for reserving these channels is to provide protection for the secondary surveillance radar (SSR) system.

108.0 MHz is not scheduled for assignment to ILS service. The associated DME operating channel No. 17X may be assigned for emergency use. The reply frequency of channel No. 17X (i.e. 978 MHz) is also utilized for the operation of the universal access transceiver (UAT). Standards and Recommended Practices for UAT are found in Annex 10, Volume III, Part I, Chapter 12.