EUR Doc 011

INTERNATIONAL CIVIL AVIATION ORGANIZATION

EUROPEAN AND NORTH ATLANTIC OFFICE

EUR FREQUENCY MANAGEMENT MANUAL

for

Aeronautical Mobile

and

Aeronautical Radio Navigation

Services

Edition December ~~2017~~2018

AMENDMENTS

Procedure for the amendment of the EUR Frequency Management Manual

Principles and procedures for the amendment of EUR Documents, as approved by EANPG, are contained in the EANPG Handbook, EUR Doc 001. Accordingly, amendments to the EUR Frequency Management Manual which have been approved by the FMG are formally endorsed by EANPG and/or COG.

Amendments to the EUR Frequency Management Manual shall be effected on the basis of an adequately documented proposal submitted to the FMG of the EANPG. Such proposals should include draft new text clearly identifying additions, modifications and deletions of existing text.

The latest edition of this Manual, including endorsed aAmendments, to the EUR Frequency Management Manual which have been approved by the FMG and will be promulgated to its FMG members by the ICAO Regional Office or and access to the latest edition of this Manual will be provided at the ICAO Website.

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Edition	*Subject(s)*	*Approved*
2002	Introduction of EUR Frequency Management Manual	FMG/6
2003	Amendment of criteria for 3rd adjacent 8.33 kHz COM channel; Addition of note on COM offset-carrier systems; Addition of note on extension of ILS Glide Path up to 15 NM; Amendment of DME planning criteria for different pulse code; and Amendment of planning criteria for identifications of radio navigation aids.	FMG/7
2004	Amendment concerning VDL and 8.33 kHz for OPC; Amendment concerning VHF COM area to broadcast services separation distance; Amendment concerning NDB frequency co-ordination above 526.5 kHz; Amendment of GBAS VDB provisions; and Amendment of planning criteria for identifications according to Annex 11.	FMG/8
2005	Amendment concerning ILS frequency assignment planning; Addition of note concerning VHF COM vertical separation; Addition of Block Planning Rules (Appendix to Part II); and Addition of offset carrier (CLIMAX) information.	FMG/9
2006	Amendment concerning temporary guidance for GBAS/H planning criteria, Amendment concerning temporary use of ILS to GBAS planning co-ordination criteria,	FMG/10

	Amendment concerning GBAS VDB frequency planning assignment criteria, Amendment concerning Block Planning procedure	
2007	Amendment concerning Maritime Radio Beacons with DGPS transmissions Amendment concerning the RSBN4 System Amendment concerning ground-based augmentation system (GBAS) Amendment concerning the procedure to allocate or request a new UHF Channel for ATC communications in GAT	FMG/11
2008	Amendment concerning the utilization of the frequency band 117.975 – 137 MHz Amendment concerning the coordination and registration procedure for aeronautical frequency	
2009	Amendment concerning the utilization of the frequency band 117.975 – 137 MHz; Amendment concerning the VHF AirGround communications frequency assignment planning criteria; Amendment concerning Directional DME; Amendment concerning unwarranted objections; Amendment concerning country codes & addresses to be used for frequency coordination; Amendment concerning international coordination of mobile offshore NDB idents; Amendment concerning handling incomplete COM3 & COM4 coordination messages.	FMG/13
2010	Amendment concerning DME. Amendment concerning GBAS material	FMG/14
2011 2011 (corrigended)	Amendment in Part II in relation to AS Assignments Amendment in Part III, Section 1, NDB & Locator Amendment in Appendix A part IV Amendment in Part II, Section 4 (para. 4.1.1.1 added)	FMG/15
2012	Amendment in Part I, section 3 Amendment in Part II, section 1, 4 and 5 Removal of Appendix in Part II	FMG/16
2013	Amendment in Part II, new section 7 “Utilization of the frequency band 112 – 117.975 MHz Note added to the title of Part III Amendment in Part I, section 3 Amendment in Part II, section 4, para 4.2.5	FMG/17
2013	Amendment in Part II, section 5 Amendment in Part II, section 2 , “8.33 in the OPC band”	FMG/18
2014	Amendment in Part III, section 3, MLS	FMG/19
2014	Amendment in Part II, section 2, addition of para 2.2 Amendment in Part II, section 1, addition of para 1.9 Amendment in Part IV, Section 1, 2, 3 and 4 Amendment in Part III, Section 7, identification of NDBs on maritime Vessels	FMG/20
2015	Amendment in Part II, General, 8.33 kHz Climax Amendment in Part II, section 4, addition of text “consideration of terrain in compatibility assessment” Amendment in Part II, section 5, DSM-AM to DSB-AM	FMG/21

	Amendment in Part III, Part 7, Note on "NDB identifications" Amendment in Part IV, Appendix C "Mandatory Coordination Data", deletion of Appendix D	
2016	Amendment in Part II, Section 2, utilization of frequency band 117.975-137 MHz	FMG/22
	Amendment in Part II, Section 3 and 4 Amendments in Part II, Section 7, Utilization of the Frequency band 112 – 117.975 MHz Amendment in Part II, addition of section 8 "VDL Mode 2 Assignments" Amendment in Part III, Section 1, NDB Amendment in Part III, Section 3, Addition of Note in Para 3.1.1 Amendment in Part III, Section 5, DME Amendment to the Supplement of EUR Doc 011, Insertion of section "B. Guidance on the Coordination of Common Assignments"	
2017	Amendment in Part II, Section 1 Amendment in Part II, Section 3 and Section 8 Amendment in Part III, Section 2, ILS Frequency Assignment Planning Criteria Amendment in Part III, Section 5, DME Editorial Updates in Part III, Section 1 Amendment to the Supplement of EUR Doc 011, Insertion of section F "VDL Ground Station Installation Guidance"	
2018	Amendment List of Abbreviations and Part I, General Overview Amendment Part II, Section 1, Pilot Controlled Lighting Amendment Part II, Add Section 9, VLD Mode 4 Assignements Amendment part III, Section 5, DME Amendment part III, Section 4, GBAS Amendment to the Supplement of EUR Doc 011: • Addition of Guidance on DME First Adjacent-Channel Compatibility • Addition Section D 'Prioritisation Method for DME Channels'	FMG/24

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

Abbreviations which are defined All abbreviations used in this document are contained in the *Procedures for Air Navigation Services – ICAO Abbreviations and Codes (PANS-ABC)* (Doc 8400) are used in accordance with the meanings and usages given therein. As far as possible, the abbreviations used in this document and outlined below are those which have the widest international use. or tTheir meaning is explained below:

ACARS	Aircraft Communications Addressing and Reporting System
AM	Amplitude Modulation
ANP	Air Navigation Plan
ARB	Authoritative Representative Body
BP	Block Planning
BPM	Block Planning Meeting
CCIR	International Radio Consultative Committee (predecessor of ITU-R)
COG	EANPG Coordination Group
COMT	Eurocontrol COM Team
dB	Decibel
DOC	Designated Operational Coverage
DPSK	Differential Phase Shift Keying
D/U	Desired to Undesired
eANP	Electronic Air Navigation Plan
EANPG	European Air Navigation Planning Group
ECAC	European Civil Aviation Conference
EIRP	Equivalent Isotropically Radiated Power (ITU Radio Regulations 1.161)
EMRP	Effective Monopole Radiated Power (ITU Radio Regulations 1.163)
ERP	Effective Radiated Power (ITU Radio Regulations 1.162)
EUR	ICAO European region
EUR ANP	European Air Navigation Plan (Doc 7754)
FASID	Facilities and Services Implementation Document (predecessor of the eANP)
FCB	Frequency Co-ordinating Body (predecessor of the FMG and dissolved in 1995)
FMG	Frequency Management Group (established in 1995)
GBAS	Ground-based augmentation system (a GNSS element)
GHz	Gigahertz
IAOPA	International Aircraft Owners and Pilots Association
IATA	International Air Transport Association
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
kHz	Kilohertz
MHz	Megahertz
SAFIRE	Spectrum and Frequency Information Resource
SUM	Standard Updating Message
VDL	VHF Air-ground Digital Link
W	Watt

Conventions

Shall	Indicates that the requirement is mandatory to be able to claim compliance with this document.
Will	Indicates an intention or assumption for something.
Should	Indicates a desirable requirement that cannot be justifiably mandated.
May	Indicates that may be at the choice for example of a State or frequency manager.

PART I SCOPE AND GENERAL OVERVIEW

1 Scope

1.1 Frequency assignment planning for the aeronautical frequency bands listed below are subject to ICAO EUR regional planning criteria and procedures:

LF/MF	255 – 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
SHF	5030 – 5150 MHz	MLS

1.2 Aeronautical HF air-ground communications frequencies are planned in accordance with Appendix 27 of the ITU Radio Regulations and are not subject to ICAO regional planning procedures. Compilation of co-ordinated frequencies and ground stations is handled by ICAO Headquarters in Montreal.

1.3 A number of other frequency bands are used by aviation. In many cases, these bands are not allocated exclusively to aeronautical services. ICAO frequency assignment planning procedures, however, have been developed and are applied only for the bands listed under paragraph 1.1 above.

2 The Frequency Management Group

2.1 ~~In the European Region, civil aviation frequency matters are handled by the FMG of the EANPG.~~ The Frequency Management Group (FMG) is established by EANPG Decision 37/2 to pursue the tasks of the Group in the field of aeronautical frequency spectrum management in support to the relevant ICAO Strategic Objectives with the following TORs:

a) Ensure the continuous and coherent development of the relevant sections of the European eANP and other relevant regional documents, including EUR Doc 011 Frequency Management Manual, taking into account the evolving operational requirements in the EUR Region and the need for harmonization with the adjacent regions in compliance with the Global Air Navigation Plan;

b) Monitor and coordinate implementation of the relevant ICAO SARPs and regional procedures, facilities and services by the EUR States and where necessary promote and facilitate harmonization, taking due account of financial and institutional issues;

c) Identify any deficiencies in the aeronautical frequency spectrum management related matters in the EUR Region and coordinate the development and implementation of relevant action plans by the States to resolve them;

d) Foster implementation by facilitating the exchange of know-how and transfer of knowledge and experience among States of the Region;

e) Provide input to the work of appropriate ICAO bodies in the field of aeronautical frequency spectrum, according to the established procedures.

~~2.1~~2.2 The main tasks of the FMG are:

a) to establish co-ordinated frequency assignment plans for the EUR aeronautical mobile services and the EUR radio navigation aids service, and to make recommendations, as necessary, concerning frequency aspects of their implementation;

b) to co-ordinate the frequency aspects of new requirements, as necessary;

c) to give advice to States on questions of frequency assignment, rated coverage, etc., as necessary;

d) to undertake specific tasks assigned to it by the EANPG;

e) to advise the EANPG on frequency spectrum issues covering all aeronautical radio services, including satellite based facilities; and

f) to work in liaison with relevant international organisations.~~, COMT, ARB, etc.~~

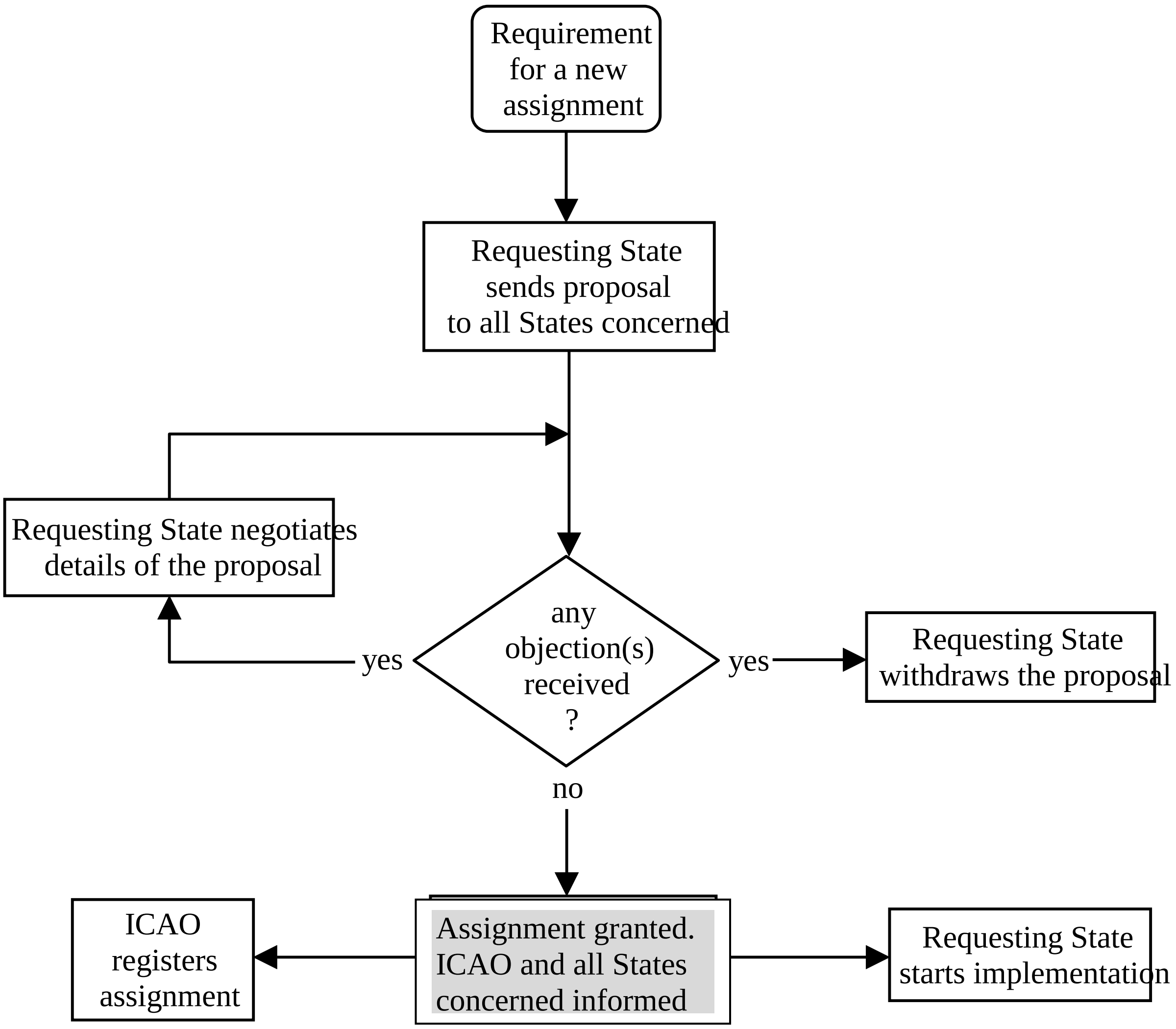
~~2.2~~2.3 Each State within the region ~~(~~and relevant international organisations such as ~~also~~ EUROCONTROL, IATA and IAOPA~~)~~ should nominate a FMG Member, being authorised with the responsibility for aeronautical frequency management. In order to take care of possible problems in the border area between Regions, the EUR FMG also includes experts from States adjacent to the European Region, in practice the States along the Mediterranean. Contact ~~D~~details ~~like name, postal address, phone, AFTN/telex address and E-mail address,~~ can be found in a "List of FMG members and frequency experts" published by the ICAO Paris office.

3 General Rules for Co-ordination of Frequency Assignments

3.1 Chapters 4 and 5 of Volume I of the ICAO "Handbook on Radio Frequency Spectrum Requirements for Civil Aviation" (Doc 9718) provide an overview of institutional relations important to aeronautical frequency management and co-ordination of assignments.

3.2 In most cases a Telecommunications Administration / Radio Authority within a State is the responsible superior authority for use of the radio spectrum. This includes the authority to co-ordinate new assignments with other States under the rules of the ITU and after successful co-ordination to register the new assignment ~~with ITU~~.

3.3 ~~In addition to ITU requirements~~ There is an ~~parallel~~ arrangement for coordination between Civil Aviation representatives in the EUR region. The coordination processes are designed to ensure that~~e~~ States have an opportunity to assess compatibility with the planning rules contained in this document prior to a frequency being assigned for operational use. The EANPG has mandated~~With very few exceptions, States~~ the use of the Spectrum and Frequency Information (SAFIRE) web based tool to carry out coordination and registration of frequency assignments in the EUR Region. The basic aeronautical co-ordination procedure is depicted below.



3.4 Co-ordination is deemed to have been completed and the assignment is considered to be granted when either:

i. All concerned States have registered their acceptance, or
ii. A 4 week period has elapsed without an objection having been registered.

3.5 For the VHF communications band 117.975 - 137 MHz special procedures are applied due to the congestion problems in this band. Block Planning Exercises are organised, as required, based on the mutual arrangements agreed between the States involved. These exercises are organized for those requirements for which an available channel can only be identified through shifting of one or more existing assignments to some other channel. The normal ad-hoc procedure coordination procedure can be used if no shifts are involved.

3.6 Co-ordination must be made with all States that in some way may be affected by the proposed assignment. This should take into account the possibilities that an assignment already exists in another State which is not shown in the available aeronautical frequency assignment tables. Additionally some States may have an interest in being informed about changes, although not directly affecting them, in order to update national databases or for other purposes.

3.7 After successful co-ordination of a new or modified assignment, the assignment is registered in SAFIRE database.a Standard Updating Message (SUM) is sent to All States and the ICAO Paris office, are informed about the registration of assignments through SAFIRE. The registered assignments are published - notifying the successful completion of the co-ordination and requesting the registration of the new or modified assignment in the appropriate frequency assignment table of the ICAO databaseEUR Air Navigation Plan.

PART II VHF AIR-GROUND COMMUNICATIONS FREQUENCY ASSIGNMENT PLANNING CRITERIA

1 General

1.1 The band 117.975 - 137 MHz is allocated to the aeronautical mobile (R) service and used mainly for air/ground voice communications and, to some extent, air/ground data communications.

1.2 References to documents:

- Annex 10, Volume V, paragraph 4.1
  (allotment table, channelling, protection criteria);
- Annex 10, Attachment A to Volume V
  (protection criteria, calculations, propagation curves);
- European Region Air Navigation Plan (Doc 7754), Volume I, Basic ANP, Part IV, paragraphs 25, 28-30, 33-41
  (136-137 MHz, communications for ATS, uniform designated operational coverage, frequency assignment planning).
- European Region Air Navigation Plan (Doc 7754), Volume II, FASID, Part IV, paragraphs 11, 18-21
  (tables of requirements, co-existence of different channel spacing, sector combinations).

1.3 Depending on the type of service, the protected range can be from 16 NM to 260 NM or defined by the border of a FIR or sector. The protected altitude can vary from 3000 ft up to 45000 ft. The actual protection details can be obtained from the frequency assignment table.

1.3.1 Protection by distance separation has in the past been achieved by making sure that any other transmitter (on the ground or airborne) is below the radio horizon. Alternatively, a recently introduced change to Annex 10 allows the Regional use of a desired to undesired signal ratio of 14 dB, equivalent to a 5 to 1 distance ratio, if this separation distance is shorter than the distance to the radio horizon.

1.3.2 Risk of conflict normally only occurs between two aircraft, one in each service area, while the location of the ground transmitter is of less importance. For practical planning special software made available through EUROCONTROL or a table may be used, listing the required distance between combinations of services on the same channel. Also the adjacent channel is considered.

1.3.3 Some sub-bands are reserved for special purposes. From 121.5417 to 121.9917 MHz only ground-ground communication is allowed, typically for communications between the TWR and taxiing aircraft. The bands 131.400 to 131.975 MHz is used by airlines for OPC according to special rules. In several States, common frequencies are used for applications such as light aviation, gliding and ballooning activities, etc.

1.3.3.1 Frequency assignment should be done in the dedicated sub-bands. Due to the limitations of the sub-bands, States are strongly encouraged to introduce 8.33 kHz channel spacing to reduce frequency congestion.

1.3.3.2 It is recommended that States reduce the antenna height and transmit power to reduce the possibility of interference to other stations, but still be able to provide sufficient coverage.

1.3.3.3 In case of congestion of the dedicated AS sub-band, frequencies may be planned on a temporary basis outside the sub-band in accordance with the planning criteria.

1.3.4 Three channels are used for ACARS which is not an ICAO system. The uppermost part of the VHF COM band (136.700 – 136.975 MHz) is reserved for VDL Mode 2 and VDL Mode 4.

1.3.5 Frequency assignments can be reserved for a common use over several States. Guidance material on the allotment, coordination and compatibility assessment between common assignments is provided in the Supplement to EUR Doc011.

1.4 The risk of interference from broadcasting stations in the band 87 - 108 MHz, due to interference caused by unwanted emissions into the aeronautical band or generated in the airborne receiver, is generally not considered to be an operational problem for this type of communications.

1.5 Co-ordination must at least be made with States which may be affected by the proposal. Special care is required for assignments with a very large co-ordination distance (e.g. VOLMET) which may exist on almost any frequency in the band.

1.6 It has been agreed within the FMG to use a special procedure due to the congestion problems in this band. Requests for assignments which cannot be satisfied without shifts have to be submitted to a Block Planning exercise , which is run about every six months and based on the mutual arrangements agreed between the States involved.

1.7 Call signs and designators are not considered as part of the frequency planning process in this band.

1.8 The ICAO planning criteria presented in this document do not provide protection against interference phenomena which may occur if communication facilities are co-located (e.g. interference caused by intermodulation). It is therefore possible that a proposed frequency is not acceptable due to specific local conditions.

1.9 *8.33 kHz CLIMAX*. Significant numbers of aircraft currently operating in European airspace are believed not to be equipped with radios intended for 8.33 kHz offset carrier operation. Consequently,the assignment of 8.33 kHz channels for operation in offset carrier mode shall not be permitted until further notice, whilst studies are conducted, except in cases where all aircraft receiving the service are equipped with a radio intended for 8.33 kHz offset carrier operation.

Note: Aircraft radios intended for 8.33 kHz offset carrier operation should be compliant with the requirements for EUROCAE ED-23C Class H1 or H2 receivers.

1.10 EANPG Conclusion 56/04 invites States to permit the use of TWR frequencies by vehicles involved in runway operations, where required:

Note: Any assignment of a TWR frequency to vehicles involved in runway operation should be subject to local safety assessment. Such assessment should address in particular training, operating procedures and the use of one language in radiotelephony communications between air crews, vehicle drivers and TWR controllers, and enforcement measures.

1.11 *At aerodromes where a VHF pilot-controlled lighting systems are deployed, these should generally operate on the frequency assigned to the aerodrome. No separate frequency should be required.*

~~1.11~~1.12 *Assignment of VHF Data Link (VDL) services*. States shall only coordinate and assign VDL Mode 2 and 4 frequencies approved by the FMG and contained in the VHF data link channel plan.

2 Utilization of the frequency band 117.975 – 137 MHz

2.1 The table is based on Annex 10, Volume V, 4.1.1 also incorporating regional agreements on specific uses of individual frequencies or sub-bands and the identification of the assignable 25 kHz and 8.33 kHz channels:

Channel	**Frequencies (MHz)**	**Worldwide General utilization**	**EUR special application or remarks**
118.000 – 121.460 inclusive	118.000 –121.4583 inclusive	Aeronautical Mobile Services	119.700 MHz reserved for regional guard supplementary tower and approach services.
121.500	121.500	Emergency frequency	
121.540 – 121.990 inclusive	121.5417 –121.9916 inclusive	Aerodrome Surface Communications	
122.000 – 123.060	122.000 –123.0583 inclusive	Aeronautical Mobile Services	122.100 MHz reserved as common channel to provide supplementary TWR/APP services in a number of nations. 122.500 MHz reserved for regional light aviation.
123.100	123.100	Auxiliary frequency SAR	
123.140 – 136.490	123.1417 –136.4916 inclusive	Aeronautical Mobile Services 123.450 MHz reserved for air-to-air communications for flights over remote and oceanic areas out of range of VHF ground stations	123.300 MHz reserved as common channel to provide PAR services in a number of nations. 123.450 MHz reserved for air-to-air communications only for flights over remote and oceanic areas out of range of VHF ground stations 123.500 MHz reserved for regional light aviation 131.400 – 131.975 MHz reserved for operational control (OPC) communications***** 131.525, 131.725 and 131.825 reserved for ACARS data link
136.500 – 136.675	136.500 -136.675	Aeronautical Mobile Services	New assignments permitted only on a temporary basis.
136.700 – 136.975******	136.700 – 136.975 inclusive	Aeronautical Mobile Services 136.900 - 136.975 MHz reserved for air-ground data link communications on a worldwide basis.	reserved for air-ground data link communications (see paragraph 2.2.)

Guard bands:
For 121.500: Channels 121.475, and 121.525, are not assignable; and
For 123.100: Channels 123.065, 123.075, 123.080, 123.085, 123.115, 123.125, 123.130, and 123.135 are not assignable, except for ATIS on channels 123.080 and 123.130.
For VDL: Channels 136.700, 136.750, 136.800, 136.850, 136.900 and 136.950 are not assignable (FMG/6).

*OPC: Assignments used for OPC purposes shall not be co-ordinated on protected channels. 8.33 kHz channel spacing to be used wherever possible, between 131.405 – 131.980[1] except for the ACARS channels 131.525, 131.725 and 131.825. The use of voice at the first adjacent 8,33KHz channel to ACARS is not possible. Care should be taken when considering the use of the second adjacent channel at 16,67 KHz from the ACARS.
Unprotected assignments within this band can accommodate services other than OPC, where local planning conditions permit.

Concerning the use for ATS purposes of the lower adjacent frequencies to 131.400 and the upper adjacent frequencies to 131.975, care should be exercised for the observance of adjacent channel compatibility requirements.

**Note: 8.33 kHz channel spacing is not to be used for frequencies 136.500 – 136.975 MHz inclusive (Annex 10, Volume V, Note 1 to paragraph 4.1.8.1.1).

[1] The band 131.405 – 131.980 is suggested in accordance with the proposed definition on Unprotected assignments. (FMG22/WP11)

2.2 The table below contains the VHF data link channel plan in the sub-band 136.700 – 136.975 MHz

Frequencies (MHz)	*Usage*	*Remarks*
136.700	-	guard channel
136.725	VDLMode 2	GND
136.750	-	guard channel
136.775	-VDL Mode 2	AIR
136.800	-	guard channel
136.825	VDL Mode 2	AIR
136.850	-	guard channel
136.875	VDL Mode 2	GND
136.900	-	guard channel
136.925	VDL Mode 4	common signalling channel (CSC)
136.950	-	guard channel
136.975	VDL Mode 2	common signalling channel (CSC)

Note 1: GND means that the channel is planned for use mainly by ground stations providing airport coverage.
AIR means that the channel is planned for use mainly by ground stations providing en-route coverage.
Networks solely advertised as ARINC are expected to operate on channels 136.725 or 136.825 and States are expected to accommodate this planning element to the extent possible.
Networks solely advertised as SITA are expected to operate on channels 136.775 or 136.875 and States are expected to accommodate this planning element to the extent possible.

Note 2: Services in all VDL Mode 2-allotted channels can be delivered by using dual DSP ID (dual squitter) technology.

Note 3: "No new permanent 25 or 8.33 kHz DSB-AM voice assignments at or above 136.500 MHz shall be coordinated until the future use of those frequencies is clarified.
Note: Existing 25 kHz DSB-AM voice assignments at or above 136.500 MHz may remain at least until they are converted to 8.33 kHz. In accordance with ICAO Annex 10 requirements, existing 8.33 kHz DSB-AM voice assignments at or above 136.500 MHz shall be migrated to a lower frequency"

3 Services and frequency protection volumes

3.1 Information on frequency assignments includes designations of services for which the frequencies are used. The designations and abbreviations indicated below should be used:

3.1.1 Aerodrome

TWR	Aerodrome control service
AS	Aerodrome surface communications
PAR	Precision approach radar
AFIS	Aerodrome flight information service

3.1.2 Approach

APP	Approach control service
ATIS	Automatic terminal information service

3.1.3 En route

FIS	Flight information service
ACC	Area control service

3.1.4 Other functions

A/A	Air-to-air
A/G	Air-to-ground
EMERG	Emergency
OPC	Operational control
SAR	Search and rescue
VOLMET	Meteorological broadcast for aircraft in flight
DL	Data Link services

3.2 The DOC is that agreed to be the standard for the region (Attachment B, Part V.II, European Region Air Navigation Plan, Volume II, FASID). Values different from those indicated may be used in some cases, as appropriate. Minimum required coverage volumes should be used where frequency congestion exists.

3.3 The frequency protection volume of a service is usually identical to the designated operational coverage. It defines the airspace where the frequency assignment planning process provides protection from other assignments.

3.4 A combined code was developed in the EUR Region for the definition of the service type and the frequency protection volume.

3.4.1 A letter provides information on the type of service:

- A area service (e.g. ACC);
- B broadcast service without airborne transmission (e.g. ATIS, VOLMET);
- C circular service (e.g. TWR, APP, AS);
- E European service (e.g. EMERG, SAR); and
- U Unprotected service (e.g. OPC).

3.4.2 A numeric part specifies the DOC (range (r)/height (h)) for all service types except for area services where the horizontal extension is defined as a polygon):

A-h the vertical extension is provided as an integer multiple of 100 ft (e.g. A-450 is used for an area service with an upper limit at 45000 ft for sector Upper1);

B-r/h the horizontal circular extension is expressed in NM and the vertical extension in integer multiples of 100 ft (e.g. B-60/200 is used for a broadcast service with a range of 60 NM and a vertical extension of 20000 ft);

C-r/h as for B-r/h (e.g. C-40/150 is used for an approach service with a range of 40 NM and a vertical extension of 15000 ft);

ICAO Table COM 2 contains a specific field to indicate whether an assignment has protected or unprotected status. Unprotected services, such as OPC, are recorded in Table COM 2 with the protection field set to “U”.

4 Co-channel separation distances between services

DSM-AM TO DSB-AM

4.1 The following principles for VHF planning criteria for determining the separation distances between RTF services with DSB AM carriers and 8.33 or 25 kHz channel spacing should be used in the EUR region. Co-channel separation criteria should be applied between an 8.33 kHz and a 25 kHz channel using the same frequency (co-frequency, e.g. channels 132.000 / 132.005).To protect a service with a circular operational coverage (circular service), the distance from the edge of the service to another airborne or ground transmitter should be 5 times the range of that circular service; if the other transmitter is below the radio horizon from that service edge and the radio horizon distance is also less than 5 times the circular service range then radio horizon distance should be used.

4.1.1 In order to ensure the appropriate frequency planning and assignment of circular services, it is recommended that the operational coverage of circular services is such that the radius is in appropriate proportion to the height (note : further work on this issue to be carried out).

4.1.2 To protect a service with a non-circular operational coverage area, the ground or airborne transmitter of the other service should be below the radio horizon.

4.1.3 The protection criteria for both the requested service and the existing assignment should be met for a valid assignment.

4.2 The following co-channel protection criteria should be used for planning purposes.

4.2.1 Circular service areas (except broadcast functions) should be planned so that the separation distance from the edge of one circular service area to another circular service should be 5 times the larger range from those respective DOCs or the sum of their radio horizon, whichever is least.

4.2.2 The separation distance between circular and area services should be calculated using the radio horizon method. The separation distance between the service edge of the two services should be the sum of the two relevant radio horizon distances (radio line-of-sight distance).

4.2.3 The separation distance between circular and broadcast services should be determined as follows:

a) the separation distance between the aircraft receiver at the circular service edge and the ground broadcast transmitter (actual location, not broadcast service edge) should be a minimum of 5 times the circular service range or the radio line-of-sight distance, assuming a ground antenna height of 20 m (65 ft);

b) the separation distance between an aircraft receiver at the broadcast service edge and an airborne transmitter at the circular service edge should be a minimum of 5 times the broadcast service range or the sum of the two radio horizon distances; and

c) both criteria in a) and b) should be satisfied to make a valid assignment.

4.2.4 The separation distance between two area services should be calculated using the radio horizon method.

4.2.5 In the case of national aerodrome assignments, the co-channel protection criteria applied and the coordinated DOC should be sufficient to protect, but not exceed, that of its sub-ordinate services.

4.2.6 For broadcast service to broadcast service planning, the separation distance between the edge of one service and the ground station of the other should be calculated as follows:

a) for each service in turn, calculate:

1) the radio line-of-sight distance, assuming a ground antenna height of 20 m (65 ft); and

2) 5 times the service range; and

b) take the minimum of these figures for each service.

The broadcast service having the larger of these two figures determines the separation distance between the edge of that service and the ground station of the other.

4.2.7 The separation distance between area and broadcast services should be determined as follows:

a) the separation distance between the aircraft receiver at the area service edge and the ground broadcast transmitter (actual location, not broadcast service edge) should be at least the radio line-of-sight distance, assuming a ground antenna height of 20 m (65 ft);

b) the separation distance between an aircraft receiver at the broadcast service edge and an airborne transmitter at the area service edge should be a minimum of 5 times the broadcast service range or the sum of the two radio horizon distances; and

c) both criteria in a) and b) should be satisfied to make a valid assignment.

Separation distances between services

The table below presents examples of minimum co-channel separation distances between edges of service areas. The DOCs were taken from Attachment B, Part V.II, European Region Air Navigation Plan, Volume II, FASID (except for VOLMET).

	AFIS or TWR	TWR	APP	APP	ATIS	APP	VOLMET	ACC	ACC	ACC	ACC
DOC range (NM) height (ft)	(a) 16 3000	(b) 25 4000	(c) 25 10000	(d) 40 15000	(e) 60 20000	(f) 50 25000	(g) 271 45000	(h) 15000	(i) 25000	(j) 35000	(k) 45000
(a) AFIS or TWR	80	125	125	200	241* *Note 1*	250	328*	218*	261*	297*	328*
(b) TWR	125	125	125	200	252*	250	339*	229*	272*	308*	339*
(c) APP	125	125	125	200	297*	250	384*	274*	317*	353*	384*
(d) APP	200	200	200	200	300	250	412*	302*	345*	381*	412*
(e) ATIS	241*	252*	297*	300	124*+	300	211*+	300	300	300	300
(f) APP	250	250	250	250	300	250	455*	345*	388*	424*	455*
(g) VOLMET	328*	339*	384*	412*	211*+	455*	10*+	412*	455*	491*	522*
(h) ACC	218*	229*	274*	302*	300	345*	412*	302*	345*	381*	412*
(i) ACC	261*	272*	317*	345*	300	388*	455*	345*	388*	424*	455*
(j) ACC	297*	308*	353*	381*	300	424*	491*	381*	424*	460*	491*
(k) ACC	328*	339*	384*	412*	300	455*	522*	412*	455*	491*	522*

Note 1 *Distances marked with an asterisk (*) are limited to the radio-horizon*
(e.g. 241: 241 =* $1.23*(\sqrt{3000} + \sqrt{20000})$*).*

Note 2 *All distances given in the table are in NM and are measured between service areas.*
Note 3 *Distances marked with (+) were calculated assuming a ground antenna height of 65 ft (20 m).*

Consideration of terrain in compatibility assessment

4.2.8 Frequency managers are encouraged to take into consideration the effect of terrain when conducting frequency compatibility assessment. When assessing frequency compatibility between co-channel assignments, in cases where the path profile of the undesired co-channel transmission is intersected by terrain, the resulting undesired field strength at a receiver can be expected to be lower by at least 6 dB than that which would be achieved if the signal path was unobstructed. This equates to a 50% reduction in the undesired path length. The following approach to assessing compatibility in these cases is recommended.

4.2.9 **The 5:1 Case**

4.2.9.1 In cases where the co-channel planning rule requires that the separation distance between the edges of two services should be 5 times the larger of their respective DOCs (e.g. circular-versus-circular), compatibility can generally be assumed when:

a) The undesired signal path is intercepted by terrain; and

b) The distance between the edges of the DOCs is not less than 2.5 times the path length of the desired signal.

4.2.10 **The RLOS case**

4.2.10.1 In cases where the co-channel planning rules require that the minimum separation distance between DOC edges is the sum of the RLOS distances of the two services (e.g. area-versus-area), compatibility can generally be assumed when:

a) The undesired signal path is intercepted by terrain; and

b) The distance between the edges of the DOCs is not less than 5 times the path length of the desired signal.

4.2.10.2 In the case of area services where the length of the desired path is not known (i.e. where the ground station location has not been coordinated), it is recommended that the desired path length is taken to be 70% of the length of the maximum diagonal of the desired DOC polygon.

Notes:

1. *MANIF AFM provides a capability for conducting the compatibility assessment using the above criteria;*

2. *A technical justification for the above recommendations is provided in the Supplement to ICAO EUR Doc 011.*

4.2.11 **Recording of terrain masking in SAFIRE**

4.2.11.1 Where a State coordinates a new assignment that does not comply with the co-channel planning rules but, by reason of the terrain effects described above, is deemed to be compatible with another existing assignment or with a proposal under coordination, *a relevant remark should be provided in the SAFIRE Remarks field simply by inserting the word "TERRAIN".*

VDL TO VDL & OTHER SERVICES

4.2.12 The separation distance between VDL and DSB-AM as well as between VDL and another VDL service shall be calculated using the radio horizon method. The separation distance between the service edges of the two services shall be the sum of their radio horizon distances.

AERODROME SURFACE ASSIGNMENTS

4.2.13 **Aerodrome Surface assignments should be planned according to the following guidance**:

4.2.13.1. The band [121.5417 to 121.9916 MHz] inclusive is reserved exclusively for aerodrome surface movement assignments (AS).

4.2.13.2. The DOC area should be coordinated as circular, with a radius of 5NM and a maximum antenna height of 100ft (C-5/1).

4.2.13.3. AS assignments used for ATS purposes should be coordinated as protected.

4.2.13.4. AS assignments should be co-ordinated preferably in the dedicated band [121.5417 to 121.9916 MHz] inclusive. If it is necessary to plan an AS assignment outside of this band, it should be coordinated on a temporary basis.

5 Adjacent channel separation distances between services

DSM-AM to DSB-AM

The following planning criteria should be used for the deployment of DSB AM RTF services on adjacent channels:

5.1. Services with equal channel spacing (either 8.33 or 25 kHz) and frequency separation of one (1) channel or with different channel spacing and frequency separation of 25 kHz:

a) These services may have overlapping service areas provided that a separation distance of at least 10 NM is maintained between a ground receiver of one service and a ground transmitter of the other service, except when both services under consideration are on 8.33 kHz channels and at least one utilises offset carrier systems.

b) In the case of two 8.33 kHz services where one or both utilises an offset carrier system, the separation distance between services should be determined on the basis of co-channel separation criteria.

Note: For international co-ordination purposes, the only requirement for States in this case is to notify to a neighbouring State the location of ground receivers and ground transmitters that are located within 10NM of the land mass of the neighbouring State except when they are sited at the centre of a circular service. Notwithstanding, States are urged to ensure compliance with the constraint in a) within their own territories.

5.2. Services using different channel spacing and frequency separation of 8.33 kHz:
The distance separation of services as above should be determined on the basis of co-channel separation criteria.

5.3. Services using different channel spacing and frequency separation of 16.67 kHz:

a) The separation distance between edges of service areas should be at least 10 NM except when both services under consideration are broadcast services;

b) A broadcast service may have an overlapping service area with another broadcast service provided that the ground transmitter of each service is at least 10 NM outside the edge of the service area of the other service.

Note 1: These planning rules are based on the assumption that the ground transmitters and receivers are placed within the protected service volume.

Note 2: As a consequence of the above criteria, adjacent channel services for ATS purposes should not be deployed in the same airport.

Note 3: Where a State proposes a new offset-carrier service where the location of the ground transmitter(s) may affect an existing foreign assignment, it is the responsibility of that State to ensure that sufficient technical data is made available to the adjacent State(s) through bi-lateral coordination to allow the other State to complete a compatibility assessment."

VDL to VDL & Other Services

5.4. Adjacent channel separation between VDL and DSB-AM systems operating in the same geographical area shall be in accordance with the following table.

Vs.		Interference source		
		DSB-AM	VDL Mode 2 (117.975-137 MHz)	VDL Mode 4 (130-137 MHz)
Victim	DSB-AM	-	1	2
	VDL Mode 2	1	1	1
	VDL Mode 4	2	1	1

Note 1: *The numbers in the table represent the guard channels (25 kHz). The next frequency that can be used without any frequency assignment planning constraint is 1 (one) higher (e.g. a desired DSB-AM station that is interfered by a VDL mode 2 aircraft station requires one 25 kHz guard band channel. The next frequency, 50 kHz separated from the VDL Mode 2 assigned frequency, can be used in the same designated operational coverage area without any frequency assignment planning constraint.*

Note 2: *Attention is drawn to the possibility of interference between DSB-AM and VDL when used onboard an aircraft on the surface of an airport. Interference can occur if the channel separation (guard band) is four or less. In this case, interference can be prevented by securing that the minimum field strength at the (receiving) antenna is at least -70 dBm.*

Note 3: *Any interference that can be caused by aircraft transmission of DSB-AM or VDL signals on the surface of an airport into a ground-based (i.e. not an aircraft) receiving station can be mitigated or removed through using cavity filters in the ground based receiver. These filters block the reception of unwanted signals.*

6 Operational control

6.1 Dedicated frequencies for operational control purposes should be assigned to those aircraft operators who are required to maintain a system of Operational Control under the provisions of Annex 6, Part I.

6.2 Strict economy in the number and use of frequencies assigned for this purpose should be observed. Shared use of channels by different operators is a method which may help to achieve this goal. Eurocontrol can provide advice to States (see paragraph 1.3.3).

6.3 The Annex 10 provisions for frequency protection should not apply to OPC frequencies used in the EUR region.

7 Utilization of the frequency band 112 – 117.975 MHz

7.1 In accordance with provisions of the Regional Supplementary Procedures (Doc 7030), based on an agreement reached at FMG/21, the assignment of VDL Mode 4 frequencies in the band 112 – 117.975 MHz shall not be permitted until further notice.

Note: Currently, all navigation aids operating in the band 112-117.975 MHz make use of ground based transmitters and no transmissions take place from the aircraft. There is the potential for aircraft-based VDL Mode 4 transmissions to cause harmful interference to the users of these existing ground-based navigation aids, and their monitors, unless a capability is provided to prohibit unintended VDL Mode 4 transmission outside of designated operational coverage. It is not currently clear whether this capability is available and further studies need to be conducted.

7.2 Subject to a satisfactory solution ensuring that VDL Mode 4 transmission do not cause harmful interference to other users of the band, the Regional Supplementary Procedures ~~FMG~~ may be amended to remove the above restriction. In those circumstances, in accordance with the provisions of Annex 10 and the ITU Radio Regulations, the frequency band 112 – 117.975 MHz could be used for VDL Mode 4. When making frequency assignments to VDL Mode 4 in this frequency band, the following frequency assignment planning parameters apply:

7.3 VDL Mode 4 to VDL and VHF DSB/AM (air/ground voice)

7.3.1 Co-frequency

Note: the frequency band 112 – 117.975 MHz is (currently) not to be used for VHF DSB/AM or VDL mode 3 systems as per provisions of Annex 10, Volume III and no co-frequency assignment planning to secure compatibility between VDL Mode 4 and VHF DSB/AM or VDL Mode 2 are necessary.

Co-frequency use of frequencies for VDL Mode 4 (different VDL Mode 4 networks)

The separation distance between VDL Mode 4 frequency assignments shall be calculated using the radio horizon method. The separation distance between the service edges of the two services shall be equal or greater than the sum of their respective distances to the radio horizon (see also paragraphs 4.2.8 above)

7.3.2 Adjacent frequency

Adjacent channel compatibility of VDL Mode 4 with DSB/AM or VDL Mode 2 systems is secured when applying the provisions of paragraph 5.4 above.

7.4 VDL Mode 4 and ILS-Localizer

7.4.1 Co-frequency

Note: Since, in accordance with the provisions of Annex 10 (Volumes I and II) the highest assignable frequency for the ILS Localizer is 111.950 MHz and the lowest assignable VDL Mode 4 frequency is 112 MHz, no co-frequency use of VDL Mode 4 and the ILS Localizer is expected.

7.4.2 Adjacent frequency

Note: Since, in accordance with the provisions of Annex 10 (Volumes I and III) the highest assignable frequency for the ILS Localizer is 111.950 MHz and the lowest assignable frequency for VDL Mode 4 is 112 MHz, the minimum frequency separation between an ILS-Localizer frequency and a VDL Mode 4 frequency is 50 kHz.

VDL Mode 4 can be used without frequency assignment planning constraints when separated from an operational ILS-Localizer frequency with 50 kHz or more.

Note: In certain cases VDL Mode 4 may be subject to harmful interference from transmissions from the ILS-Localizer transmitter if the separation distance is less than 2.5 NM. Such interference is typically transient in nature.

7.5 VDL Mode 4 and VOR

7.5.1 Co-frequency and first adjacent (25 kHz) frequency

The separation distance between VDL Mode 4 and VOR frequency assignments shall be calculated using the radio horizon method. The separation distance between the service edges of the two services shall be equal or greater than the sum of their respective distance to the radio horizon.

7.5.2 Second adjacent frequency (50 kHz separation between VOR and VDL Mode 4 frequency assignments)

VDL Mode 4 can be used without frequency assignment planning constraints when separated from an operational VOR station with 50 kHz or more.

Note: In certain cases VDL Mode 4 may be subject to harmful interference from transmissions from the VOR transmitter if the separation distance is less than 2.5 NM. Such interference is typically transient in nature.

7.6 VDL Mode 4 and GBAS

7.6.1 Co-frequency and first adjacent (25 kHz) frequency

The co-frequency separation distance between VDL Mode 4 and GBAS frequency assignments shall be calculated using the radio horizon method. The separation distance between the service edges of the two services shall be equal or greater than the sum of their respective distance to the radio horizon.

The first adjacent (25kHz) frequency channel separation distance shall be 10 Km between the service edge of the GBAS VDB and any VDL4 transmitter.

7.6.2 Second adjacent frequency (50 kHz separation between VDL Mode 4 and GBAS)

VDL Mode 4 can be used without frequency assignment planning constraints when separated from an operational GBAS station with 50 kHz or more.

Note: *VDL Mode 4 should not operate on the 2nd, 3rd or 4th adjacent channel to a VDB GBAS frequency at the surface of an airport in case the separation between a VDB GBAS and a VDL Mode 4 equipped aircraft can be less than 130 m. Note: This is an operating restriction that may affect the use of VDL Mode 4 on an airport.*

8 VDL Mode 2 Assignments

8.1 In order to support evolution of the VDL band plan, the VHF data link assignments should be coordinated as follows:

a) Assignments on auxiliary frequencies should be made on temporary basis to support changes to the Data Link Allotment Plan accordingly;
b) Assignments should be deleted if the frequencies are not used within one year;
c) Discrete assignments should be made for each CSP at each location;
d) Assignments should be coordinated as DL services with a DOC of C-1/0 and include the precise location of the ground station(s) and their EIRP;
e) Assignments should include the CSP name and the ground station identifier in the Remarks field.

9 VDL Mode 4 assignments

9.1 In order to support evolution of the VDL band plan, VDL Mode 4 assignments on the VDL4 Common Signalling Channel (CSC) 136.925 should be coordinated as follows:

a) Assignments on channel 136.925 should be on a temporary basis to support changes to the Data Link Allotment Plan accordingly;

b) Assignments should be deleted if the frequencies are not used within one year;

c) States using VDL4 should create Assignments on channel 136.925. Assignments should be coordinated as DL services with the text “VDL4 CSC” in the SAFIRE Remarks field.

d) Protected polygonal assignments should be created in the areas where aircraft will use VDL4 CSC.

e) Discrete assignments could be made for each fixed ground station: they should include the precise location of the ground station(s) and their EIRP. In addition, they should contain the operator name in the Remarks field.”

PART III RADIO NAVIGATION AID FREQUENCY ASSIGNMENT PLANNING CRITERIA

1 NDB and locator

1.1 General

1.1.1 A number of sub-bands in the range of 255 – 526.5 kHz (excluding 495 - 505 kHz) are allocated to aeronautical radio navigation with various status. Only the sub-band 325 - 405 kHz is allocated exclusively to the aeronautical radio navigation service, the other sub-bands being shared with other services.

1.1.1.1. As for the other users of the band, the sub-band 255 - 283.5 kHz is mainly used by broadcasting stations, while the sub-bands 283.5 - 315 kHz and 315 - 325 kHz are used by maritime beacons. The small segment 405 - 415 kHz is designated for radio direction-finding in the maritime radio navigation service, while the sub-bands in the range 415 - 526.5 kHz (excluding the segment 495 – 505 kHz) are used by the maritime mobile service, limited to radiotelegraphy.

1.1.1.2. It is noted additionally that Rradio frequency carrier systems are widely used for remote control or transmission of speech or data over segments of high-voltage overhead power lines. In some cases frequencies in the LF/MF bands are used and this has been proved to be able to affect ADF indications in aircraft at several nautical miles from the power lines.

1.1.2 Organization of Planning

1.1.2.1. In order to secure the international and the operational status of their assignments, States are required to apply the rules and procedures of the ITU Radio Regulations. This is particularly necessary for the shared sub-bands, since the ICAO EUR Table COM4 is not supposed to include non-aeronautical assignments.

1.1.2.2. For assignments in the aeronautical radio navigation service, States are required to apply the ICAO EUR FMG rules and procedures.

Note 1: *Although in the shared sub-bands the FMG process is evidently partial and cannot result, if applied alone, in the required status, this process is necessary for the co-ordination of the identifications of the radio navigation aids.*

Note 2: *In the shared sub-bands, States are advised to avoid including assignments for non-aeronautical services (e.g. maritime services) in the FMG co-ordination process, as such assignments are not taken into account in compatibility assessments.*

1.1.3 References to documents:

- Annex 10, Volume I, Attachment C, paragraph 6.2.1.6 *(field strength);*
- Annex 10, Volume V, paragraph 3.2 (*general about protection, sharing and frequency congestion*);
- Annex 10, Attachment A to Volume V (*protection, receiver characteristics, filter attenuation*);
- European Region Air Navigation Plan (Doc 7754), Volume II, FASID, Part IV, paragraphs 19-20 *(reference to Table COM4).*

1.1.4 The range can be from 10 NM (nautical miles) up to 100 NM (in some rare cases more) and the operational range is listed in the national AIP and the frequency assignment table. The maximum altitude is not specified. Co-channel separation between two transmitters shall be such that an unwanted signal is more than 15 dB below the wanted signal within the specified service area (DOC). This protection criterion is also included in the ITU Radio Regulations. The bandwidth characteristics of the airborne receiver need to be taken into account which require in principle that existing transmitters within ± 7 kHz from the frequency of the wanted station be considered.

1.1.5 In the band 325 - 405 kHz, aviation is the only user and new assignments should therefore preferably be made in this segment. Use of a segment where aeronautical radio navigation is secondary should only be considered in areas where the primary service is not used, like inland areas where the distance to any maritime station is sufficient.

1.1.6 The co-ordination of LF/MF radio navigation aids to be applied for aeronautical purposes above 526.5 kHz shall be carried out between national radio regulators, applying the relevant ITU procedures. The co-ordination of the identification of such a radio navigation aid shall be carried out between FMG members according to the rules in Part IV.

1.1.7 For normal coverage ranges (15 - 50 NM) co-ordination should, as an absolute minimum, be made with States within a radius of 300 - 400 NM. Co-ordination should also be made with the national authority responsible for protection of the maritime services if a shared band segment is to be used.

1.1.8 Information on the planning of identifications can be found in section 7.

1.2 Frequency assignment planning principles

1.2.1 Wherever possible, frequencies at kHz points (i.e. integral multiples of 1 kHz) in the bands used for NDBs should be chosen to meet particular requirements. Frequency assignments at 0.5 kHz points may also be utilized, provided the full required protection can be ensured.

1.2.2 In the planning of frequency assignments, ADF receiver characteristics as specified in paragraph 3 of Attachment A to Annex 10, Volume V, should be assumed.

1.2.3 For the purpose of assessing the signal attenuation with distance, the LF/MF ground wave propagation curves agreed by the ITU-R should be used, taking into account the frequency of operation and the effect of mixed land/sea path where appropriate.

1.3 Frequency assignment planning criteria

1.3.1 The protection of a NDB against interference from another NDB can be calculated using the propagation curves in Recommendation ITU-R P.368-9. These curves (known also as CCIR curves) represent the propagation characteristics of a transmitter (beacon) with an effective monopole radiated power (e.m.r.p.) of 1 kW. These curves can be adjusted to describe the propagation characteristics (field strength as a function of the distance from the beacon) of a beacon with a given coverage area. Such adjustment needs to ensure that the field strength at the edge of the coverage area is the minimum required. For aeronautical beacons this field strength is 70 µV/m or 36.9 dB (µV/m). (Ref.: Annex 10, Volume I, section 3.4 and ITU Radio Regulations Appendix 12).

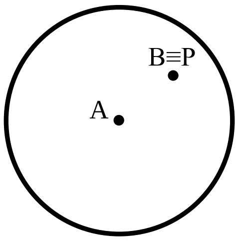
1.3.2 For frequency planning purposes, the CCIR curves for sea water and wet ground propagation are used, with the following characteristics:

Sea water: σ = 5 S/m Wet ground: σ = 10^{-2} S/m
ε = 70 ε = 30

1.3.3 The protection ratio has to be calculated at the point P where the interference is maximum. There are two cases to consider:

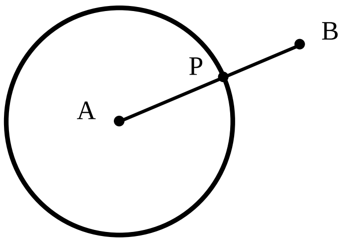
i) when the undesired beacon (B) is inside the coverage area of the desired beacon (A): at the location of that (undesired) beacon (see Figure 1)

Figure 1



ii) when the undesired beacon (B) is outside the coverage area of the desired beacon (A): at that point on the edge of the coverage area of the desired beacon closest to the undesired beacon (see Figure 2)

Figure 2



1.3.4 Calculation of the minimum protection ratio (D/U) shall ensure identification of the worst-case interference.

1.3.5 To ensure the compatibility of two beacons, it is necessary to consider successively the two cases where each of the beacons is treated as desired and the other one as undesired. In each case, the protection ratio needs to be calculated at the point of maximum interference. The lowest value of these two protection ratios is the value at risk and to be used in frequency planning.

1.3.6 Once the worst case protection ratio is known, the minimum frequency separation can be determined taking into account the ADF selectivity characteristics.

1.4 Description of the calculations

1.4.1 As a first step, the ITU-R curves (see section 1.6) are adjusted to obtain field-strength values corresponding to the effective monopole radiated power of the beacon, necessary to obtain the minimum field strength required at the edge of coverage (36.9 dB μV/m).

Let *a* and *b* denote respectively the operational ranges of the beacons A and B.

The following symbols are additionally used:

f(R)	field strength at distance R, for e.m.r.p.= 1kW (from ITU-R curves).
$f^A(R)$	field strength for beacon A at distance R.
$f^B(R)$	field strength for beacon B at distance R.
f(*a*)	field strength f(R) at R = *a*
f(*b*)	field strength f(R) at R = *b*
$f^A(a)$; $f^B(b)$	field strengths $f^A(R)$ at R = *a* and $f^B(R)$ at R = *b* [normally 36.9 dB µV/m].
f(1); $f^A(1)$; $f^B(1)$	field strengths f(R), $f^A(R)$ and $f^B(R)$ at R = 1 km. f(R) at R = 1 km is 109.5 dB µV/m. See also Recommendation ITU-R P.368-9.

The field strengths produced by beacons A and B at any distance R from the beacon satisfy:

$$f^A(R) = f(R) - [f(a) - 36.9] \quad (1)$$

$$f^B(R) = f(R) - [f(b) - 36.9] \quad (2)$$

Note: In general the field strength (f(R), $f^A(R)$ or $f^B(R)$) depends not only on the path distance R (this dependence being the only explicit in the notation), but also on the frequency as well as on the geological constitution of the radio-path (proportion of sea-path over the total path distance R).

1.4.2 Determination of the field strengths f(*a*) and f(*b*)

On considering each beacon separately, the first step is the identification of the radial along which the proportion *p* of sea-path over a total path distance equal to the range of the beacon is lowest.

On the basis of the lowest proportion *p*, the mixed-path calculation method (see section 1.5) is then applied for the determination of the quantity f(*a*) or f(*b*) and the consequent dimensioning of the output power of the beacon (see section 1.7).

1.4.3 Calculation of the protection ratio when the undesired beacon is inside the coverage area of the desired beacon (see paragraph 1.3.3 i) above). In this case the maximum level of the undesired signal that contributes to the interference of the desired signal is at the location of the transmitter of the undesired beacon.

If we assume A to be the desired beacon and B the undesired beacon, the maximum level of the undesired signal is:

$$E_U = f^B(1) \quad = f(1) - [f(b) - 36.9]$$
$$= 109.5 - [f(b) - 36.9] \qquad (3)$$

The signal level of the desired facility A at this point of maximum interference is:

$$E_D = f^A(R_s) \quad = f(R_s) - [f(a) - 36.9] \qquad 0<R_s<a \qquad (4)$$

R_s = separation distance between A and B.

The protection ratio D/U is: $E_D - E_U$ or $f^A(R_s) - f^B(1)$.

Substitution of (3) and (4) in this formula gives:

$$D/U = f(R_s) - f(a) + f(b) - 109.5 \qquad (5)$$

Note: *For the application of formula (5), the quantity $f(R_s)$ at the position of the undesired beacon is determined by the application of the mixed-path calculation method (see section 1.5).*

1.4.4 Calculation of the protection ratio when the undesired beacon is outside the coverage area of the desired beacon (see paragraph 1.3.3 ii) above). In this case the maximum level of the undesired signal that contributes to the interference of the desired signal is at the location of point P in Figure 2.

At this point the signal level of the desired facility A is:

(6)
$$E_D = f^A(a^*) = f(a^*) - [f(a) - 36.9]$$

($f^A(a^*)$, $f(a^*)$ denote respectively the adjusted and the non-adjusted (corresponding to e.m.r.p.=1kW) field strengths at the particular point P).

The signal level of the undesired facility B at this point is:

$$E_U \quad = f^B(R_s - a)$$
$$= f(R_s - a) - [f(b) - 36.9], \qquad a<R_s, \qquad (7)$$

R_s = separation distance between beacon A and B.

The protection ratio D/U is: $E_D - E_U$ or $f^A(a^*) - f^B(R_s-a)$.

Substitution of (6) and (7) in this formula gives:

$$D/U = f(b) - f(R_s - a) + f(a^*) - f(a). \qquad (8)$$

Note: *For the application of formula (8), the quantities* $f(a^*)$ *and* $f(R_s-a)$ *are determined by the application of the mixed-path calculation method (see section 1.5),* $f(a^*)$ *corresponding to the propagation path AP, while* $f(R_s-a)$ *corresponding to propagation path BP (see Figure 2).*

1.4.5 Formulas (5) and (8) can be used to calculate the interference from beacon B (undesired) to beacon A (desired). When the outcome of the calculations shows that the D/U is equal or greater than 15 dB, the desired beacon is protected and the beacons can operate on the same frequency. When the outcome is less than 15 dB, a frequency separation between the frequencies assigned to these beacons has to be maintained.

The required frequency-separation depends upon the calculated D/U ratio and can be taken from the following table:

D/U(dB)	frequency-separation (kHz) between desired and undesired signal
≥ 15	0
< 15 to ≥ 9	1
< 9 to ≥ (-5)	2
< (- 5) to ≥ (-20)	3
< (-20) to ≥ (-35)	4
< (-35) to ≥ (-50)	5
< (-50) to ≥ (-65)	6
< -65	7

Table 1 – Required Frequency Separation

The above relation between the D/U ratio and the required frequency-separation corresponds to the ADF-receiver selectivity curve in Annex 10, Volume V, Attachment A, paragraph 3.

Since the D/U ratio, for a combination of beacons with a range of a and b respectively, is a function of the distance between these beacons and the required frequency separation is a function of the D/U ratio, the minimum required frequency separation is a complex function of the separation distance.

1.5 Mixed Path Calculations

1.5.1. The method described below pertains to a propagation path which contains both land and sea segments.

1.5.2. Although ITU-R is, for this purpose, recommending the Millington method (reference Recommendation ITU-R P.368-9, Annex 2), a simplified method was developed and recommended to be used in calculations when mixed path conditions exist.

1.5.3. In this simplified method the calculation of the signal-level of a beacon is based upon the following formula:

$$f(R)_M = f(R)_L + \{ f(R)_S - f(R)_L \}p \qquad (9)$$

where :

$f(R)_M$ = effective field strength of a beacon with EMRP=1kW at a point P, at distance R from the beacon

$f(R)_L$ =field strength at P if the total path were over land.

$f(R)_S$ =field strength at P if the total path were over sea.

R = total path length.

p = S/R where S is the total sea-path length.

1.6 ITU-R Propagation Curves

1.6.1 The ITU-R propagation curves (known also as CCIR curves) can be found in Recommendation ITU-R P.368-9. They were generated through the application of the computer program GRWAVE, which is made available by ITU-R.

1.6.2 The program GRWAVE was used as well for calculating the field strength values of Table 2 below for EMRP=1 kW. Field strength values at intermediate frequencies can be estimated by linear interpolation.

SEPARATION DISTANCE	BEACON RANGE	SEA 300 kHz	SEA 400 kHz	SEA 500 kHz	LAND 300 kHz	LAND 400 kHz	LAND 500 kHz
KM	NM	DB(UV/M)	DB(UV/M)	DB(UV/M)	DB(UV/M)	DB(UV/M)	DB(UV/M)
2		103.5	103.4	103.4	103.2	103	102.8
4		97.4	97.4	97.4	97.1	96.9	96.6
6		93.9	93.9	93.9	93.5	93.3	93
8		91.4	91.4	91.4	91	90.7	90.3
10		89.5	89.5	89.4	89	88.6	88.2
18.5	10	84.1	84.1	84.1	83.4	82.9	82.3
20		83.4	83.4	83.4	82.7	82.2	81.5
27.8	15	80.5	80.5	80.5	79.6	79	78.2
37	20	78	77.9	77.9	76.9	76.1	75.1
40		77.3	77.3	77.2	76.1	75.3	74.2
46.3	25	76	76	76	74.7	73.7	72.6

55.6	30	74.4	74.4	74.3	72.9	71.8	70.4
60		73.7	73.7	73.6	72.1	70.9	69.5
80		71.1	71	70.9	69.1	67.6	65.8
92.6	50	69.7	69.6	69.5	67.5	65.8	63.8
100		69	68.9	68.8	66.6	64.8	62.7
138.9	75	65.7	65.6	65.5	62.7	60.3	57.5
185.2	100	62.7	62.5	62.3	58.9	55.9	52.4
200		61.8	61.6	61.4	57.8	54.6	50.9
231.5	125	60.1	59.8	59.6	55.6	52	47.9
277.8	150	57.9	57.5	57.2	52.7	48.5	43.8
370.4	200	53.9	53.3	52.8	47.4	42.1	36.4
400		52.7	52.1	51.5	45.8	40.2	34.1
463	250	50.3	49.5	48.8	42.6	36.3	29.6
555.6	300	46.9	45.9	45	38.1	30.8	23.2
600		45.3	44.2	43.2	36	28.2	20.3
800		38.4	36.8	35.4	26.9	17.1	7.3
1000		31.8	29.7	28	18.2	6.2	-5.3
1200		25.4	22.8	20.7	9.6	-4.4	-17.8
1400		19.1	16	13.5	1.2	-14.9	-30.1
1600		12.9	9.3	6.4	-7.2	-25.3	-42.4
1800		6.7	2.7	-0.7	-15.5	-35.6	-54.5
2000		0.6	-3.9	-7.6	-23.7	-45.9	-66.6

Table 2 – 1 kW EMRP Field Strength at a Given Separation Distance

1.7 Effective Monopole Radiated Power (EMRP)

1.7.1 Pursuant to the ITU Radio Regulations (Article 28.23), the power radiated by each radio beacon shall be adjusted to the value necessary to produce the stipulated field strength (36.9 dB (µV/m)) at the limit of its operational range.

1.7.2 The EMRP is calculated not for frequency co-ordination purposes but for the determination of the transmitter output power P of the beacon which is required for the desired operational coverage. The quantities EMRP and P in dBW are related as follows:

$$P = EMRP + \text{cable and tuning losses} - Gv,$$

where Gv is the gain of the antenna with regard to a short vertical monopole. In most practical cases Gv=0dB. Cable and tuning losses, on the other hand, are usually not less than 10 dB (see also Attachment C to Annex 10, Volume I, paragraph 5 of section 6.3.2).

1.7.3 The EMRP in dBW can be calculated, using the ITU-R propagation curve for a 1 kW transmitter, as follows:

$$EMRP = 30 - [f(a) - 36.9]$$
$$= 66.9 - f(a),$$

where

30 = term for the conversion of the ITU-R propagation curves from a 1 kW transmitter to a 1Watt transmitter in order to obtain an EMRP value in dB relative to 1 Watt.

36.9 = minimum field strength in dB(µV/m) required at the edge of the coverage.

f(*a*) = field strength in dB(µV/m) at the edge of the beacon's desired coverage calculated for an EMRP of 1kW as described in paragraph 1.4.2.

1.8 Treatment of assignments over polygonal areas

1.8.1. In exceptional cases, frequency assignments can be co-ordinated over polygonal areas. In such a case :

1.8.1.1. Frequency protection is accorded over the co-ordinated polygonal area.

1.8.1.2. The envisaged distance (range) between receiver and transmitting beacon is specified at co-ordination in addition to the polygonal area. This range shall not exceed the length of the maximum diagonal of the polygonal area.

1.8.1.3. The transmitting beacon can be anywhere inside the polygonal area.

1.8.2. The following instructions are provided for the calculation of the required D/U ratio involving assignments over polygonal areas (referred to henceforth as area assignments) :

1.8.3. The field strength f(a) at the range of an area assignment is calculated by considering all possible paths of length a within the polygonal area and by identifying the lowest sea-path proportion among those paths.

1.8.4. Area assignment versus circular assignment.

1.8.4.1. Protection of the area assignment

1.8.4.1.1. If the centre of the circular assignment is inside the polygon of the area assignment, formula (5) is applicable with R_s being equal to the minimum of (i) the range a of the area assignment and (ii) the maximum distance between the centre of the circular assignment and the polygon. f(R_s) can be calculated by considering the radial with the lowest sea-path proportion among those radials of length R_s from the centre of the circular assignment which end up within the polygon.

Note: When $R_s=a$, $f(R_s)\geq f(a)$. In general $R_s=a$ does not imply $f(R_s)=f(a)$ because the minimisation of the sea-path proportion is effected over different sets of possible paths of length a.

1.8.4.1.2. If the centre of the circular assignment is outside the polygon of the area assignment, formula (8) is applicable with R_s-a being equal to the distance between the centre of the circular assignment and its closest point on the polygon. f(a*) can be calculated by considering the radial with the lowest sea-path proportion among those radials which originate from the point on the polygon closest to the centre of the circular assignment, have length equal to the range a of the area assignment and end up within the polygon. If the distance of this point from any other point on the polygon is less than the range a, the length of the radial for the calculation of f(a*) is reduced to the maximum value of this distance.

1.8.4.2. Protection of the circular assignment

1.8.4.1.3. If the polygon of the area assignment overlaps with the coverage area of the circular assignment, formula (5) is applicable with R_s being equal to the minimum of (i) the range a of the circular assignment and (ii) the maximum distance between the centre of the circular assignment and the polygon. f(R_s) can be calculated by considering the radial with the lowest sea-path proportion among those radials of length R_s from the centre of the circular assignment which end up within the polygon.

1.8.4.1.4. If the polygon of the area assignment does not overlap with the coverage area of the circular assignment, formula (8) is applicable with R_s being equal to distance between the centre of the circular assignment and its closest point on the polygon. In this case the situation is very similar to the compatibility between two circular assignments.

1.8.5. Area assignment versus area assignment :

1.8.4.3. Protection of each area assignment

1.8.4.1.5. If the two polygonal areas overlap, formula (5) is applicable with R_s being equal to the minimum of (i) the range *a* of the area assignment to be protected and (ii) the maximum distance between any point in the intersection of the two polygonal areas and any other point on the polygon to be protected. $f(R_s)$ can be calculated by considering the path with the lowest sea-path proportion among all possible paths of length R_s which originate from points in the intersection of the two polygonal areas and end up within the polygon to be protected.

1.8.4.1.6. If the two polygonal areas do not overlap, formula (8) is applicable with R_s-*a* being equal to distance between the two polygons. f(*a**) can be calculated by considering the radial with the lowest sea-path proportion among those radials which originate from the point on the polygon to be protected closest to the opposite polygon, have length equal to the range *a* of the area assignment to be protected and end up within the polygon to be protected. If the distance of this point from any other point on the polygon to be protected is less than the range *a*, the length of the radial for the calculation of f(*a**) is reduced to the maximum value of this distance.

2 ILS

2.1 General

2.1.1 The band 108 - 112 MHz is used by ILS Localizer and VOR, on different channels and the ILS Glide Path is using the band 328.6 - 335.4 MHz. Within the band 108 - 112 MHz, channels on odd multiples of 100 kHz (108.10, 108.30, ...) are used for ILS. Normally channels spaced 100 kHz are used, however, in congested areas also the intermediate channels (50 kHz) may be used.

2.1.2 References to documents:

- Annex 10, Attachment C to Volume I, paragraph 2.6
  (signal ratios, localizer and glide path receiver protection requirements and distance separations);
- Annex 10, Volume I, paragraphs 3.1.3.3 and 3.1.5.3
  (localiser and glide path coverage);
- Annex 10, Volume I, paragraph 3.1.6
  (localiser and glide path frequency pairing);
- European Region Air Navigation Plan (Doc 7754), Volume I, Basic ANP, Part IV, paragraph 44
  (geographical separation criteria and channel spacing).

2.1.3 The operational service area of an ILS localizer is defined Annex 10 and often formed as a "key-hole" out to 25 NM. The ILS Glide Path has shorter range and the frequency is fixed in relation to the ILS Localizer. The adjacent channel criteria require special attention, because the localizer to glide path frequency pairing does not make sure that facilities on the adjacent localizer channel are automatically using an adjacent glide path channel and vice versa (e.g. 330.65/110.95 MHz; 330.80/110.90 MHz; 330.95/111.95 MHz). Therefore, the frequency assignment planning for localizer and glide path has to be performed separately.

2.1.4 For the co-channel case, the wanted signal must be at least 20 dB stronger than an unwanted signal. The distance from the edge of the service area of the wanted station to another ILS on the same frequency should be more than 80 NM. Another ILS on the first adjacent channel (50 kHz) should not be closer than 5 NM.

2.1.5 The co-ordination should also take into account the risk of interference from broadcasting stations in the band 87.5 - 108 MHz, due to interference caused by unwanted emissions into the aeronautical band or generated in the airborne receiver. Rules for this are available from the Recommendation ITU-R SM.1009-1 “Compatibility between the sound-broadcasting service in the band of about 87 - 108 MHz and the aeronautical services in the band 108 - 118 MHz”.

2.1.6 Co-ordination should be made with States within a radius of at least 150 NM. Co-ordination should also be made with the authority responsible for the analysis of the broadcasting versus aeronautical situation.

2.1.7 Information on the planning of identifications can be found in section 7 below.

2.2 Frequency assignment planning criteria

2.2.1 Frequencies for ILS facilities should be selected from the list at Annex 10, Volume I, 3.1.6.1 in accordance with the regional agreement permitted under Annex 10, Volume V, 4.2.2.1. Where DME is provided, the appropriate DME channel selected from Table A at Annex 10, Volume I, Chapter 3 should be used.

2.2.2 The co-channel and adjacent channel geographical separations between ILS localizers and between ILS glide path installations should be as specified in Annex 10, Volume I, Attachment C, 2.6 – for ILS localizers designed for 50 kHz channel spacing and for ILS glide paths designed for 150 kHz channel spacing.

2.2.3 The geographical separations between ILS and VOR installations where they operate on an adjacent frequency should conform to the criteria stated at Annex 10, Volume I, Attachment C, 3.5.

2.3 Required separation distances

2.3.1 Table of required ILS localizer and glide path separation distances

Equipment	Frequency Separation	Minimum separation between second facility and the service volume of the first facility (NM)
Localizer	Co-Channel	80
	50 kHz	5
Glide Path	Co-Channel	50
	150 kHz	1

<u>Note 1</u>. *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 10 NM distance and 760 m (2500 ft) height.*

<u>Note 2</u>. *States, in applying the separations shown in the table, should 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.*

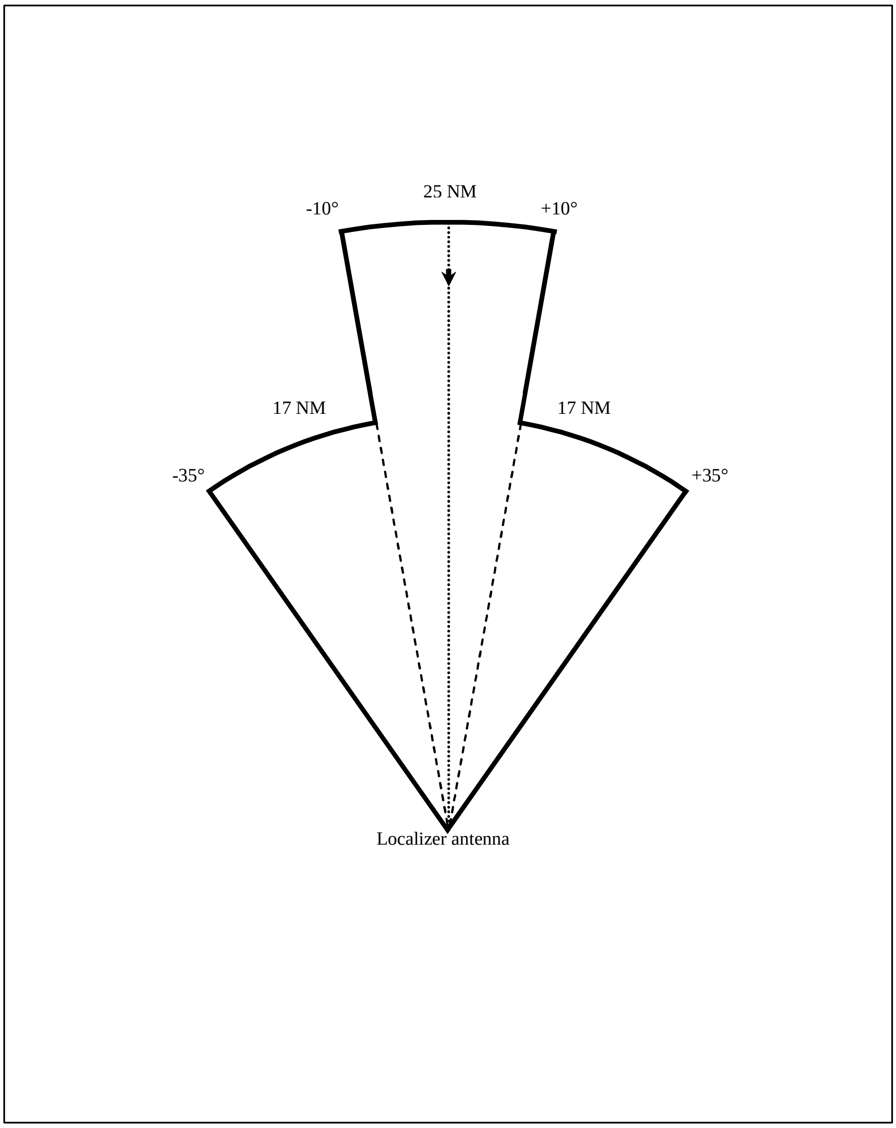
<u>Note 3</u>. *States, in applying the separations shown in the table, should recognize the necessity to site ILS glide path facilities in a manner which will preclude the possibility of erroneous glide path indications due to reception of adjacent channel signals when the desired signal ceases to radiate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

<u>Note 4</u>. *Criteria for geographical separation between ILS and VOR facilities operating in the band 108 - 112 MHz can be found in paragraph 3.5 of Attachment C to Volume I of Annex 10.*

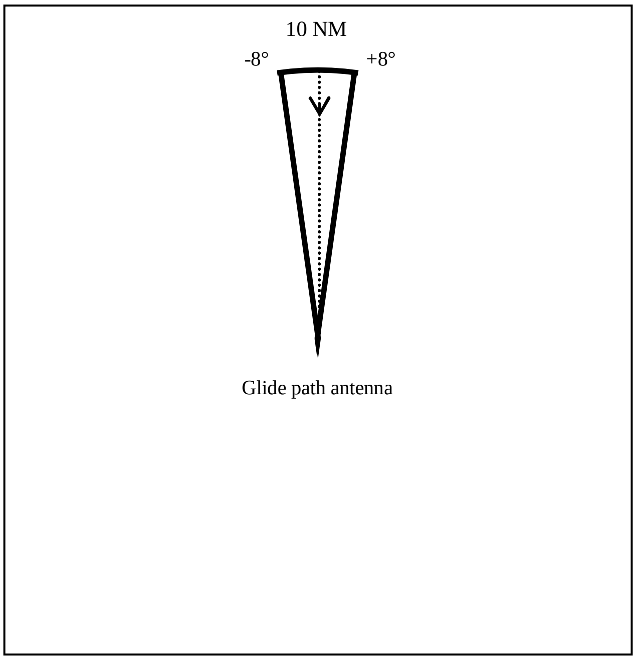
<u>Note 5</u>. *Studies have shown that for an extended glide path range of 10 to 15 NM, a separation distance of 2 NM instead of 1 NM for the adjacent channel provides adequate protection. The co-channel is automatically protected by the localizer separation distance.*

2.3.2 The horizontal extensions of the ILS localizer and glide path DOCs are shown in the figures below.

Horizontal extension of the ILS localizer DOC


25 NM
-10°
+10°
17 NM
17 NM
-35°
+35°
Localizer antenna

Horizontal extension of the ILS glide path DOC



2.3.3 The glide path co-channel minimum separation distance of 50 NM does not require any specific action, because it is indirectly and automatically provided for by the application of the localizer co-channel minimum separation distance of 80 NM.

2.3.4 The adjacent channel glide path minimum separation distance of 1 NM does not require any specific action for about half of the adjacent channels, because it is indirectly and automatically covered by the adjacent localizer channel minimum separation distance of 5 NM.

Column A of the table below lists the ILS channels. Column B lists the adjacent glide path channels that require no specific action. Column C lists the adjacent glide path channels that do require specific action (i.e. to check if the minimum required separation distance of 1 NM is respected).

A	*B*	*C*
LLZ / GP (MHz)	*adjacent GP / (LLZ) (MHz)*	*adjacent GP / (LLZ) (MHz)*
108.10 / 334.70	334.55 / (108.15)	334.85 / (110.35)
108.15 / 334.55	334.70 / (108.10)	334.40 / (110.10)
108.30 / 334.10	333.95 / (108.35)	334.25 / (110.15)
108.35 / 333.95	334.10 / (108.30)	333.80 / (109.90)
108.50 / 329.90	329.75 / (108.55)	330.05 / (110.75)
108.55 / 329.75	329.90 / (108.50)	329.60 / (110.50)
108.70 / 330.50	330.35 / (108.75)	330.65 / (110.95)
108.75 / 330.35	330.50 / (108.70)	330.20 / (110.70)
108.90 / 329.30	329.15 / (108.95)	329.45 / (110.55)
108.95 / 329.15	329.30 / (108.90)	- / (-)
109.10 / 331.40	331.25 / (109.15)	331.55 / (111.15)
109.15 / 331.25	331.40 / (109.10)	331.10 / (111.90)
109.30 / 332.00	331.85 / (109.35)	332.15 / (111.35)
109.35 / 331.85	332.00 / (109.30)	331.70 / (111.10)
109.50 / 332.60	332.45 / (109.55)	332.75 / (111.55)
109.55 / 332.45	332.60 / (109.50)	332.30 / (111.30)
109.70 / 333.20	333.05 / (109.75)	333.35 / (111.75)
109.75 / 333.05	333.20 / (109.70)	332.90 / (111.50)
109.90 / 333.80	333.65 / (109.95)	333.95 / (108.35)
109.95 / 333.65	333.80 / (109.90)	333.50 / (111.70)
110.10 / 334.40	334.25 / (110.15)	334.55 / (108.15)
110.15 / 334.25	334.40 / (110.10)	334.10 / (108.30)
110.30 / 335.00	334.85 / (110.35)	- / (-)
110.35 / 334.85	335.00 / (110.30)	334.70 / (108.10)
110.50 / 329.60	329.45 / (110.55)	329.75 / (108.55)
110.55 / 329.45	329.60 / (110.50)	329.30 / (108.90)
110.70 / 330.20	330.05 / (110.75)	330.35 / (108.75)
110.75 / 330.05	330.20 / (110.70)	329.90 / (108.50)
110.90 / 330.80	330.65 / (110.95)	330.95 / (111.95)
110.95 / 330.65	330.80 / (110.90)	330.50 / (108.70)
111.10 / 331.70	331.55 / (111.15)	331.85 / (109.35)
111.15 / 331.55	331.70 / (111.10)	331.40 / (109.10)
111.30 / 332.30	332.15 / (111.35)	332.45 / (109.55)
111.35 / 332.15	332.30 / (111.30)	332.00 / (109.30)
111.50 / 332.90	332.75 / (111.55)	333.05 / (109.75)
111.55 / 332.75	332.90 / (111.50)	332.60 / (109.50)
111.70 / 333.50	333.35 / (111.75)	333.65 / (109.95)
111.75 / 333.35	333.50 / (111.70)	333.20 / (109.70)
111.90 / 331.10	330.95 / (111.95)	331.25 / (109.15)
111.95 / 330.95	331.10 / (111.90)	330.80 / (110.90)

2.3.5 The ILS co-ordinates provided shall be those of the localizer antenna system.

2.3.6 The calculation of the required separations distances may be simplified by the following procedures (see figures below):

a) If the radiation direction (runway) is known, then the area where no **co-channel localizer** should be located may be defined as a circle with radius 92.5 NM (93 NM) around a point on the front course line 12.5 NM from the localizer antenna.

   Note: If the radiation direction (runway) is unknown, then a circle with a radius of 105 NM centred at the localizer antenna position defines the area where no co-channel localizer should be located.

b) If the radiation direction (runway) is known, then the area where no **adjacent channel localizer** should be located may be defined as a circle with radius 17.5 NM (18 NM) around a point on the front course line 12.5 NM from the localizer antenna.

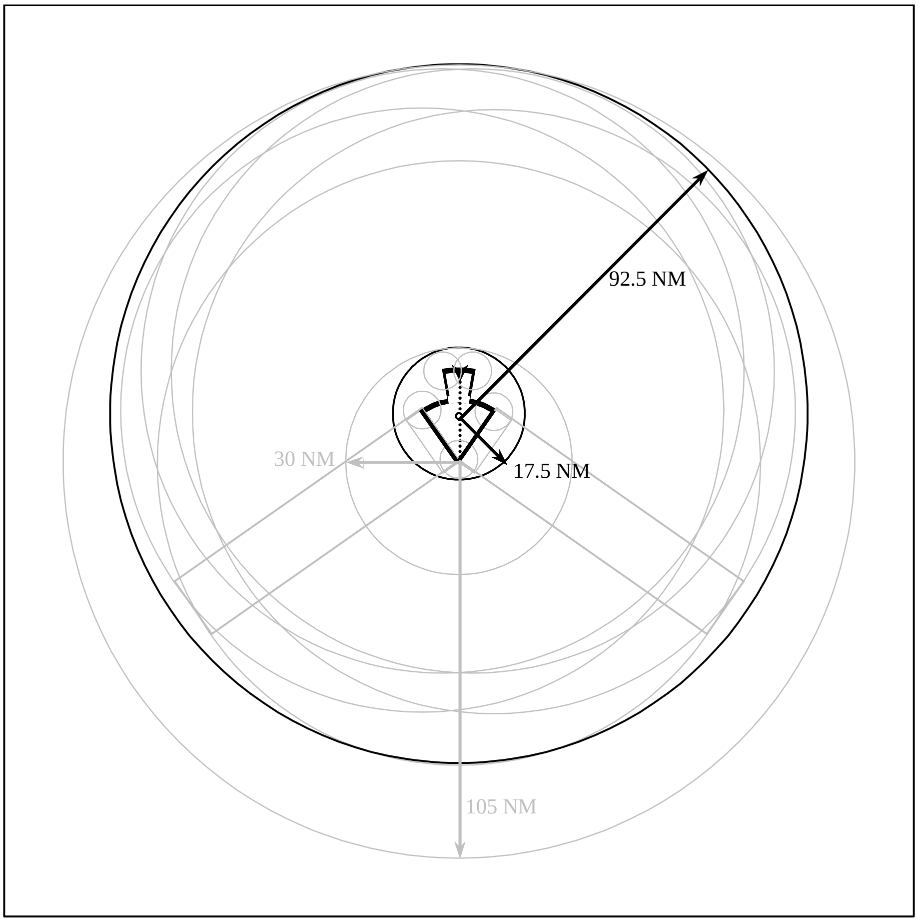
   Note: If the radiation direction (runway) is unknown, then a circle with a radius of 30 NM centred at the localizer antenna position defines the area where no adjacent channel localizer should be located.

c) If the radiation direction (runway) is known, then the area where no **adjacent channel glide path** should be located may be defined as a circle with radius 7 NM around a point on the front course line 6 NM from the localizer antenna (assuming that the distance between the two antenna systems is 2 NM).

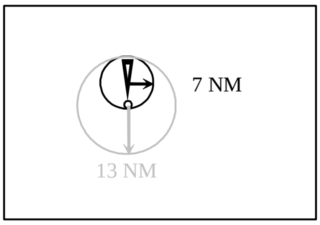
   Note: If the radiation direction (runway) is unknown, then a circle with a radius of 13 NM centred at the localizer antenna position defines the area where no adjacent channel glide path should be located.

ILS protection areas

Localizer



Glide path



3 VOR

3.1 General

3.1.1 The band 108 - 112 MHz is used by ILS Localizer and VOR, on different channels, while the band 112 - 118 MHz is used only by VOR. Within the band 108 - 112 MHz, all channels on even multiples of 100 kHz (108.20, 108.40, ...) are used for VOR. Normally channels spaced 100 kHz are used, however, in congested areas also the intermediate channels (50 kHz) may be used. The VOR channels in this sub-band are usually used for terminal VOR, with short range. Within the 112 - 118 MHz portion of the band all channels (100 and 50 kHz) are available for VOR services.

Note : *In the EUR region, for the avoidance of harmful interference, it is not permitted for a VOR facility to operate, even on a temporary basis, on a frequency allotted to ILS localizers.*

3.1.2 References to documents:

- Annex 10, Volume I, paragraphs 3.3.2
  (frequency band, channel spacing);
- Annex 10, Attachment C to Volume I, paragraphs 3.4 and 3.5
  (geographical separations);
- European Region Air Navigation Plan (Doc 7754), Volume I, Basic ANP, Part IV, paragraphs 42-44
  (geographical separation criteria, channel spacing and harmonics;
- European Region Air Navigation Plan (Doc 7754), Volume II, FASID, Part IV, paragraphs 22, 24
  (principles and criteria).

3.1.3 The DOC of a VOR can vary from 25 NM to approximately 200 NM and the protected altitude up to between 10000 feet and 60000 feet. Any unwanted signal must be at least 20 dB lower than the signal from the wanted station. Sectorization of the coverage may be used, in this case the range is different in different directions according to a system described in the EUR ANP. In this case the full circle is divided into 24 slices, each 15 degrees wide, labelled from A to X for identification. Operational coverage of each station is available from the national AIP and from Table COM 3. Both the co-channel and the first adjacent channel on each side are considered in the planning.

3.1.4 The co-ordination should also take into account the risk of interference from broadcasting stations in the band 87.5-108 MHz, due to interference caused by unwanted emissions into the aeronautical band or generated in the airborne receiver. Rules for this are available from the Recommendation ITU-R SM.1009-1 "Compatibility between the sound-broadcasting service in the band of about 87 - 108 MHz and the aeronautical services in the band 108 - 118 MHz".

3.1.5 Co-ordination should as a minimum be made with States within a radius of approximately 400 - 500 NM, and also be made with the authority responsible for the analysis of the broadcasting versus aeronautical situation.

3.1.6 Information on the planning of identifications can be found in section 7 below.

3.2 Basic principles

3.2.1 Frequencies for VOR facilities should be selected at 50 kHz points, in accordance with Annex 10, Volume I, 3.3.2.1 and Volume V, 4.2.1, 4.2.3 and 4.2.3.1. The associated DME channels should be selected from Table A of Chapter 3 of Volume I.

3.2.2 Where the designated operational range of a given frequency is not the same throughout 360°, the angular limits of sectorization in range should be indicated in accordance with the method described in Appendix A to Part III.

3.3 Frequency assignment planning criteria

3.3.1 Introduction

Note: 113.250 MHz is reserved for possible future use as a VDL Mode 4 CSC. Assignments of VOR on this frequency are not permitted until further notice.

3.3.1.1 The criteria for VOR frequency planning are based on paragraph 3.4 of Attachment C of Volume I, Annex 10.

3.3.1.2 The 1976 EUR FCB Meeting agreed that, for VOR frequency planning purposes, the attached Tables should be used in replacement of existing material, for the calculation of geographical separation between VOR in the co-channel and adjacent channel cases in the EUR Region (cf. Resolution No. 10).

3.3.1.3 These tables take into account, as appropriate:

a) The fact that 20 dB has been retained by the EUR FCB as the planned minimum D/U signal strength ratio, within the protected coverage of EUR VOR facilities;

b) The relative VOR effective radiated power, covering power ratios up to 100 (i.e. ±20 dB), so that account can be taken of VORs whose ERP varies, for example, from 200 W to 2 W;

c) The adjacent channel protection ratio corresponding to the particular ground and airborne equipment situations.

3.3.1.4 As the geographical separations have been calculated on the basis of a typical ground VOR antenna and its vertical directivity taken into account, it is only necessary in the case of VOR facilities having typical ground VOR antennas to specify the total radiated power. The pertinent characteristics of the assumed ground VOR antenna are given in 3.3.2.2 and such characteristics are typical for range calculation purposes of existing known VOR ground facilities having single dipoles located above the counterpoise and for which the elevation angle of maximum radiation is about 25 to 30 degrees.

3.3.1.5 In the case of any facilities where the vertical pattern substantially differs from that of a single dipole (i.e. where a two-element antenna may be used to enhance the lower angle radiation), the radiated power could be suitably adjusted for the angles of elevation of most interest. A factor of 3 to 4 dB would appear to be appropriate, i.e. for geographical separation purposes a VOR with a two-element antenna and having a total radiated power of 25 W would be considered as having a total radiated power of 50/65 W.

3.3.1.6 Criteria for geographical separation between ILS and VOR facilities operating in the band 108 - 112 MHz can be found in paragraph 3.5 of Attachment C to Volume I of Annex 10.

3.3.2 Desired to undesired signal ratio contours

3.3.2.1 If two VOR facilities of equal radiated power are separated in distance, it is possible to construct desired/undesired facility signal ratio contours. Figure 1 shows the contours that will be obtained when the desired facility is at 0 NM and the undesired facility at 371 km (200 NM) (i.e. a geographical separation of 200 NM). The 20 dB contour is relevant to the co-channel case, the -34 dB contour relevant to the 50 kHz adjacent channel case (9960 harmonics in conformity with Annex 10), and the -20 dB contour relevant to the 50 kHz adjacent channel case (9960 Hz harmonics not in conformity with Annex 10). For other geographical separation distances the D/U ratio contours follow a similar pattern.

3.3.2.2 Also shown on Figure 1 is a "nominal range curve". The nominal range curve shows the range and altitude at which a power density of -113 dBW/m2 will be obtained at 108 MHz for a radiated power of 100 W (20 dBW), the ground VOR facility being assumed to have a circular horizontal pattern and a vertical pattern similar to a dipole 1.22 m (4 ft) above a 16 m (52 ft) diameter counterpoise which in turn is assumed to be 4.83 m (16 ft) above ground level. Under favourable conditions (e.g. path, airborne receiver sensitivity greater than that assumed), the range obtainable may exceed the "nominal range" by a factor of 1.15 or so. This greater range approximates to the horizon range based on a true earth radius.

3.3.2.3 The following deductions can be made from Figure 1:

a) +20 dB Contour. This is applicable to the co-channel case. For the geographical separation distance of 371 km (200 NM), it would be possible to have cylindrical service volumes of 93 km (50 NM), 11278 m (37000 ft) or 139 km (75 NM), 3353 m (11000 ft). It will be noted that in the co-channel case, because of the direction of the +20 dB contour, the highest altitude to be protected is the controlling factor in determining the geographical separation distance.

b) -20 and -34 dB contours. These are applicable to adjacent channel cases. Because the direction of the slope of the contour is the opposite of the co-channel case, the lowest altitude to be protected is the controlling factor. For a given distance separation, it is only necessary to protect those altitudes above the "horizon" curve because at lower altitudes there will be insufficient signal level to reliably actuate the airborne receiver (see 3.3.2.2 above).

3.3.3 The co-channel case

3.3.3.1 The geographical separation distances, at Tables 1 to 9 inclusive, have been derived from the formulas given at 3.4.5 of Attachment C to Volume I of ICAO Annex 10 and reproduced here, for easy reference. When using geographical separation distances derived from ICAO Annex 10, particular note should be taken of 3.4.7 of Attachment C to Volume I which states that "the application of the figures will only be correct within the limitations set by those (the) assumptions. The assumptions include that the change of field strength with distance (Factor "S") at various altitudes of reception is only valid for angles of elevation at the VOR of up to about 5 degrees, but above the radio line of sight". In practice account need only be taken of this limitation for short range/high altitude facilities, where the altitude component is 15240 m (50000 ft) and above, and long range/high altitude facilities, where the altitude component is 12192 m (40000 ft) and above. Increased geographical separation distances (marked + in the tables) are recommended to assure adequate protection for the combinations specified, i.e. where the elevation angle exceeds 5 degrees. Decreased geographical separation distances (marked *) may be used for the combinations specified due to the higher rate of change of field strength (Factor "S") at or near the horizon.

Example:

Facility 1: DOC 25 NM / 10000 ft, 100 W (20 dBW) EIRP
Facility 2: DOC 100 NM / 50000 ft 400 W (26 dBW) EIRP
D/U = 20 dB
D_1 = 25 NM
D_2 = 100 NM
K = -6 dB (20 dBW - 26 dBW)
S (10000 ft) = 0.43 dB/NM (Table C-3, Attachment C to Volume I of Annex 10)
S (50000 ft) = 0.18 dB/NM (Table C-3, Attachment C to Volume I of Annex 10)
Separation distance: the greater of $2D_1$ + (D/U-K)/S or $2D_2$ + (D/U+K)/S:
2*25+(20+6)/0.43 NM= 110 NM or 2*100+(20-6)/0.18 NM = 278 NM
Required minimum separation distance = 278 NM

3.3.4 The adjacent channel case

3.3.4.1 Tables 10 and 11 give the necessary geographical separation of adjacent channel facilities for the following cases:

a) 50 kHz channel spacing, harmonic levels low (Table 10)

b) 50 kHz channel spacing, harmonic levels high (Table 11)

The undesired facility should always be outside the DOC of the desired facility.

3.3.4.2 In each table, the necessary geographical separation has been derived from the formula at 3.4.5, Attachment C to Volume I of ICAO Annex 10, in accordance with the method given in 3.3.4.3 below.

3.3.4.3 The derivation of adjacent channel geographical separation distances requires that account be taken of both the range and the lowest altitude at which the provision of the necessary desired/undesired (D/U) field strength ratio is required. The lowest altitude at which protection is to be provided is assumed to be that height corresponding to the horizon distance (based on true earth radius) for the range in question, experience having shown that this horizon distance is the normal maximum range achievable (see 3.3.2.2 and 3.3.2.3 b) above).

The horizon distance for a true earth radius is given by the formula:

$$D = \sqrt{1.13H}$$

where H is in feet, D in NM.

This formula can be re-arranged as follows :

$$H = 0.9\,D^2$$

3.3.4.4 The following Table gives for the ranges specified, values of H together with corresponding S values to be inserted in the ICAO adjacent channel geographical separation formula:

D km(NM)	H m (ft)	S (dB/NM)
46 km (25)	171 m (560)	1.0
74 km (40)	439 m (1 440)	1.0
111 km (60)	987 m (3 240)	0.65
148 km (80)	1 756 m (5 760)	0.55
185 km (100)	2 743 m (9 000)	0.44
278 km (150)	6 172 m (20 250)	0.28
333 km (180)	8 888 m (29 160)	0.23
380 km (205)	11 521 m (37 800)	0.20
426 km (230)	14 511 m (47 610)	0.18

The above values D and S have been used in the derivation of geographical separation distances based on the use of the adjacent channel geographical separation formula given at 3.4.5 of Attachment C to Volume I of ICAO Annex 10.

Example:

Facility 1: DOC 25 NM / 10000 ft, 100 W (20 dBW) EIRP
Facility 2: DOC 100 NM / 50000 ft 400 W (26 dBW) EIRP
D/U = -34 dB (Paragraph 3.4.6.1 b), Attachment C to Volume I of Annex 10)
D1 = 25 NM
D2 = 100 NM
K = -6 dB (20 dBW - 26 dBW)
S (25 NM) = 1.00 dB/NM (Paragraph 3.3.4.4)
S (100 NM) = 0.44 dB/NM (Paragraph 3.3.4.4)
Separation distance: the greater of 2D1 - (34+K)/S or 2D2 - (34-K)/S:
2*25-(34-6)/1.00 NM= 22 NM or 2*100-(34+6)/0.44 NM = 109 NM
Required minimum separation distance: 109 NM.

3.3.5 **Sectorization**

Application of the calculation methods described above may produce incorrect results if sectorization (key-holing) is used. The figure below can be used to explain the problem:

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. Its vulnerability is further enhanced by the distance from facility A which is the maximum possible within the DOC of A.

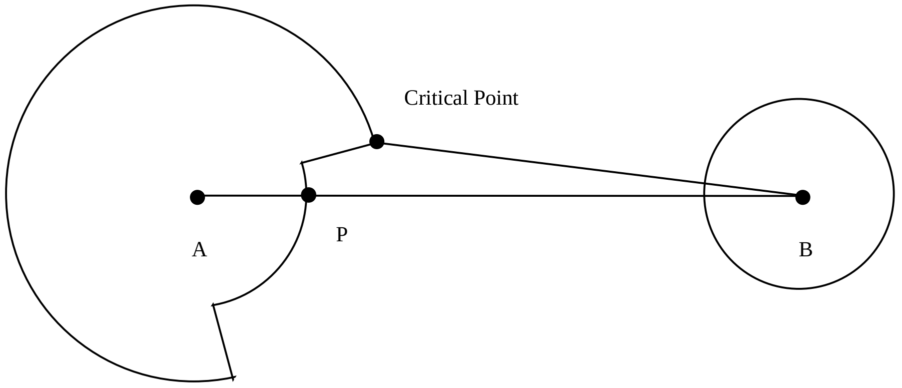
The correct assessment of compatibility for facility A requires the following calculations:

Co-channel:
Minimum separation distance between “Critical Point” and transmitter B: D1+(20-K)/S;
(this is derived from a subtraction of D1 from 2D1+(20-K)/S).

Adjacent channel:
Minimum separation distance between “ Critical Point” and transmitter B: D1-(34+K)/S;
(this is derived from a subtraction of D1 from 2D1-(34+K)/S);

where
D1 = range of facility A at the “Critical Point”.

Sectorization



Critical Point:
Point of minimum ratio between desired (A) and undesired (B) signal

VOR DESIRED/UNDESIRED SIGNAL RATIO CONTOURS
FACILITY SEPARATION 200 NM (K = 0)
Note: Curves - 6 dB and - 40 dB are not relevant for 50 kHz channel spacing

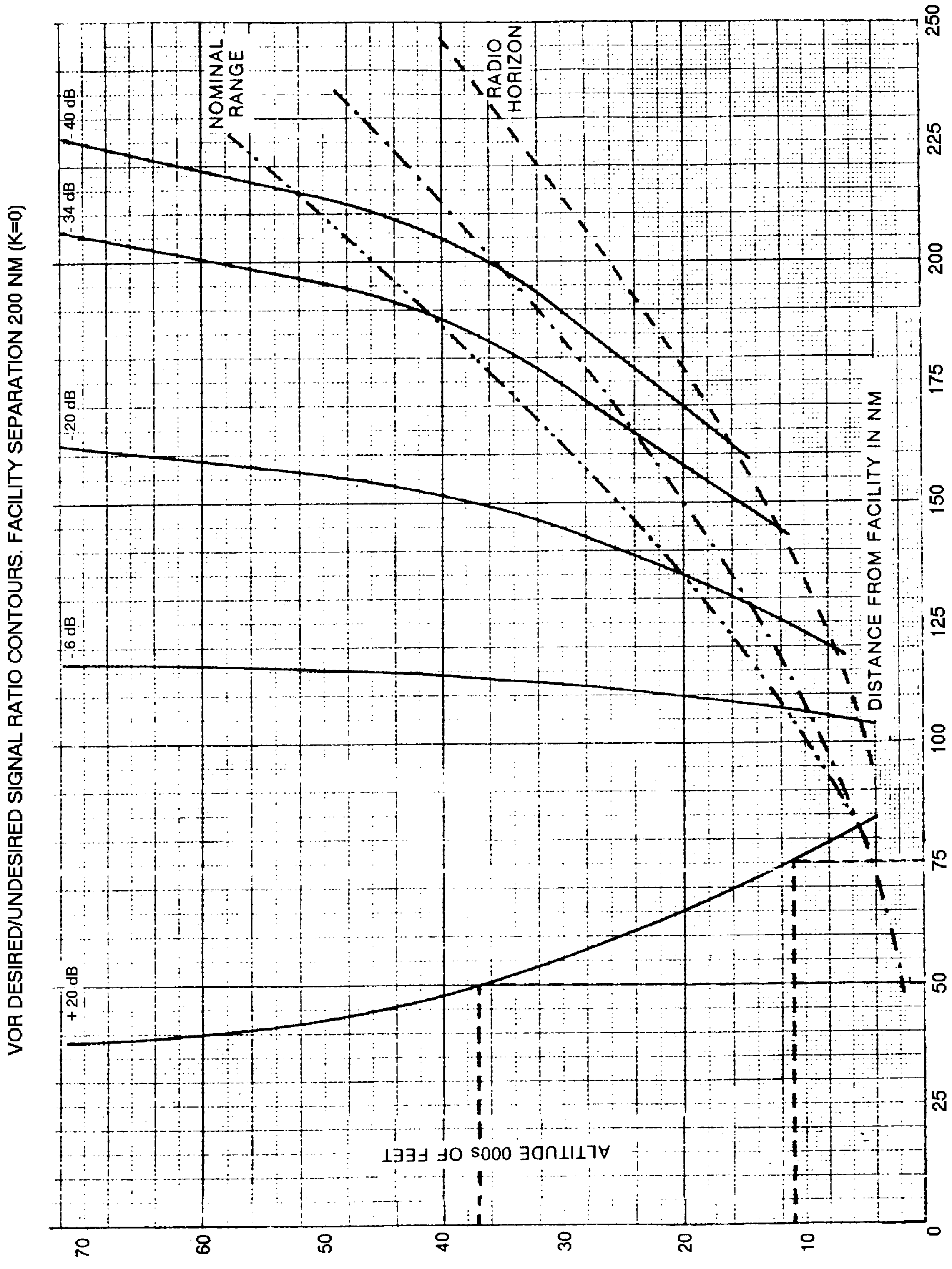


Figure 1

EUR VOR GEOGRAPHICAL SEPARATION TABLES
(For circular coverage only)

CONTENTS

Table 1

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
21,336 (70,000)	25	50	100	125	170	190 (225)+	245 (315)+	275 (345)+		27°
	40	80	130	155	200 (255)+	220 (300)+	275 (340)+	305 (365)+		15°
	60	120	170	195	240 (325)+	260 (350)+	315 (375)+	345 (390)+		11°
	80	160	210 (270)+	235 (325)+	280 (360)+	300 (380)+	355 (400)+	385 (415)+		9°
	100	200	250 (295)+	275 (350)+	320 (380)+	340 (410)+	395 (425)+	425 (435)+		6°
	150	300	350	375	420	440	495	525		3.5°
	230	460	510	535	580 (555)*	600 (560)*	655 (570)*	685 (600)*		1.3°
	280	560	610	635	680 (620)*	700 (625)*	755 (680)*	785 (725)*	Horizon	0.4°
	315	630	680	705	750	770	825	855	Radio Horizon	0°

Table 2

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
15,240 (50,000)	25	50	90	125	160	190 (205)+	220 (260)+	270 (300)+		19°
	40	80	120	155 (190)+	190 (235)+	220 (270)+	250 (320)+	300 (335)+		13°
	60	120	160 (210)+	195 (250)+	230 (290)+	260 (310)+	290 (330)+	340		9.5°
	80	160	200 (225)+	235 (275)+	270 (310)+	300 (335)+	330 (355)+	380		6°
	100	200	240	275	310	340	370	420		4°
	150	300	340	375	410	440 (420)*	470 (428)*	520 (435)*		2°
	205	410	450	485	520 (490)*	550 (495)*	580 (505)*	630 (560)*		1°
	240	480	520	555 (525)*	590 (535)*	620 (540)*	650 (600)*	700 (655)*	Horizon	0.4°
	270	540	580 (565)*	615 (570)*	650 (620)*	680 (650)*	710 (680)*	760 (730)*	Radio Horizon	0°

Table 3

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
12.592	25	50	90	125	155	190	220	260		15°
(40.000)	40	80	120	155	185	220	250	290		9°
	60	120	160	195	225	260	290	330		6°
	80	160	200	235	265	300	330	370		4.2°
	100	200	240	275	305	340	370	410		3°
	150	300	340	375	405	440	470	510		1.5°
	180	360	400	435 (425)*	465 (435)*	500 (440)*	530 (450)*	570 (485)*		0.9°
	210	420	460	495 (470)*	525 (475)*	560 (480)*	590 (535)*	630 (580)*	Horizon	0.4°
	245	490	530 (515)*	565 (520)*	595 (560)*	630 (600)*	660 (635)*	700 (680)*	Radio horizon	0°

Table 4

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
9.144	25	50	85	110	140	165	190	225		11°
(30.000)	40	80	115	140	170	195	220	235		7°
	60	120	165	180	210	235	260	275		4.5°
	80	160	205	220	250	275	300	315		3°
	100	200	245	260	290	315	340	355		2.3°
	150	300	345	360	390	415	440	455		0.9°
	165	330	375	390	420	445	470	485		0.6°
	190	380	425	440	470	495	520	535	Horizon	0.3°
	210	420	465	480	510	535	560	575	Radio Horizon	0°

Table 5

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
7,620	25	50	80	105	130	155	180	210		9°
(25,000)	40	80	110	135	160	185	210	240		6°
	60	120	150	175	200	225	250	280		3.8°
	80	160	190	215	240	265	290	320		2.5°
	100	200	230	255	280	305	330	360		1.8°
	150	300	330	355	380	405	430	460		0.6°
	170	340	370	395	420	445	470	500	Horizon	0.4°
	195	390	420	445	470	495	520	550	Radio Horizon	0°

Table 6

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
6,096	25	50	80	90	110	130	160	190		7°
(20,000)	40	80	110	123	140	160	190	220		4.5°
	60	120	150	160	180	200	230	260		3°
	80	160	190	200	220	240	270	300		2°
	100	200	230	240	260	280	310	340		1.3°
	135	270	300	310	330	350	380	410		0.6°
	155	310	340	350	370	390	420	450	Horizon	0.2°
	175	350	380	390	410	430	460	490	Radio Horizon	0°

Table 7

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
4,572	25	50	75	90	110	130	145	170		6°
(15,000)	40	80	105	120	140	160	175	200		3°
	60	120	145	160	180	200	215	240		2°
	80	160	185	200	220	240	265	280		1.3°
	100	200	225	240	260	280	305	320		0.8°
	120	240	265	280	300	320	345	360		0.5°
	140	280	305	320	340	360	385	400	Horizon	0.2°
	155	310	335	350	370	390	415	430	Radio Horizon	0°

Table 8

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
3,048	25	50	70	85	95	110	125	145		4°
(10,000)	40	80	100	115	125	140	155	175		2°
	60	120	140	155	165	180	195	215		1.3°
	80	160	180	195	210	220	235	255		0.7°
	100	200	220	235	245	260	275	295		0.4°
	115	230	250	265	275	290	305	323	Horizon	0.2°
	130	260	280	295	305	320	335	355	Radio Horizon	0°

Table 9

Desired coverage		Minimum co-channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power							Remarks	Direct ray elevation angle
Altitude m (ft)	Range NM	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB		
1,524	25	50	65	75	85	95	105	115		2°
(5,000)	40	80	95	105	115	125	135	145		1.2°
	60	120	135	145	155	165	175	185		0.5°
	75	150	165	175	185	195	205	215		0.2°
	85	170	185	195	205	215	225	235	Horizon	0.1°
	95	190	205	215	225	235	245	255	Radio Horizon	0°

Table 10

Range NM	Minimum adjacent channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power (harmonic levels low)						
	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB
25	25	25	25	25	25	28	36
40	40	40	40	45	52	57	65
60	60	60	60	67	77	86	100
80	80	80	87	97	110	120	135
100	100	100	109	125	135	150	170
150	150	150	157	180	200	220	250
180	180	180	186	210	240	265	300
205	205	205	210	240	270	300	340
230	230	230	238	270	305	340	380

Table 11

Range NM	Minimum adjacent channel geographical separation in NM to provide protection for the indicated ratios (K) of desired to undesired radiated power (harmonic levels high)						
	+20 dB	+12 dB	+6 dB	0 dB	-6 dB	-12 dB	-20 dB
25	25	25	25	30	36	42	50
40	40	48	54	60	66	72	80
60	60	70	80	90	98	108	120
80	87	102	113	125	135	145	160
100	109	127	140	155	168	182	200
150	157	185	207	230	250	272	300
180	186	220	245	273	300	325	360
205	210	250	280	310	340	370	410
230	238	282	315	350	382	415	460

4 GBAS

4.1 General

4.1.1 The GNSS ground-based augmentation system (GBAS) VHF data broadcast (VDB) frequency band is 108 to 117.975 MHz. The lowest assignable frequency is 108.025 MHz and the highest assignable frequency is 117.950 MHz – channel spacing is 25 kHz. This band is also used for ILS (below 112 MHz) and for VOR. GBAS VDB applies a time division multiple access (TDMA) technique with 8 time slots which are repeated every 0.5 seconds. The signal timing is synchronised with UTC.

Note: 113.250 MHz is reserved for possible future use as a VDL Mode 4 CSC. Assignments of GBAS on the frequencies 113.225, 113.250 and 1123.275 MHz are not permitted until further notice.

4.1.2 References to documents**:**

- Annex 10, Volume I, paragraph 3.7.3.5
  (coverage, carrier frequency, channelling, field strength);
- Annex 10, Appendix B to Volume I, paragraph 3.6.8.2.2.5-7
  (co- and adjacent channel rejection requirements);
- Annex 10, Attachment D to Volume I, paragraph 7.2.1 and 7.9
  (frequency planning, geographical separation, adjacent frequency requirements, assignment of reference path data selector and reference station data selector);
- Annex 10, Volume V, paragraph 4.2
  (use of the band 108 – 117.975 MHz).

4.1.3 The GBAS precision approach coverage is defined relative to the runway. However, it is recommended to use an omnidirectional designated operational coverage (DOC) with a range of 23 NM and up to a height of 10000 ft above threshold. The GBAS positioning service coverage is dependent upon the specific operations intended. Undesired signals from co-channel GBAS or VOR stations must be at least 26 dB below the desired GBAS signal. Adjacent channels up to ±100 kHz must be considered in the compatibility assessment.

4.1.4 The risk of interference from FM broadcasting stations in the band 87.5 – 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.

4.1.5 Co-ordination should be made with States within a radius of about 500 NM and also with the authority responsible for compatibility between FM broadcasting and aeronautical radio navigation services.

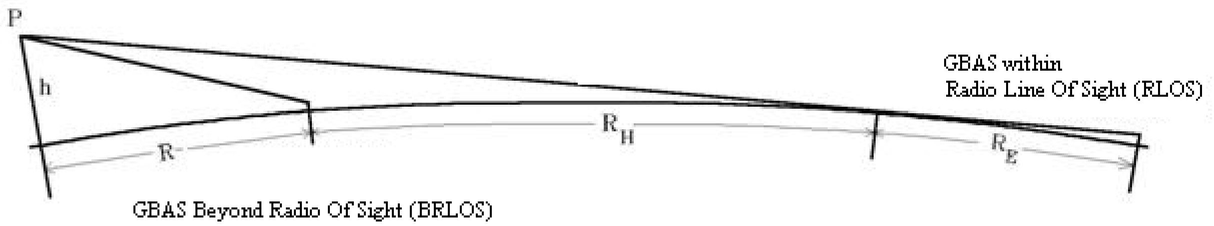
4.1.6 Besides the frequency, co-ordination must also take into account reference path data selectors and reference station data selectors (RPDS and RSDS) and time slots.

4.1.7 Information on the planning of identifications can be found in section 7 below.

4.1.8 The prerequisite for any D/U calculation to be valid is that the minimal receive power is achieved at all points throughout the coverage.

4.1.9 Beyond Radio Line Of Sight (BRLOS) attenuation for GBAS signals BRLOS is 0.72/NM dB for the first 30 NM and 0.14 dB/NM thereafter, as extracted from ITU-R Recommendation P.528-2 125 MHz, 50% curve A and C (Annex 10, Attachment D 7.2.1.3.3). The BRLOS shall be calculated using the real site elevation of the antenna phase center.

4.1.9.1



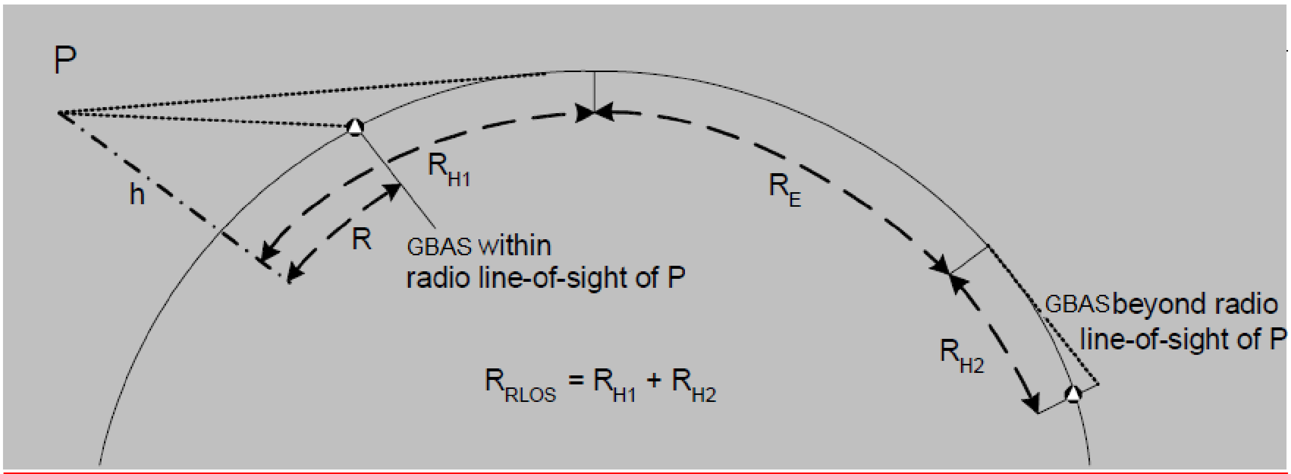
RH = 1.23 *(√ h Rx)

Where:
RH = radio horizon distance in nautical miles (NM)
h Rx = height of receiving point P (ft) above Mean Sea Level

Taking the height of the phase centre above Mean Sea Level of the GBAS antenna, the GBAS will be beyond the radio line-of-sight when:

RH > 1.23 * [(√ h Rx) + (√ h GBAS-unwanted)]

Where:
RE = distance of GBAS behind the radio horizon in NM.
h GBAS-unwanted = height of DME in (ft) above Mean Sea Level



The radio horizon distance (denoted by R_{H1} in the above figure) of a receiving point P is given by:

$$RH1 = 1.23 * \sqrt{h}$$

Where:
R_{H1} = radio horizon distance of receiving point P in nautical miles (NM)
h = height of receiving point P in feet (ft) above Mean Sea Level

The radio horizon distance of the unwanted GBAS facility (RH2) is calculated by the same formula as above:

$$RH2 = 1.23 * \sqrt{h_{GBAS\ unwanted}}$$

Where:
RH2 = radio horizon distance of unwanted GBAS facility in nautical miles (NM).
$h_{GBAS\text{-}unwanted}$ = height of GBAS antenna phase center in (ft) above Mean Sea Level

Two points are considered to be within radio line-of-sight (RLOS) if their separation distance is smaller or equal than the sum of their respective radio horizon distances.

$$R_S \leq R_{RLOS} = RH_1 + RH_2$$

Two points are considered to be beyond radio line-of-sight (BRLOS) if their separation distance is greater than the sum of their respective radio horizon distances.

$$R_S > R_{RLOS}\text{, with } R_S = RH_1 + RH_2 + R_E$$

Where:
Rs = separation distance in NM between point P and the undesired GBAS facility.
R_{RLOS} = radio line-of-sight distance in NM, given the heights of point P and the unwanted GBAS facility (= sum of radio horizon distances from height P and $h_{GBAS\text{-}unwanted}$).
R_E = propagation distance in NM covered by diffraction (= radio path distance separating point P from the GBAS facility minus R_{RLOS})

4.1.10 The EIRP of a GBAS 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!

EIRP PEP[dBW] = P Transmitter-Output [dBW] - A Cable loss [dBW] + G Antenna gain [dBi]

4.1.11 Polarization of GBAS systems for aviation purposes shall use horizontal polarization (=GBAS/H).

Note: *While, Annex 10 states that elliptical polarization is permissible, FMG/10 decided the standard polarization for GBAS in Europe to be horizontal. Therefore no D/U calculation criteria for coordination of vertical polarization (GBAS/E) are available The reasoning for allowing elliptical polarization was that a number of US military aircraft were identified that do not possess a horizontal polarized antenna. To provide, where necessary, service for these type of aircraft elliptical polarization (GBAS/E) was added to Annex 10. The VDB link budget from Annex 10, Attachment D, Table D-2 (Table 1 of this working paper) specifies the system loss for vertical polarized aircraft systems to be a 4 dB lower than for a comparable horizontally polarized aircraft system. Horizontally polarized signal have to be therefore 4 dB stronger then vertical polarized signals in order to achieve the same signal strength (e.g if the horizontal polarization transmitter has 17 dBW EIRP PEP then the vertical polarized signal requires only 13 dBW EIRP PEP).*

4.1.12 Since only horizontal polarization is assumed to be in operation in the European Region, the consideration of cross polar isolation between a purely horizontal polarized GBAS system and a vertical polarized system, like VHF-COM-CDSB will provide significantly reduced separation requirements. The temporary value for cross polarization isolation between horizontal and vertical polarization is assumed to be 10 dB (Annex 10, Attachement D, 7.2.4).

4.1.13 To allow a use of Frequency Management Programs, temporary values for calculation are given in the table below. The appropriate GBAS vertical and horizontal polarization and the respective EIRP PEP have to be available for calculation. The temporary separation requirements based on EIRP PEP, polarization and system GBAS, ILS and VHF-COM-CDSB, is provided in the table below.

GBAS/H		VHF-COM-CDSB	VDL-2	VDL-3	VDL-4	ILS	VOR	GBAS/H
h-pol	polarization	v-pol	v-pol	v-pol	v-pol	h-pol	h-pol	h-pol
25 kHz	channelization	8,33 & 25 kHz	25 kHz	25 kHz	25 kHz	50 kHz	50 kHz	25 kHz
	EIRP	air 1 dBW gnd 19 dBW				No recommend-dations for EIRP	17 dBW	17 dBW
±0 kHz co-chn		not applicable				D/U,+10dB safety margin, (x-pol.-loss-isolation) 26 +10 = 36	D/U, (x-pol.-loss-isolation) 26	D/U, (x-pol.-loss-isolation) 26
±25 kHz 1.adj.-chn.		not applicable				D/U,+6dB safety margin, (x-pol.-loss-isolation) 0 +6 = 6	D/U, (x-pol.-loss-isolation) 0	D/U, (x-pol.-loss-isolation) -18
±50 kHz 2.adj.-chn.		D/U,+6dB safety margin, (x-pol.-loss-isolation) -53 +6(-10) = -57				D/U,+6dB safety margin, (x-pol.-loss-isolation) -34 +6 = -28	D/U, (x-pol.-loss-isolation) -34	D/U, (x-pol.-loss-isolation) -43
±75 kHz 3.adj.-chn.		D/U,+6dB safety margin, (x-pol.-loss-isolation) -60 +6(-10) = -64				D/U,+6dB safety margin, (x-pol.-loss-isolation) -46 +6 = -40	D/U, (x-pol.-loss-isolation) -46	D/U, (x-pol.-loss-isolation) -46
±100 kHz 4.adj.-chn.		D/U,+6dB safety margin, (x-pol.-loss-isolation) -63+6(-10) = -67				D/U,+6dB safety margin, (x-pol.-loss-isolation) -65 +6 = -59	D/U, (x-pol.-loss-isolation) -65	no restriction
±125 kHz and beyond						no restriction	no restriction	no restriction

The table is based on the following assumptions:

- FMG/10 decided the standard polarisation of GBAS in Europe to be horisontal. Therefore no D/U calculation criteria for vertical polarisation (GBAS/E) are available.
- GBAS to have similar characteristic as VDL-M2 so that the guidance in [1] Table.11 can be applied.
- ILS criteria were taken from
- A safety margin of 10 dB was added for co-channel and 6 for adjacent channel
- Cross-polar-isolation of 10 dB(Annex 10, Attachment D, 7.2.4) .

Acronyms:

GBAS/E-h	GBAS elliptical polarization - horizontal component
GBAS/E-v	GBAS elliptical polarization - vertical component
GBAS/E	GBAS elliptical polarization
GBAS/H	GBAS horizontal polarization
adj.	adjacent channel
Chn.	channel
CDSB	Carrier Double Side Band

4.2 GBAS to GBAS frequency assignment planning criteria

For a more refined calculation considering ERIP PEP separated by polarization shall be used as provided in the planning criteria Table in 4.1.

4.2.1 The signal ratios between desired and undesired signals (D/U) to protect GBAS precision approach VDB in the presence of an other GBAS station are (Annex 10 SARPs for ±100 kHz and beyond are more conservative):

Frequency offset	*Minimum D/U ratio required*
0 kHz (co-channel)	26 dB
±25 kHz (first adjacent channel)	-18 dB
±50 kHz (second adjacent channel)	-43 dB
±75 kHz (third adjacent channel)	-46 dB
±100 kHz and beyond	planning freedom

<u>Note</u>: *Criteria to achieve compatibility via time slot co-ordination are not presented here.*

4.2.2 Appendix B to Part III describes the calculation for the determination of the required geographical separation distance. The example separation distances indicated in the table below were the result of calculations assuming a GBAS VDB field strength of 215 µV/m (-99 dBW/m^2) corresponding to the minimum required field strength at the edge of coverage for the desired facility and of different radiated powers as indicated for the undesired facility, a constant attenuation factor of 0,72 dB/NM for the first 30 NM and 0,14 dB/NM thereafter for beyond radio line-of-sight, a GBAS VDB antenna height of 0 ft (phase centre) and a DOC of 23 NM/10000 ft. Signal polarization was assumed to be horizontal:

Desired facility: GBAS station (DOC 23 NM /10000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance between stations for different radiated powers (EIRP) of the undesired GBAS station*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	194 NM	198 NM	200 NM
±25 kHz (first adjacent channel)	35 NM	38 NM	40 NM
±50 kHz (second adjacent channel)	24 NM	24 NM	24 NM
±75 kHz (third adjacent channel)	23 NM	24 NM	24 NM
±100 kHz and beyond	no restrictions		

4.3 GBAS to VOR frequency assignment planning criteria

4.3.1 For a more refined calculation considering ERIP PEP separated by polarization shall be used as provided in the planning criteria Table in 4.1.

4.3.2 The signal ratios between desired and undesired signals (D/U) to protect GBAS receivers in the presence of a VOR signal and VOR receivers in the presence of a GBAS signal (Annex 10 SARPs and guidance material for ±100 kHz and beyond are not identical for GBAS – VOR and VOR – GBAS desired to undesired situations and they are more conservative if VOR is the undesired facility):

Frequency offset	*Minimum D/U ratio required*
0 kHz (co-channel)	26 dB
±25 kHz (first adjacent channel)	0 dB
±50 kHz (second adjacent channel)	-34 dB
±75 kHz (third adjacent channel)	-46 dB
±100 kHz (fourth adjacent channel)	-65 dB
±125 kHz and beyond	planning freedom

4.3.3 Appendix B to Part III describes the calculation for the determination of the required geographical separation distance. The example separation distances indicated in the tables below were calculated assuming a VOR field strength of 90 µV/m (-107 dBW/m^2), corresponding to the minimum required field strength at the edge of coverage for the desired facility, a VOR DOC as indicated in the tables, a constant attenuation factor of 0.72 dB/NM for the first 30 NM and 0,14 dB/NM thereafter for beyond radio line-of-sight, a GBAS VDB and a VOR antenna height of 0 ft. GBAS signal polarization was assumed to be horizontal:

Desired facility: VOR (DOC 25 NM / 15000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance between stations for different radiated GBAS VDB powers (EIRP) of the undesired station*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	236 NM	240 NM	242 NM
±25 kHz (first adjacent channel)	184 NM	188 NM	190 NM
±50 kHz (second adjacent channel)	30 NM	31 NM	32 NM
±75 kHz (third adjacent channel)	26 NM	27 NM	27 NM
±100 kHz (fourth adjacent channel)	25 NM	25 NM	25 NM
±125 kHz and beyond	no restrictions		

Desired facility: VOR (DOC 40 NM / 20000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance between stations for different radiated GBAS VDB powers (EIRP) of the undesired station*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	272 NM	276 NM	278 NM
±25 kHz (first adjacent channel)	220 NM	224 NM	226 NM
±50 kHz (second adjacent channel)	45 NM	46 NM	47 NM
±75 kHz (third adjacent channel)	41 NM	42 NM	42 NM
±100 kHz (fourth adjacent channel)	40 NM	40 NM	40 NM
±125 kHz and beyond	no restrictions		

Desired facility: VOR (DOC 50 NM / 25000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance between stations for different radiated GBAS VDB powers (EIRP) of the undesired station*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	300 NM	304 NM	306 NM
±25 kHz (first adjacent channel)	248 NM	252 NM	254 NM
±50 kHz (second adjacent channel)	55 NM	56 NM	57 NM
±75 kHz (third adjacent channel)	51 NM	52 NM	52 NM
±100 kHz (fourth adjacent channel)	50 NM	50 NM	50 NM
±125 kHz and beyond	no restrictions		

Desired facility: VOR (DOC 60 NM / 30000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance between stations for different radiated GBAS VDB powers (EIRP) of the undesired station*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	327 NM	331 NM	333 NM
±25 kHz (first adjacent channel)	275 NM	279 NM	281 NM
±50 kHz (second adjacent channel)	65 NM	66 NM	67 NM
±75 kHz (third adjacent channel)	61 NM	62 NM	62 NM
±100 kHz (fourth adjacent channel)	60 NM	60 NM	60 NM
±125 kHz and beyond	no restrictions		

Desired facility: VOR (DOC 70 NM / 40000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance between stations for different radiated GBAS VDB powers (EIRP) of the undesired station*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	368 NM	372 NM	374 NM
±25 kHz (first adjacent channel)	316 NM	320 NM	322 NM
±50 kHz (second adjacent channel)	75 NM	76 NM	77 NM
±75 kHz (third adjacent channel)	71 NM	72 NM	72 NM
±100 kHz (fourth adjacent channel)	70 NM	70 NM	70 NM
±125 kHz and beyond	no restrictions		

Desired facility: VOR (80 NM / 50000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance between stations for different radiated GBAS VDB powers (EIRP) of the undesired station*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	405 NM	409 NM	411 NM
±25 kHz (first adjacent channel)	353 NM	357 NM	359 NM
±50 kHz (second adjacent channel)	85 NM	86 NM	87 NM
±75 kHz (third adjacent channel)	81 NM	82 NM	82 NM
±100 kHz (fourth adjacent channel)	80 NM	80 NM	80 NM
±125 kHz and beyond	no restrictions		

Desired facility: VOR (100 NM / 50000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance for different radiated GBAS VDB powers (EIRP)*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	425 NM	429 NM	431 NM
±25 kHz (first adjacent channel)	373 NM	377 NM	379 NM
±50 kHz (second adjacent channel)	105 NM	106 NM	107 NM
±75 kHz (third adjacent channel)	101 NM	102 NM	102 NM
±100 kHz (fourth adjacent channel)	100 NM	100 NM	100 NM
±125 kHz and beyond	no restrictions		

Desired facility: VOR (150 NM / 50000 ft)			
Undesired facility: GBAS station			
Frequency offset	*Minimum required geographical separation distance for different radiated GBAS VDB powers (EIRP)*		
	50 W 47 dBm 17 dBW	*80 W 49 dBm 19 dBW*	*100 W 50 dBm 20 dBW*
0 kHz (co-channel)	475 NM	479 NM	481 NM
±25 kHz (first adjacent channel)	423 NM	427 NM	429 NM
±50 kHz (second adjacent channel)	155 NM	156 NM	157 NM
±75 kHz (third adjacent channel)	151 NM	152 NM	152 NM
±100 kHz (fourth adjacent channel)	150 NM	150 NM	150 NM
±125 kHz and beyond	no restrictions		

4.4 GBAS to ILS and ILS to GBAS frequency assignment planning criteria

4.4.1 For a more refined calculation considering ERIP PEP separated by polarization shall be used as provided in the planning criteria Table in 4.1. In absence of relevant Annex 10 material the following temporary criteria are provided, to allow use of of existing Frequency Management Programs (FEMP), which need D/U criteria as input values.

4.4.2 Results obtained by such programs are therefore to be used only with extreme caution and require additional validation. The required receive power density has to be provided at any point throughout the coverage.

4.4.3 The signal ratios between desired and undesired signals (D/U) to protect GBAS receivers in the presence of a ILS signal and ILS receivers in the presence of a GBAS signal (Annex 10 SARPs and guidance material for ±100 kHz and beyond are derived by adding 10 dB safety margin for co-channel and 6 dB safety margin for adjacent channel to the existing GBAS - VOR and VOR – GBAS criteria.

- The values separated by polarization are contained in the planning criteria Table in 4.1.

Frequency offset	co-chn.	±25 kHz (first adjacent channel)	±50 kHz (second adjacent channel)	±75 kHz (third adjacent channel)	±100 kHz (fourth adjacent channel)	±125 kHz and beyond
GBAS vs. ILS	36 dB	6 dB	-28 dB	-40 dB	-59 dB	-59 dB
ILS vs. GBAS	36 dB	6 dB	-28 dB	-40 dB	-59 dB	-59 dB

Table 1

4.5 GBAS to VHF communications frequency assignment planning criteria

4.5.1 For a more refined calculation considering ERIP PEP separated by polarization shall be used as provided in the planning criteria Table in 4.1.

4.5.2 In absence of relevant Annex 10 material the following temporary criteria are provided, to allow use of of existing Frequency Management Programs (FEMP), which need D/U criteria as input values.

4.5.3 Results obtained by such programs are therefore to be used only with extreme caution and require additional validation. The required receive power density has to be provided at any point throughout the coverage.

4.5.4 The signal ratios between desired and undesired signals (D/U) to protect GBAS receivers in the presence of a VHF-COM-CDSB signal and VHF-COM-CDSB receivers in the presence of a GBAS signal and beyond are derived by adding 10 dB safety margin for co-channel and 6 dB safety margin for adjacent channel to the Draft of VHF-COM-CDSB to VDL-M.2 (= GBAS) criteria.

- The values separated by polarization are contained in the planning criteria Table in 4.1.

4.6 GBAS data selector and time slot planning criteria

4.6.1 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.

4.6.2 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.

4.7 Special provisions

4.7.1 The provisions below apply as long as ICAO Annex 10 GBAS frequency assignment criteria have not been completed:

- frequency assignments for GBAS VDB services should only be made on a temporary basis and may have to be revised after 31 December 20112019;
- frequencies should be selected from the frequency range of 112.050 – 116.400 MHz (frequencies above 116.400 MHz may be used if the necessary calculation using the D/U criteria from table in 4.1. have indicated sufficient protection). Local ILS and VHF COM frequency assignments shall be taken into account aiming at a maximum protection for ILS and VHF-COM-CDSB;
- VDB signal polarization is to be taken into account for both possible polarizations separately, but is assumed to be horizontal;
- radiated peak power of the GBAS VDB signals should be as low as practicable;
- GBAS VDB systems with multiple antennas which are separated more than 1 NM must be considered individually; and
- VDB time slot and data selector ~~assignments~~ shall be co-ordinated.

4.7.2 Proposals for co-ordination of GBAS assignments must include at a minimum

- ITU Country Code;
- Location name and co-ordinates;
- Frequency;
- Equipment (i.e. GBAS/H or GBAS/E);
- Identification;
- DOC (23 NM / 10000 ft is recommended);
- Peak radiated power EIRP PEP in W for horizontal polarization;
- Peak radiated power EIRP PEP in W for vertical polarization;
- antenna elevation above MSL of the phase center of the antenna;
- Time slot in operation.

5 DME

5.1 General

5.1.1 The band 960 - 1215 MHz is allocated, though not exclusively, to the aeronautical radio navigation service and used mainly by the DME system. Within this band, two segments, around 1030 MHz and 1090 MHz, are reserved for SSR. Furthermore, some military systems make use of this band, e.g. TACAN (essentially a DME with additional pulses for bearing information) and data/voice systems employing frequency hopping techniques. Part 960-1164 MHz of the band is also allocated to the aeronautical mobile (route) service, for use by next generation aeronautical communication systems.

Note: In order to support compatibility between DME/TACAN assignments and GNSS L5/E5 aeronautical receivers, States are encouraged to apply the recommendations contained in section D of the Supplement to EUR Doc011 when planning new DME/TACAN assignments.

5.1.2 References to documents:

- Annex 10, Volume I, paragraphs 3.5.3.3, 3.5.5.3.4.1
  (channelling, interference rejection);
- Annex 10, Volume V, paragraph 4.3
  (channel groups, pairing);
- Annex 10, Attachment C to Volume I, paragraphs 7.1.7 - 7.1.10
  (signal ratios, pulse coding, adjacent channels, etc.);
- European Region Air Navigation Plan (Doc 7754), Volume I, Basic ANP, Part IV, paragraphs 42, 44
  (principles and criteria);
- European Region Air Navigation Plan (Doc 7754), Volume II, FASID, Part IV, paragraph 22
  (principles and criteria).

5.1.3 DME is in many cases co-located and frequency paired (Annex 10, Volume I, chapter 3, Table A) with another facility (VOR, ILS, MLS) and normally has the same protected range. The protection also takes into account the pulse coding and output power. Both the first and second adjacent channels are considered.

5.1.4 Co-ordination should follow the rules for the co-located equipment; for a stand-alone DME co-ordination should at least include States within a radius of 400 - 500 NM.

5.1.5 Information on the planning of identifications can be found in section 7 below.

5.2 Frequency assignment planning criteria

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 because it is not used in EUR Region.*

5.2.1 Protection requirements

5.2.1.1 The necessary desired to undesired (D/U) signal ratios are needed to protect the desired transponder reply signals at the airborne receiver from the various co-frequency/adjacent-frequency, same pulse code/different pulse code, undesired transponder reply signal combinations that may exist.

5.2.1.2 In making an assignment, each facility must be treated as the desired source with the other acting as the undesired source. If both satisfy their individual D/U requirements, then the assignment can be made.

5.2.1.3 The channelling arrangement for DME, when considering X and Y channels only, is such that in the ground-to-air direction (transponder reply frequency) no use is made of multiplexing techniques on the same frequency, thus avoiding the situation where different pulse codings on the same or adjacent frequencies have to be studied when making frequency assignments. However, when assign4ments on DME W or Z channels have to be made, these assignments have to be checked against interference from DME X or Y channels and vice-versa.

5.2.1.4 *Co-frequency[1] protection ratios (D/U)*

The co-frequency protection ratios (D/U) are:

Same pulse code:	8 dB	
Different pulse code:	8 dB	(column A of Table C-4, Attachment C to Annex 10, Volume I).

Geographical separation distances are based upon the required D/U ratio, taking into consideration the EIRP of both the desired and the undesired DME and the appropriate propagation characteristics.

5.2.1.5 *Adjacent frequency protection ratios (D/U)*

The following values are assumed for the adjacent-channel emissions of the transponder:

200 mW (-7 dBW) on the first adjacent frequency
2 mW (-27 dBW) on the second adjacent frequency.

The minimum required D/U ratio within the operational service volume shall be in accordance with the values given in Table C-4, Attachment C to Annex 10, Volume I.

5.2.1.6 *Designated Operational Coverage (DOC)*

5.2.1.6.1 When the DME is associated with a VOR or an ILS the coverage should be at least that of the VOR or ILS to the extent practicable.

5.2.1.6.2 When the DME is associated with an MLS, the coverage should be omnidirectional up to the operational range of the MLS approach azimuth facility. The protected height of the DME should be the same as for the MLS approach azimuth sector.

5.2.1.6.3 Where the designated operational range of a given DME facility is not the same throughout 360°, the angular limits of sectorization in range should be indicated in accordance with the method described in Appendix A to Part III.

5.2.1.6.4 The DOC for a DME with directional antenna should be specified on the basis of the particular operational requirements. The orientation of the DOC should be defined relative to the true (i.e. with respect to the true north – not the magnetic one) radiation direction (TRD) of the facility. When defining the DOC for a DME with directional antenna, the antenna characteristics of the DME facility need to be taken into account in order to ensure that throughout the DOC the available signal level will not be lower than the minimum signal level to be protected (-89 Dbw/m²).

5.2.1.7 *Calculation of EIRP*

5.2.1.7.1 The EIRP (in dBW) in any particular direction α can be calculated by means of the general formula:

[1] Co-frequency and adjacent frequency are referred to the transponder reply frequency.

$EIRP(\alpha) = EIRP_{max} + G_{Antenna,\ rel}(\alpha)$,

where

$EIRP_{max} = P_{Transmitter\ Output} - A_{Line} + G_{Antenna,\ max}$.

$P_{Transmitter\ Output}$ is the output power of the transmitter in dBW, A_{Line} is the attenuation of the transmission line in dB and $G_{Antenna,\ max}$ is the antenna gain in the main beam direction in dBi (with respect to an isotropic antenna) at the given frequency. Furthermore, $G_{Antenna,\ rel}(\alpha)$ denotes the normalised antenna gain in dB relative to $G_{Antenna,\ max}$, at the given vector direction α. In the case of DME, EIRP and $P_{Transmitter\ Output}$ are meant as PEP (Peak Envelope Power) values.

Note: $G_{Antenna,\ rel}$ is always less than or equal to 0 dB. For an omnidirectional antenna, the normalized gain $G_{Antenna,\ rel}$ is taken equal to 0 dB.

5.2.1.7.2 The value of the foreseen $EIRP_{max}$ shall be provided with the frequency co-ordination request. It is calculated as above, where $P_{Transmitter\ Output}$ should be sufficient to produce adequate power flux density throughout the DOC.

5.2.1.7.3 Typical $EIRP_{max}$ values per category of facility are given below as guidance, based on standard transmitter output power, feeder line losses and antenna gain:

Landing DME:	27 dBW, Omnidirectional
	29 dBW, Directional
En-route DME:	37 dBW
TACAN:	40 dBW.

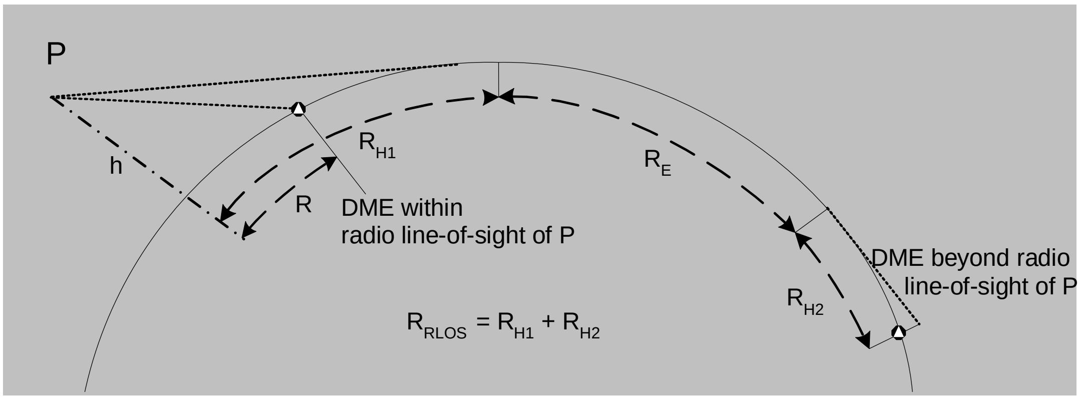
5.2.1.7.4 For the sake of spectrum economy, it is highly recommended that technical measures be taken so that the $EIRP_{max}$ of landing DME with directional antenna does not exceed 29 dBW, despite the high gain provided by the beacon antenna.

5.2.2 ***Propagation model***

5.2.2.1 *Propagation characteristics*

5.2.2.1.1 The same propagation conditions along the path of the desired and the undesired signals are assumed. Within the radio line-of-sight, free space attenuation is assumed. Beyond the radio line-of-sight, propagation is approximated by an attenuation rate of 1.6 dB/NM. This is derived from the propagation 1200 MHz/50% time curve in Rec. ITU-R P.528-2 (former CCIR Rec. 528-1). For radio propagation and radio horizon calculations a smooth Earth is assumed with an effective 4/3 Earth radius.

Within and beyond the radio line-of-sight situations are depicted below. Two points are considered to be within radio line-of-sight if their separation distance is smaller than the sum of their respective radio distances.



5.2.2.1.2 Calculation of the radio horizon distance:

The radio horizon distance of a point P is given by:

$$R_H = 1.23 * \sqrt{h}$$

where

R_H = radio horizon distance in nautical miles (NM)

h = height of point P in feet (ft)

For the calculation of the radio horizon distance of a receiving point to be protected (denoted by R_{H1} in the above figure), the above formula is applied with *h* being the altitude in feet.

The radio horizon distance of the DME facility (denoted by R_{H2} in the above figure) is calculated by the same formula as above. In general, the height of the phase centre of the facility's antenna above ground level should be taken for the calculation of the facility's radio horizon.

If a facility's antenna height is not provided it will be assumed equal to 30 feet.

5.2.2.1.3 When radio line-of-sight conditions exist between the DME and the protection point P, the following formula may be used to calculate the power flux density at point P as:

$$P_d = EIRP - 20 \log R - 76.3 \qquad (1a)$$

where

P_d = power flux density in dBW/m^2

EIRP = effective isotropically radiated power in dBW

R = distance of point P to DME in NM

5.2.2.1.4 For distances between a DME facility and a receiving point P greater than the sum of their respective radio horizon distances, the following formula may be used instead:

$$P_d = EIRP - 20 \log R_{\cancel{H}RLOS} - 1.6*R_E - 76.3, \qquad (1b)$$

where

R_{RLOS} = sum of the radio horizon distances of point P and the DME facility
= maximum radio line-of-sight distance, given the heights of point P and the DME facility

R_E = propagation distance in NM covered by diffraction (see above figure)
= radio path distance separating point P from the DME facility minus R_{RLOS}

5.2.2.2 *Additional means of calculation*

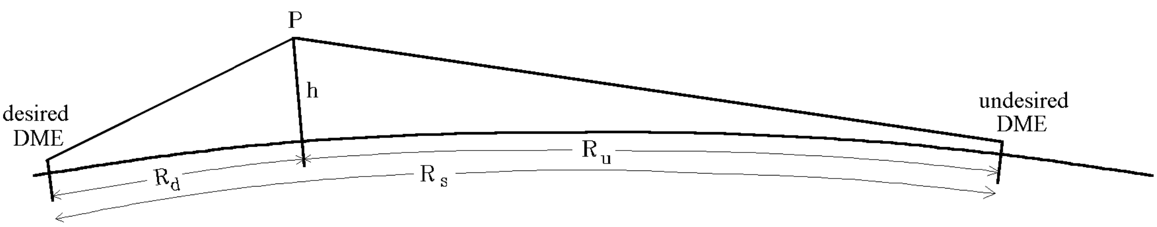
As a means of improving the efficiency of spectrum utilization, in particular in frequency congested areas, compatibility of assignments could also be assessed on a bilateral basis using more realistic propagation models taking into account other signal attenuation elements such as terrain which can affect signal propagation significantly.

5.2.3 ***Calculation of minimum required separation distances***

The conditions for the satisfactory operation of DME are expressed in terms of the protection ratio (D/U) in dB, which is equal to the difference in power flux densities of the desired and undesired DME facilities at the protection point P. The minimum acceptable value of D/U is used to calculate the minimum required separation distance between two DME facilities. In calculating separation distances, the conditions of paragraph 5.2.1 above shall be met. The table at the end of chapter 5 contains the co-frequency, different pulse code, and adjacent frequency, same and different pulse code, DME channels to consider when an assignment on a particular DME channel is proposed.

5.2.3.1 *Co-frequency; desired and undesired DME facilities having the same pulse code.*

5.2.3.1.1 Undesired DME facility within the radio line-of-sight



Application of formula (1a) to the desired and undesired DME as appropriate, results in:

$$D/U = K + 20 \log (R_u/R_d) \qquad (2a)$$

where

D/U = protection ratio in dB (minimum 8 dB)

K = EIRP of the desired minus the EIRP of the undesired facility in dBW

R_u = distance between the edge of the DOC of the desired facility and the undesired facility in NM

R_d = operational range of desired facility in NM

Thus for the required separation distance $R_s$it is obtained

$$R_s = R_d + R_u = R_d (1 + 10^{[(D/U - K) / 20]}), \text{ or} \qquad (2b)$$

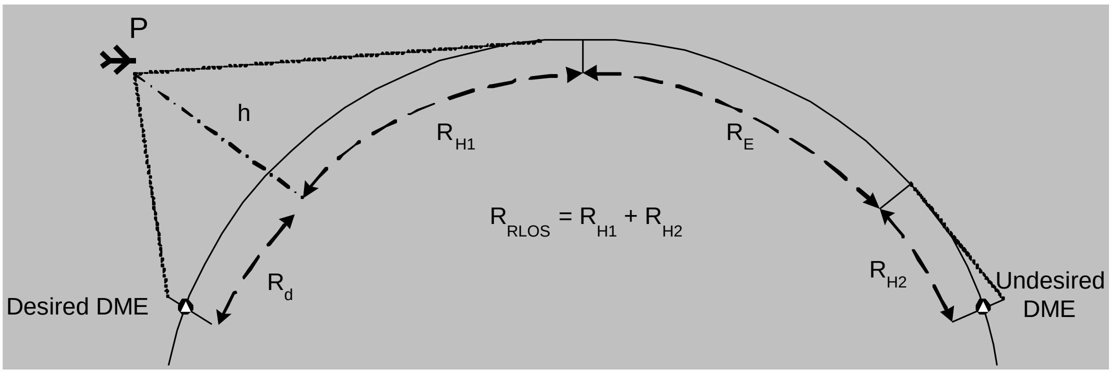
$$R_s = R_d + 10^{T / 20}.$$

where

R_s = required separation distance between the desired and undesired facilities in NM and

T = D/U - K + 20 log R_d.

5.2.3.1.2 Undesired DME facility beyond the radio line-of-sight



Application of formula (1a) to the desired DME and of (1b) to the undesired DME leads to:

$$D/U = K + 20 \log (R_{RLOS}/R_d) + 1.6 R_E \qquad (3a)$$

This can be expressed as the required separation distance R_s:

$$R_s = R_d + R_{HRLOS} + [T - 20 \log R_{RLOS}]/ 1.6 \qquad (3b)$$

The numerical examples below are valid only for omnidirectional DME (the facilities antenna heights are assumed equal to 30ft above ground level):

a) DME(1) coverage: 23 NM, 10 000 ft; EIRP = 27 dBW
DME(2) coverage: 23 NM, 10 000 ft; EIRP = 27 dBW

Since the two services have identical characteristics, one check is sufficient. For a D/U ratio of 8 dB, no EIRP difference: K=0 and thus T = 8 - 0 + 20 log (23) = 35.23; therefore $10^{T/20}$=58NM. The R_{RLOS} is equal to $1.23*(\sqrt{10000}+\sqrt{30})$=130NM >58NM. Hence the undesired facility and a receiving point at the edge of the service area of the desired facility can be within radio line of sight, the minimum separation distance between facilities being equal to $R_d + 10^{T/20} = 23 + 58 = 81$NM.

b) DME(1) coverage: 25 NM, 10 000 ft; EIRP = 27 dBW
DME(2) coverage: 120 NM, 40 000 ft; EIRP = 40 dBW

D/U = 8 dB.

i) separation distance to protect DME(1):

$T = 8 - (27-40) + 20 \log (25) = 49,\ 10^{T/20}= 281$ NM.

$R_{RLOS} =1.23*(\sqrt{10000}+\sqrt{30})$=130 NM.
Since $10^{T/20} > R_{RLOS}$, DME(2) should be located beyond the radio line of sight of a receiving point at the edge of the service area of DME(1).
Hence the minimum separation distance between facilities to protect DME(1) should be calculated with formula (3b): $R_s= R_d+R_{RLOS}+[T-20 \log R_{RLOS}]/1.6 = 25 +130 + 4 = 159$NM.

ii) separation distance to protect DME(2):

$T = 8 - (40-27) + 20 \log (120) = 36.6,\ 10^{T/20}= 68$NM.

$R_{RLOS} =1.23*(\sqrt{40000}+\sqrt{30})$=253 NM.

Now $10^{T/20} < R_{RLOS}$, with the result that DME(1) can be within radio line of sight of a receiving point at the edge of the service area of DME(2), the minimum separation distance between facilities to protect DME(2) being equal to $R_s = R_d + 10^{T/20} = 120 + 68 = 188$ NM.

To assure protection to both facilities, the required separation distance between these facilities should be at least 188 NM.

5.2.3.2 *Co-frequency; desired and undesired DME facility having different pulse codes*

Since the required protection is provided at the airborne DME receiver, different pulse coding protection is only required when a DME X channel is interfered with a DME W channel (or DME Y versus DME Z) or vice versa (see also paragraph 5.2.1.3). The separation distances can be calculated along the same principles as indicated in paragraph 5.2.3.1. The protection ratio is 8 dB (see paragraph. 5.2.1.4).

5.2.3.3 *Adjacent channel separation distances*

5.2.3.3.1 First adjacent frequency

The minimum separation distance between DMEs operating on first-adjacent channels shall be 65 NM between beacons or 5NM from the DOC-edge of the desired beacon, whichever gives the lesser distance between beacons.

Notes:

1 *The above criteria ensure that the D/U ratio within the operational service volume does not fall below the values given in Table C-4, Attachment C to Annex 10, Volume I.*

2. *Since calculations for a DME/P show that all separation distances derived for the Initial Approach (IA) mode (-89 dBW/m^2 at 23 NM) are larger than for the Final Approach (FA) mode (-75 dBW/m^2 at 7 NM), it is sufficient to consider only the IA mode protection.*

5.2.3.3.2 Second adjacent frequency

The second adjacent frequency separation distances are almost insignificant. However it is recommended that second adjacent frequency assignments on the same aerodrome should be avoided. For practical planning purposes, a minimum required separation distance between the facilities of 10 NM may be used.

5.2.3.4 *Separation requirement for DME frequencies which are separated by 63 MHz*

Annex 10, Attachment C to Volume I, paragraph 7.1.9 indicates that "assignment of an Y or Z channel whose reply frequency is 63 MHz from the reply frequency of another channel (either W, X, Y, Z) or vice versa requires a separation distance of at least 28 km (15 NM) between facilities" (Annex 10, Attachment C to Volume I, paragraph 3.4.9 gives a less conservative minimum separation distance of 10 NM).

This requirement is to prevent desensitization that may occur to the transponder that is receiving on the same frequency the other transponder is transmitting, irrespective of the pulse code.

For example:

	downlink	uplink		downlink	uplink
18X(W)	1042	979	81X(W)	1105	1168

18Y(Z)	1042	1105	81Y(Z)	1105	1042

Channel 18Y(Z), transmitting on 1105 MHz may cause interference to the transponder receiver operating on channels 81X(W) or 81Y(Z). Similarly, channel 81Y(Z) may interfere with channels 18X(W) and 18Y(Z).

5.2.3.5 *Sectorization*

The material of paragraph 3.3.5 (VOR) on sectorization is also applicable for DME. However, the calculation of the separations distance must be adapted as indicated below:

The correct assessment of compatibility for facility A requires the following calculations:

Co-channel:

Minimum separation distance between "Critical Point" and transmitter B:

$R_s = R_d*10^{[(D/U-K)/20]}$ if undesired facility within radio line-of-sight; or

$R_s = R_H+[D/U-K-20 \log (R_H/R_d)]/1.6$ if undesired facility beyond radio line-of-sight;

(this is derived from a subtraction of Rd from $R_s = R_d (1 + 10^{[(D/U-K)/20]})$ and from $R_d+R_H+[D/U-K-20 \log (R_H/R_d)]/1.6.$);

where

R_d = operational range of facility A at the " Critical Point".

Co-frequency:

Minimum separation distance between " Critical Point" and transmitter B:

$R_s = R_d*10^{[(D/U-K)/20]}$ if undesired facility within radio line-of-sight; or

$R_s = R_H+[D/U-K-20 \log (R_H/R_d)]/1.6$ if undesired facility beyond radio line-of-sight;

(this is derived from a subtraction of Rd from $R_s = R_d (1 + 10^{[(D/U-K)/20]})$ and from $R_d+R_H+[D/U-K-20 \log (R_H/R_d)]/1.6.$).

First adjacent channel for DMEs with a DOC radius of 60 NM or less:

Minimum separation distance between " Critical Point" and transmitter B:

Range of facility A plus 5 NM.

First adjacent channel for DMEs with a DOC radius of greater than 60 NM:

Minimum 65 NM separation distance between facilities A and B.

Second adjacent channel:

Minimum separation distance between transmitter A and transmitter B:

10 NM.

63 MHz separated facilities:

Minimum separation distance between transmitter A and transmitter B:

15 NM.

Compatibility of facility A (undesired facility) with B (desired facility) must also be considered.

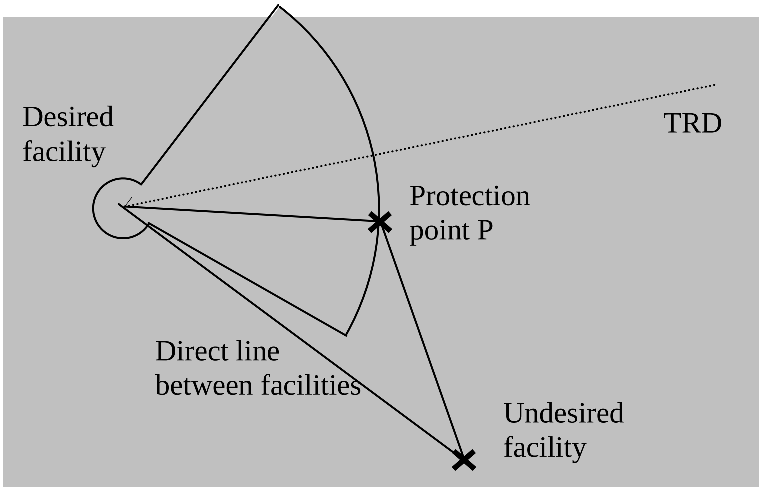
If the " Critical Point" lies on the direct line between the two facilities A and B, then the "normal" calculation method may be applied (i.e. point "P" is " Critical Point").

5.2.3.6 Use of DMEs with directional antennas

When omnidirectional coverage 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.

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.

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. The following figure depicts how the compatibility check is carried out for the protection of a directional DME.



Currently (2010), two specific antennas can be used for directional DME. One is “Kathrein 716405”, known also as “FAN88” and the other one is “Kathrein 880 10003”.

Unless otherwise specified, the normalised antenna gain $G_{Antenna,\ rel}$ of the facility’s directional antenna (in dB) will be calculated as follows:

For the transmission of desired signals:

$G_{Antenna,rel,d}\ (\varphi) = -\ 3.1\cdot10^{-3}\ \varphi^2 + 7.5\cdot10^{-8}\ \varphi^4 - 0.9\cdot10^{-12}\ \varphi^6$, for $-180°\leq\varphi\leq180°$.

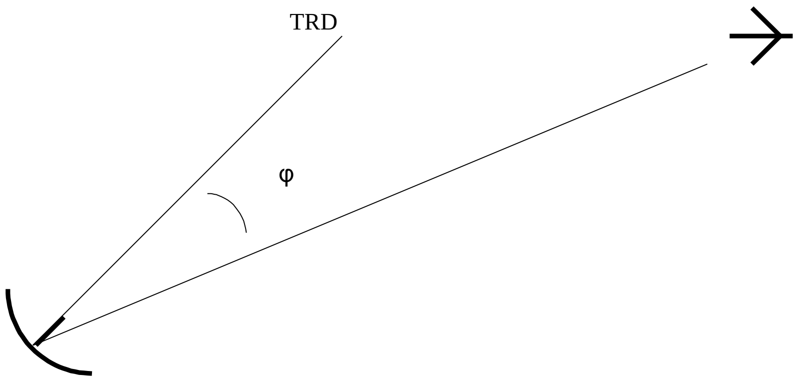
For the transmission of undesired signals:

$G_{Antenna,rel,u}\ (\varphi) = -\ 2.45\cdot10^{-3}\ \varphi^2 + 8.1\cdot10^{-8}\ \varphi^4 - 10^{-12}\ \varphi^6$, for $-180°\leq\varphi\leq180°$,

where φ denotes the azimuthal deviation in degrees from the direction of maximum radiation (see figure below). The above formulas for the calculation of the normalized antenna gain are frequency-independent approximations to the measured gain values of the afore-mentioned antennas. In particular, $G_{Antenna,rel,d}$ and $G_{Antenna,rel,u}$ represent respectively an underestimate and an overestimate of the measured normalized antenna gain. If more precision is required, use can be made of the antenna manufacturer’s data sheets. Users of other antenna types should either submit detailed antenna gain data or verify that their normalized antenna gain is not less than $G_{Antenna,rel,d}$ and not greater than $G_{Antenna,rel,u}$ as above.

Note1: *For the protection of a DME with directional antenna, no compatibility check is required outside its DOC.*

Note2: *In the coordination messages, DME facilities with directional antennas should be clearly designated as DME-dir.*


TRD
φ

5.2.4 ***Table of example minimum separation distances used in the planning of omnidirectional DME***

Facility 1	**Facility 2**	**Minimum required separation distance (NM)**		
Desired	**Undesired**	**Co-frequency**	**1st adjacent frequency**	**2nd adjacent frequency**
Cylindrical DOC and EIRP (30ft assumed for both facility heights)				
DME (MLS) 23 NM/10000 ft 27 dBW 1)	1)	81	28	10
1)	2)	81	28	10
1)	3)	155	28	10
1)	4)	156	28	10
DME (ILS) 25 NM/10000 ft 27 dBW 2)	1)	88	30	10
2)	2)	88	30	10
2)	3)	157	30	10
2)	4)	159	30	10
DME (VOR) 100 NM/50000 ft 37 dBW 3)	1)	179	65	10
3)	2)	179	65	10
3)	3)	351	65	10
3)	4)	383	65	10
TACAN 40 NM/25000 ft 40 dBW 4)	1)	62	45	10
4)	2)	62	45	10
4)	3)	111	45	10
4)	4)	140	45	10

Image - 63 MHz:
separation 28 km (15 NM) Reference Annex 10, Volume I, Attachment C, paragraph 7.1.9.

Notes:
1) *Typical for a DME associated with a MLS*
2) *Typical for a DME associated with an ILS*
3) *Typical for a DME associated with a VOR*
4) *Typical for a TACAN*

The required separation distance for two facilities A and B is the greater of the separation distances between A and B or B and A (e.g. the required co-frequency separation distance between A being a DME associated with an ILS and B a DME associated with a VOR is the greater of 157 and 179 NM, i.e. 179 NM).

Table

DME-channel	*Reply FREQ (MHz)*	*Co-FREQ different pulse code*	*1st adjacent FREQ same pulse code*		*1st adjacent FREQ different pulse code*		*2nd adjacent FREQ same pulse code*		*2nd adjacent FREQ different pulse code*	
17X	978	-	16X	18X	-	18W	15X	19X	-	-
17Y	1104	17Z	16Y	18Y	-	18Z	15Y	19Y	-	19Z
17Z	1104	17Y	-	18Z	16Y	18Y	-	19Z	15Y	19Y
18X	979	18W	17X	19X	-	-	16X	20X	-	20W
18W	979	18X	-	-	17X	19X	-	20W	16X	20X
18Y	1105	18Z	17Y	19Y	17Z	19Z	16Y	20Y	-	20Z
18Z	1105	18Y	17Z	19Z	17Y	19Y	-	20Z	16Y	20Y
19X	980	-	18X	20X	18W	20W	17X	21X	-	-
19Y	1106	19Z	18Y	20Y	18Z	20Z	17Y	21Y	17Z	21Z
19Z	1106	19Y	18Z	20Z	18Y	20Y	17Z	21Z	17Y	21Y
20X	981	20W	19X	21X	-	-	18X	22X	18W	22W
20W	981	20X	-	-	19X	21X	18W	22W	18X	22X
20Y	1107	20Z	19Y	21Y	19Z	21Z	18Y	22Y	18Z	22Z
20Z	1107	20Y	19Z	21Z	19Y	21Y	18Z	22Z	18Y	22Y
21X	982	-	20X	22X	20W	22W	19X	23X	-	-
21Y	1108	21Z	20Y	22Y	20Z	22Z	19Y	23Y	19Z	23Z
21Z	1108	21Y	20Z	22Z	20Y	22Y	19Z	23Z	19Y	23Y
22X	983	22W	21X	23X	-	-	20X	24X	20W	24W
22W	983	22X	-	-	21X	23X	20W	24W	20X	24X
22Y	1109	22Z	21Y	23Y	21Z	23Z	20Y	24Y	20Z	24Z
22Z	1109	22Y	21Z	23Z	21Y	23Y	20Z	24Z	20Y	24Y
23X	984	-	22X	24X	22W	24W	21X	25X	-	-
23Y	1110	23Z	22Y	24Y	22Z	24Z	21Y	25Y	21Z	25Z
23Z	1110	23Y	22Z	24Z	22Y	24Y	21Z	25Z	21Y	25Y
24X	985	24W	23X	25X	-	-	22X	26X	22W	26W
24W	985	24X	-	-	23X	25X	22W	26W	22X	26X
24Y	1111	24Z	23Y	25Y	23Z	25Z	22Y	26Y	22Z	26Z
24Z	1111	24Y	23Z	25Z	23Y	25Y	22Z	26Z	22Y	26Y
25X	986	-	24X	26X	24W	26W	23X	27X	-	-
25Y	1112	25Z	24Y	26Y	24Z	26Z	23Y	27Y	23Z	27Z
25Z	1112	25Y	24Z	26Z	24Y	26Y	23Z	27Z	23Y	27Y
26X	987	26W	25X	27X	-	-	24X	28W	24W	28W
26W	987	26X	-	-	25X	27X	24W	28X	24X	28X
26Y	1113	26Z	25Y	27Y	25Z	27Z	24Y	28Y	24Z	28Z
26Z	1113	26Y	25Z	27Z	25Y	27Y	24Z	28Z	24Y	28Y
27X	988	-	26X	28X	26W	28W	25X	29X	-	-
27Y	1114	27Z	26Y	28Y	26Z	28Z	25Y	29Y	25Z	29Z
27Z	1114	27Y	26Z	28Z	26Y	28Y	25Z	29Z	25Y	29Y
28X	989	28W	27X	29X	-	-	26X	30X	26W	30W
28W	989	28X	-	-	27X	29X	26W	30W	26X	30X
28Y	1115	28Z	27Y	29Y	27Z	29Z	26Y	30Y	26Z	30Z
28Z	1115	28Y	27Z	29Z	27Y	29Y	26Z	30Z	26Y	30Y
29X	990	-	28X	30X	28W	30W	27X	31X	-	-
29Y	1116	29Z	28Y	30Y	28Z	30Z	27Y	31Y	27Z	31Z
29Z	1116	29Y	28Z	30Z	28Y	30Y	27Z	31Z	27Y	31Y
30X	991	30W	29X	31X	-	-	28X	32X	28W	32W
30W	991	30X	-	-	29X	31X	28W	32W	28X	32X
30Y	1117	30Z	29Y	31Y	29Z	31Z	28Y	32Y	28Z	32Z
30Z	1117	30Y	29Z	31Z	29Y	31Y	28Z	32Z	28Y	32Y
31X	992	-	30X	32X	30W	32W	29X	33X	-	-
31Y	1118	31Z	30Y	32Y	30Z	32Z	29Y	33Y	29Z	33Z
31Z	1118	31Y	30Z	32Z	30Y	32Y	29Z	33Z	29Y	33Y
32X	993	32W	31X	33X	-	-	30X	34X	30W	34W
32W	993	32X	-	-	31X	33X	30W	34W	30X	34X
32Y	1119	32Z	31Y	33Y	31Z	33Z	30Y	34Y	30Z	34Z
32Z	1119	32Y	31Z	33Z	31Y	33Y	30Z	34Z	30Y	34Y
33X	994	-	32X	34X	32W	34W	31X	35X	-	-
33Y	1120	33Z	32Y	34Y	32Z	34Z	31Y	35Y	31Z	35Z
33Z	1120	33Y	32Z	34Z	32Y	34Y	31Z	35Z	31Y	35Y
34X	995	34W	33X	35X	-	-	32X	36X	32W	36W
34W	995	34X	-	-	33X	35X	32W	36W	32X	36X
34Y	1121	34Z	33Y	35Y	33Z	35Z	32Y	36Y	32Z	36Z
34Z	1121	34Y	33Z	35Z	33Y	35Y	32Z	36Z	32Y	36Y
35X	996	-	34X	36X	34W	36W	33X	37X	-	-
35Y	1122	35Z	34Y	36Y	34Z	36Z	33Y	37Y	33Z	37Z
35Z	1122	35Y	34Z	36Z	34Y	36Y	33Z	37Z	33Y	37Y
36X	997	36W	35X	37X	-	-	34X	38X	34W	38W
36W	997	36X	-	-	35X	37X	34W	38W	34X	38X
36Y	1123	36Z	35Y	37Y	35Z	37Z	34Y	38Y	34Z	38Z
36Z	1123	36Y	35Z	37Z	35Y	37Y	34Z	38Z	34Y	38Y

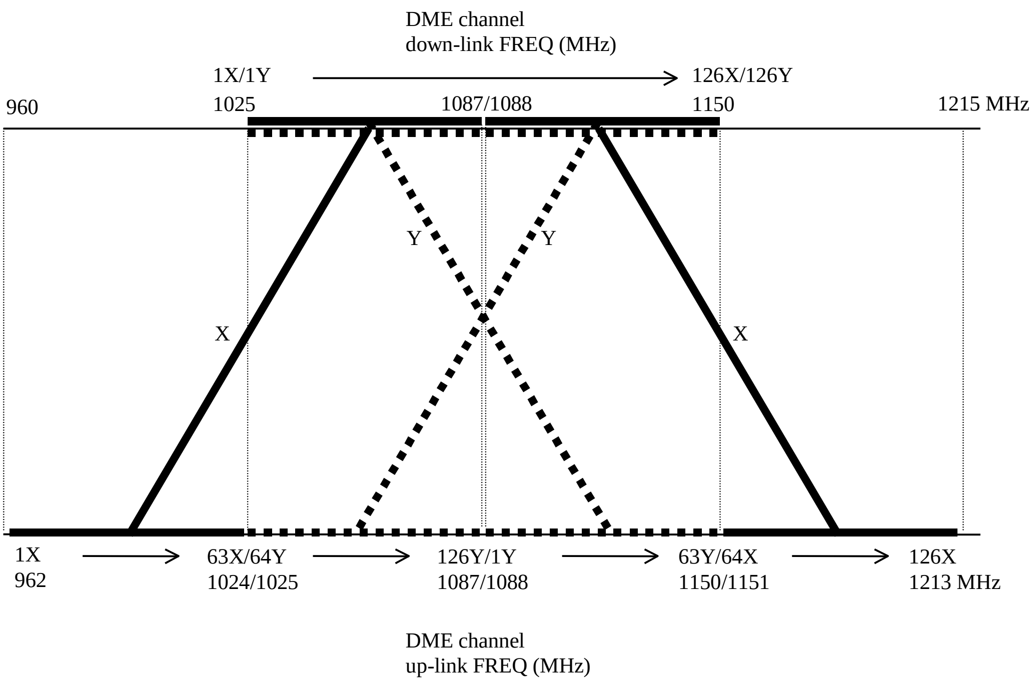
DME-channel	*Reply FREQ (MHz)*	*Co-FREQ different pulse code*	*1st adjacent FREQ same pulse code*		*1st adjacent FREQ different pulse code*		*2nd adjacent FREQ same pulse code*		*2nd adjacent FREQ different pulse code*	
37X	998	-	36X	38X	36W	38W	35X	39X	-	-
37Y	1124	37Z	36Y	38Y	36Z	38Z	35Y	39Y	35Z	39Z
37Z	1124	37Y	36Z	38Z	36Y	38Y	35Z	39Z	35Y	39Y
38X	999	38W	37X	39X	-	-	36X	40W	36W	40W
38W	999	38X	-	-	37X	39X	36W	40X	36X	40X
38Y	1125	38Z	37Y	39Y	37Z	39Z	36Y	40Y	36Z	40Z
38Z	1125	38Y	37Z	39Z	37Y	39Y	36Z	40Z	36Y	40Y
39X	1000	-	38X	40X	38W	40W	37X	41X	-	-
39Y	1126	39Z	38Y	40Y	38Z	40Z	37Y	41Y	37Z	41Z
39Z	1126	39Y	38Z	40Z	38Y	40Y	37Z	41Z	37Y	41Y
40X	1001	40W	39X	41X	-	-	38X	42X	38W	42W
40W	1001	40X	-	-	39X	41X	38W	42W	38X	42X
40Y	1127	40Z	39Y	41Y	39Z	41Z	38Y	42Y	38Z	42Z
40Z	1127	40Y	39Z	41Z	39Y	41Y	38Z	42Z	38Y	42Y
41X	1002	-	40X	42X	40W	42W	39X	43X	-	-
41Y	1128	41Z	40Y	42Y	40Z	42Z	39Y	43Y	39Z	43Z
41Z	1128	41Y	40Z	42Z	40Y	42Y	39Z	43Z	39Y	43Y
42X	1003	42W	41X	43X	-	-	40X	44X	40W	44W
42W	1003	42X	-	-	41X	43X	40W	44W	40X	44X
42Y	1129	42Z	41Y	43Y	41Z	43Z	40Y	44Y	40Z	44Z
42Z	1129	42Y	41Z	43Z	41Y	43Y	40Z	44Z	40Y	44Y
43X	1004	-	42X	44X	42W	44W	41X	45X	-	-
43Y	1130	43Z	42Y	44Y	42Z	44Z	41Y	45Y	41Z	45Z
43Z	1130	43Y	42Z	44Z	42Y	44Y	41Z	45Z	41Y	45Y
44X	1005	44W	43X	45X	-	-	42X	46X	42W	46W
44W	1005	44X	-	-	43X	45X	42W	46W	42X	46X
44Y	1131	44Z	43Y	45Y	43Y	45Y	42Y	46Y	42Z	46Z
44Z	1131	44Y	43Z	45Z	43Z	45Z	42Z	46Z	42Y	46Y
45X	1006	-	44X	46X	44W	46W	43X	47X	-	-
45Y	1132	45Z	44Y	46Y	44Z	46Z	43Y	47Y	43Z	47Z
45Z	1132	45Y	44Z	46Z	44Y	46Y	43Z	47Z	43Y	47Y
46X	1007	46W	45X	47X	-	-	44X	48X	44W	48W
46W	1007	46X	-	-	45X	47X	44W	48W	44X	48X
46Y	1133	46Z	45Y	47Y	45Z	47Z	44Y	48Y	44Z	48Z
46Z	1133	46Y	45Z	47Z	45Y	47Y	44Z	48Z	44Y	48Y
47X	1008	-	46X	48X	46W	48W	45X	49X	-	-
47Y	1134	47Z	46Y	48Y	46Z	48Z	45Y	49Y	45Z	49Z
47Z	1134	47Y	46Z	48Z	46Y	48Y	45Z	49Z	45Y	49Y
48X	1009	48W	47X	49X	-	-	46X	50X	46W	50W
48W	1009	48X	-	-	47X	49X	46W	50W	46X	50X
48Y	1135	48Z	47Y	49Y	47Z	49Z	46Y	50Y	46Z	50Z
48Z	1135	48Y	47Z	49Z	47Y	49Y	46Z	50Z	46Y	50Y
49X	1010	-	48X	50X	48W	50W	47X	51X	-	-
49Y	1136	49Z	48Y	50Y	48Z	50Z	47Y	51Y	47Z	51Z
49Z	1136	49Y	48Z	50Z	48Y	50Y	47Z	51Z	47Y	51Y
50X	1011	50W	49X	51X	-	-	48X	52X	48W	52W
50W	1011	50X	-	-	49X	51X	48W	52W	48X	52X
50Y	1137	50Z	49Y	51Y	49Z	51Z	48Y	52Y	48Z	52Z
50Z	1137	50Y	49Z	51Z	49Y	51Y	48Z	52Z	48Y	52Y
51X	1012	-	50X	52X	50W	52W	49X	53X	-	-
51Y	1138	51Z	50Y	52Y	50Z	52Z	49Y	53Y	49Z	53Z
51Z	1138	51Y	50Z	52Z	50Y	52Y	49Z	53Z	49Y	53Y
52X	1013	52W	51X	53X	-	-	50X	54X	50W	54W
52W	1013	52X	-	-	51X	53X	50W	54W	50X	54X
52Y	1139	52Z	51Y	53Y	51Z	53Z	50Y	54Y	50Z	54Z
52Z	1139	52Y	51Z	53Z	51Y	53Y	50Z	54Z	50Y	54Y
53X	1014	-	52X	54X	52W	54W	51X	55X	-	-
53Y	1140	53Z	52Y	54Y	52Z	54Z	51Y	55Y	51Z	55Z
53Z	1140	53Y	52Z	54Z	52Y	54Y	51Z	55Z	51Y	55Y
54X	1015	54W	53X	55X	-	-	52X	56X	52W	56W
54W	1015	54X	-	-	53X	55X	52W	56W	52X	56X
54Y	1141	54Z	53Y	55Y	53Z	55Z	52Y	56Y	52Z	56Z
54Z	1141	54Y	53Z	55Z	53Y	55Y	52Z	56Z	52Y	56Y
55X	1016	-	54X	56X	54W	56W	53X	57X	-	-
55Y	1142	55Z	54Y	56Y	54Z	56Z	53Y	57Y	53Z	57Z
55Z	1142	55Y	54Z	56Z	54Y	56Y	53Z	57Z	53Y	57Y
56X	1017	56W	55X	57X	-	-	54X	58X	54W	58W
56W	1017	56X	-	-	55X	57X	54W	58W	54X	58X
56Y	1143	56Z	55Y	57Y	55Y	57Y	54Y	58Y	54Z	58Z
56Z	1143	56Y	55Z	57Z	55Z	57Z	54Z	58Z	54Y	58Y
57X	1018	-	56X	58X	56W	-	55X	59X	-	-
57Y	1144	-	56Y	58Y	56Z	-	55Y	59Y	55Z	-

DME-channel	*Reply FREQ (MHz)*	*Co-FREQ different pulse code*	*1st adjacent FREQ same pulse code*		*1st adjacent FREQ different pulse code*		*2nd adjacent FREQ same pulse code*		*2nd adjacent FREQ different pulse code*	
58X	1019	-	57X	59X	-	-	56X	60X	56W	-
58Y	1145	-	57Y	59Y	-	-	56Y	60Y	56Z	-
59X	1020	-	58X	60X	-	-	57X	61X	-	-
59Y	1146	-	58Y	60Y	-	-	57Y	61Y	-	-
60X	1021	-	59X	61X	-	-	58X	62X	-	-
60Y	1147	-	59Y	61Y	-	-	58Y	62Y	-	-
61X	1022	-	60X	62X	-	-	59X	63X	-	-
61Y	1148	-	60Y	62Y	-	-	59Y	63Y	-	-
62X	1023	-	61X	63X	-	-	60X	-	-	64Y
62Y	1149	-	61Y	63Y	-	-	60Y	-	-	64X
63X	1024	-	62X	-	-	64Y	61X	-	-	65Y
63Y	1150	-	62Y	-	-	64X	61Y	-	-	65X
64X	1151	-	-	65X	63Y	-	-	66X	62Y	-
64Y	1025	-	-	65Y	63X	-	-	66Y	62X	-
65X	1152	-	64X	66X	-	-	-	67X	63Y	-
65Y	1026	-	64Y	66Y	-	-	-	67Y	63X	-
66X	1153	-	65X	67X	-	-	64X	68X	-	-
66Y	1027	-	65Y	67Y	-	-	64Y	68Y	-	-
67X	1154	-	66X	68X	-	-	65X	69X	-	-
67Y	1028	-	66Y	68Y	-	-	65Y	69Y	-	-
68X	1155	-	67X	69X	-	-	66X	70X	-	-
68Y	1029	-	67Y	69Y	-	-	66Y	70Y	-	-
69X	1156	-	68X	70X	-	-	67X	71X	-	-
69Y	1030	-	68Y	70Y	-	-	67Y	71Y	-	-
70X	1157	-	69X	71X	-	-	68X	72X	-	-
70Y	1031	-	69Y	71Y	-	-	68Y	72Y	-	-
71X	1158	-	70X	72X	-	-	69X	73X	-	-
71Y	1032	-	70Y	72Y	-	-	69Y	73Y	-	-
72X	1159	-	71X	73X	-	-	70X	74X	-	-
72Y	1033	-	71Y	73Y	-	-	70Y	74Y	-	-
73X	1160	-	72X	74X	-	-	71X	75X	-	-
73Y	1034	-	72Y	74Y	-	-	71Y	75Y	-	-
74X	1161	-	73X	75X	-	-	72X	76X	-	-
74Y	1035	-	73Y	75Y	-	-	72Y	76Y	-	-
75X	1162	-	74X	76X	-	-	73X	77X	-	-
75Y	1036	-	74Y	76Y	-	-	73Y	77Y	-	-
76X	1163	-	75X	77X	-	-	74X	78X	-	-
76Y	1037	-	75Y	77Y	-	-	74Y	78Y	-	-
77X	1164	-	76X	78X	-	-	75X	79X	-	-
77Y	1038	-	76Y	78Y	-	-	75Y	79Y	-	-
78X	1165	-	77X	79X	-	-	76X	80X	-	-
78Y	1039	-	77Y	79Y	-	-	76Y	80Y	-	80Z
79X	1166	-	78X	80X	-	-	77X	81X	-	-
79Y	1040	-	78Y	80Y	-	80Z	77Y	81Y	-	81Z
80X	1167	-	79X	81X	-	-	78X	82X	-	-
80Y	1041	80Z	79Y	81Y	-	81Z	78Y	82Y	-	82Z
80Z	1041	80Y	-	81Z	79Y	81Y	-	82Z	78Y	82Y
81X	1168	-	80X	82X	-	-	79X	83X	-	-
81Y	1042	81Z	80Y	82Y	80Z	82Z	79Y	83Y	-	83Z
81Z	1042	81Y	80Z	82Z	80Y	82Y	-	83Z	79Y	83Y
82X	1169	-	81X	83X	-	-	80X	84X	-	-
82Y	1043	82Z	81Y	83Y	81Z	83Z	80Y	84Y	80Z	84Z
82Z	1043	82Y	81Z	83Z	81Y	83Y	80Z	84Z	80Y	84Y
83X	1170	-	82X	84X	-	-	81X	85X	-	-
83Y	1044	83Z	82Y	84Y	82Z	84Z	81Y	85Y	81Z	85Z
83Z	1044	83Y	82Z	84Z	82Y	84Y	81Z	85Z	81Y	85Y
84X	1171	-	83X	85X	-	-	82X	86X	-	-
84Y	1045	84Z	83Y	85Y	83Z	85Z	82Y	86Y	82Z	86Z
84Z	1045	84Y	83Z	85Z	83Y	85Y	82Z	86Z	82Y	86Y
85X	1172	-	84X	86X	-	-	83X	87X	-	-
85Y	1046	85Z	84Y	86Y	84Z	86Z	83Y	87Y	83Z	87Z
85Z	1046	85Y	84Z	86Z	84Y	86Y	83Z	87Z	83Y	87Y
86X	1173	-	85X	87X	-	-	84X	88X	-	-
86Y	1047	86Z	85Y	87Y	85Z	87Z	84Y	88Y	84Z	88Z
86Z	1047	86Y	85Z	87Z	85Y	87Y	84Z	88Z	84Y	88Y
87X	1174	-	86X	88X	-	-	85X	89X	-	-
87Y	1048	87Z	86Y	88Y	86Z	88Z	85Y	89Y	85Z	89Z
87Z	1048	87Y	86Z	88Z	86Y	88Y	85Z	89Z	85Y	89Y
88X	1175	-	87X	89X	-	-	86X	90X	-	-
88Y	1049	88Z	87Y	89Y	87Z	89Z	86Y	90Y	86Z	90Z
88Z	1049	88Y	87Z	89Z	87Y	89Y	86Z	90Z	86Y	90Y

DME-channel	*Reply FREQ (MHz)*	*Co-FREQ different pulse code*	*1st adjacent FREQ same pulse code*		*1st adjacent FREQ different pulse code*		*2nd adjacent FREQ same pulse code*		*2nd adjacent FREQ different pulse code*	
89X	1176	-	88X	90X	-	-	87X	91X	-	-
89Y	1050	89Z	88Y	90Y	88Z	90Z	87Y	91Y	87Z	91Z
89Z	1050	89Y	88Z	90Z	88Y	90Y	87Z	91Z	87Y	91Y
90X	1177	-	89X	91X	-	-	88X	92X	-	-
90Y	1051	90Z	89Y	91Y	89Z	91Z	88Y	92Y	88Z	92Z
90Z	1051	90Y	89Z	91Z	89Y	91Y	88Z	92Z	88Y	92Y
91X	1178	-	90X	92X	-	-	89X	93X	-	-
91Y	1052	91Z	90Y	92Y	90Z	92Z	89Y	93Y	89Z	93Z
91Z	1052	91Y	90Z	92Z	90Y	92Y	89Z	93Z	89Y	93Y
92X	1179	-	91X	93X	-	-	90X	94X	-	-
92Y	1053	92Z	91Y	93Y	91Z	93Z	90Y	94Y	90Z	94Z
92Z	1053	92Y	91Z	93Z	91Y	93Y	90Z	94Z	90Y	94Y
93X	1180	-	92X	94X	-	-	91X	95X	-	-
93Y	1054	93Z	92Y	94Y	92Z	94Z	91Y	95Y	91Z	95Z
93Z	1054	93Y	92Z	94Z	92Y	94Y	91Z	95Z	91Y	95Y
94X	1181	-	93X	95X	-	-	92X	96X	-	-
94Y	1055	94Z	93Y	95Y	93Z	95Z	92Y	96Y	92Z	96Z
94Z	1055	94Y	93Z	95Z	93Y	95Y	92Z	96Z	92Y	96Y
95X	1182	-	94X	96X	-	-	93X	97X	-	-
95Y	1056	95Z	94Y	96Y	94Z	96Z	93Y	97Y	93Z	97Z
95Z	1056	95Y	94Z	96Z	94Y	96Y	93Z	97Z	93Y	97Y
96X	1183	-	95X	97X	-	-	94X	98X	-	-
96Y	1057	96Z	95Y	97Y	95Z	97Z	94Y	98Y	94Z	98Z
96Z	1057	96Y	95Z	97Z	95Y	97Y	94Z	98Z	94Y	98Y
97X	1184	-	96X	98X	-	-	95X	99X	-	-
97Y	1058	97Z	96Y	98Y	96Z	98Z	95Y	99Y	95Z	99Z
97Z	1058	97Y	96Z	98Z	96Y	98Y	95Z	99Z	95Y	99Y
98X	1185	-	97X	99X	-	-	96X	100X	-	-
98Y	1059	98Z	97Y	99Y	97Z	99Z	96Y	100Y	96Z	100Z
98Z	1059	98Y	97Z	99Z	97Y	99Y	96Z	100Z	96Y	100Y
99X	1186	-	98X	100X	-	-	97X	101X	-	-
99Y	1060	99Z	98Y	100Y	98Z	100Z	97Y	101Y	97Z	101Z
99Z	1060	99Y	98Z	100Z	98Y	100Y	97Z	101Z	97Y	101Y
100X	1187	-	99X	101X	-	-	98X	102X	-	-
100Y	1061	100Z	99Y	101Y	99Z	101Z	98Y	102Y	98Z	102Z
100Z	1061	100Y	99Z	101Z	99Y	101Y	98Z	102Z	98Y	102Y
101X	1188	-	100X	102X	-	-	99X	103X	-	-
101Y	1062	101Z	100Y	102Y	100Z	102Z	99Y	103Y	99Z	103Z
101Z	1062	101Y	100Z	102Z	100Y	102Y	99Z	103Z	99Y	103Y
102X	1189	-	101X	103X	-	-	100X	104X	-	-
102Y	1063	102Z	101Y	103Y	101Z	103Z	100Y	104Y	100Z	104Z
102Z	1063	102Y	101Z	103Z	101Y	103Y	100Z	104Z	100Y	104Y
103X	1190	-	102X	104X	-	-	101X	105X	-	-
103Y	1064	103Z	102Y	104Y	102Z	104Z	101Y	105Y	101Z	105Z
103Z	1064	103Y	102Z	104Z	102Y	104Y	101Z	105Z	101Y	105Y
104X	1191	-	103X	105X	-	-	102X	106X	-	-
104Y	1065	104Z	103Y	105Y	103Z	105Z	102Y	106Y	102Z	106Z
104Z	1065	104Y	103Z	105Z	103Y	105Y	102Z	106Z	102Y	106Y
105X	1192	-	104X	106X	-	-	103X	107X	-	-
105Y	1066	105Z	104Y	106Y	104Z	106Z	103Y	107Y	103Z	107Z
105Z	1066	105Y	104Z	106Z	104Y	106Y	103Z	107Z	103Y	107Y
106X	1193	-	105X	107X	-	-	104X	108X	-	-
106Y	1067	106Z	105Y	107Y	105Z	107Z	104Y	108Y	104Z	108Z
106Z	1067	106Y	105Z	107Z	105Y	107Y	104Z	108Z	104Y	108Y
107X	1194	-	106X	108X	-	-	105X	109X	-	-
107Y	1068	107Z	106Y	108Y	106Z	108Z	105Y	109Y	105Z	109Z
107Z	1068	107Y	106Z	108Z	106Y	108Y	105Z	109Z	105Y	109Y
108X	1195	-	107X	109X	-	-	106X	110X	-	-
108Y	1069	108Z	107Y	109Y	107Z	109Z	106Y	110Y	106Z	110Z
108Z	1069	108Y	107Z	109Z	107Y	109Y	106Z	110Z	106Y	110Y
109X	1196	-	108X	110X	-	-	107X	111X	-	-
109Y	1070	109Z	108Y	110Y	108Z	110Z	107Y	111Y	107Z	111Z
109Z	1070	109Y	108Z	110Z	108Y	110Y	107Z	111Z	107Y	111Y
110X	1197	-	109X	111X	-	-	108X	112X	-	-
110Y	1071	110Z	109Y	111Y	109Z	111Z	108Y	112Y	108Z	112Z
110Z	1071	110Y	109Z	111Z	109Y	111Y	108Z	112Z	108Y	112Y
111X	1198	-	110X	112X	-	-	109X	113X	-	-
111Y	1072	111Z	110Y	112Y	110Z	112Z	109Y	113Y	109Z	113Z
111Z	1072	111Y	110Z	112Z	110Y	112Y	109Z	113Z	109Y	113Y
112X	1199	-	111X	113X	-	-	110X	114X	-	-
112Y	1073	112Z	111Y	113Y	111Z	113Z	110Y	114Y	110Z	114Z
112Z	1073	112Y	111Z	113Z	111Y	113Y	110Z	114Z	110Y	114Y

DME-channel	*Reply FREQ (MHz)*	*Co-FREQ different pulse code*	*1st adjacent FREQ same pulse code*		*1st adjacent FREQ different pulse code*		*2nd adjacent FREQ same pulse code*		*2nd adjacent FREQ different pulse code*	
113X	1200	-	112X	114X	-	-	111X	115X	-	-
113Y	1074	113Z	112Y	114Y	112Z	114Z	111Y	115Y	111Z	115Z
113Z	1074	113Y	112Z	114Z	112Y	114Y	111Z	115Z	111Y	115Y
114X	1201	-	113X	115X	-	-	112X	116X	-	-
114Y	1075	114Z	113Y	115Y	113Z	115Z	112Y	116Y	112Z	116Z
114Z	1075	114Y	113Z	115Z	113Y	115Y	112Z	116Z	112Y	116Y
115X	1202	-	114X	116X	-	-	113X	117X	-	-
115Y	1076	115Z	114Y	116Y	114Z	116Z	113Y	117Y	113Z	117Z
115Z	1076	115Y	114Z	116Z	114Y	116Y	113Z	117Z	113Y	117Y
116X	1203	-	115X	117X	-	-	114X	118X	-	-
116Y	1077	116Z	115Y	117Y	115Z	117Z	114Y	118Y	114Z	118Z
116Z	1077	116Y	115Z	117Z	115Y	117Y	114Z	118Z	114Y	118Y
117X	1204	-	116X	118X	-	-	115X	119X	-	-
117Y	1078	115Z	116Y	118Y	116Z	118Z	115Y	119Y	115Z	119Z
117Z	1078	115Y	116Z	118Z	116Y	118Y	115Z	119Z	115Y	119Y
118X	1205	-	117X	119X	-	-	116X	120X	-	-
118Y	1079	118Z	117Y	119Y	117Z	119Z	116Y	120Y	116Z	-
118Z	1079	118Y	117Z	119Z	117Y	119Y	116Z	-	116Y	120Y
119X	1206	-	118X	120X	-	-	117X	121X	-	-
119Y	1080	119Z	118Y	120Y	118Z	-	117Y	121Y	115Z	-
119Z	1080	119Y	118Z	-	118Y	120Y	117Z	-	115Y	121Y
120X	1207	-	119X	121X	-	-	118X	122X	-	-
120Y	1081	-	119Y	121Y	119Z	-	118Y	122Y	118Z	-
121X	1208	-	120X	122X	-	-	119X	123X	-	-
121Y	1082	-	120Y	122Y	-	-	119Y	123Y	119Z	-
122X	1209	-	121X	123X	-	-	120X	124X	-	-
122Y	1083	-	121Y	123Y	-	-	120Y	124Y	-	-
123X	1210	-	122X	124X	-	-	121X	125X	-	-
123Y	1084	-	122Y	124Y	-	-	121Y	125Y	-	-
124X	1211	-	123X	125X	-	-	122X	126X	-	-
124Y	1085	-	123Y	125Y	-	-	122Y	126Y	-	-
125X	1212	-	124X	126X	-	-	123X	-	-	-
125Y	1086	-	124Y	126Y	-	-	123Y	1Y	-	-
126X	1213	-	125X	-	-	-	124X	-	-	-
126Y	1087	-	125Y	1Y	-	-	124Y	2Y	-	-

<u>Note</u>: *The DME channelling and frequency pairing (see figure below) results in "anomalous" adjacent channel combinations around 63X/64X and 63Y/64Y (e.g. 63X and 64Y). The term "up-link FREQ" is used instead of "reply FREQ".*



6 MLS

<u>Note</u>*: *the MLS material has been temporarily removed, pending conclusion of the on-going work in various groups. For any additional information on this subject please consult FMG/19 WP02 and the ICAO EUR FMG.

7 Identifications of radio navigation aids

7.1 References to documents

- Annex 11, Appendix 2, paragraph 2.2
- Annex 10, Volume I, paragraphs 3.1.3.9, 3.3.6, 3.4.5, 3.5.2.5, 3.5.3.6, 3.11.4.8.2.1n and Appendix B, paragraph 3.6.3.4.1
  (ILS, VOR, NDB, DME, MLS and GBAS);
- European Region Air Navigation Plan (Doc 7754), Volume II, FASID, Part IV, paragraph 27 *(significant points marked by a radio navigation aid).*

7.2 Composition of identifications

7.2.1 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 below provides an overview of the requirements which have to be taken into account for identifications:

Facility	*Identification*	*Remarks*
NDB and Locator	2 or 3 letters of the International Morse Code. See Note 2 below	
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/TACAN also called VORTAC)	VOR: 2 or 3 letters of the International Morse Code. DME: Identical to associated VOR.	Associated DME identification signal.
DME (TACAN)	Letters and numerals of the International Morse Code.	Independent DME identification signal for stand-alone DME facility.
MLS	3 letters A to Z. The characters shall be transmitted as a digital word and encoded in accordance with the International Alphabet No. 5. A letter M is added at the beginning of the identification, but not transmitted.	No MLS configurations without associated DME are planned.
MLS/DME	MLS: 3 letters A to Z. DME: Identical to associated MLS.	See further details under MLS above. Associated DME identification signal.
ILS/MLS/DME	ILS: 3 letters of the International Morse Code which may start with the letter I. See Note below. MLS: Identical to associated ILS. DME: Identical to associated ILS.	Triple frequency pairing. See further details under MLS above. Associated DME identification signal.
GBAS	4 characters (upper case letters, numeric digits, space) of the International Alphabet No. 5. Use of the Location Indicator of nearest airport is recommended. The fourth character may be a space (i.e. 3 letter identifications are acceptable).	

Note 1: 4 letter ILS identifications do not fit into the triple frequency pairing requirements because of the fixed number (3) of letters to be used for MLS and the associated DME.

Note 2: 3 letter NDB identifications commencing with "X" are reserved for use by maritime vessels and should not be assigned to other facilities. In order to coordinate the assignment of a common NDB identification for use in all the States where a vessel may wish to operate, a table of agreed NDB identifications per vessel is available at https://portal.icao.int/NDBIDENT. To register for access to the database or request further information, contact icaoeurnat@paris.icao.int.

7.2.2 A letter M is added ahead of the MLS identification as described above. This letter M is not transmitted. Since it is added to all MLS identifications, it does not provide any additional information which is not already available. It may be useful for operational purposes, but should not be included in the planning process for identifications of radio navigation aids. With such an arrangement, it is sufficient to co-ordinate and to register one single identification for each collocated MLS/DME and ILS/MLS/DME facility.

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

7.2.4 The two following combinations of letters should not be used for identifications (FMG Decision 4/2): GAT and OAT.

7.3 Duplication

7.3.1 Duplication of the same identification of a navigation aid should, as far as possible, be avoided in the EUR Region and in any case should not be permissible for two aids located less than 600 NM apart. 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.

7.3.2 The provisions of 7.3.1 above do not apply when two radio navigation aids operating in different bands of the frequency spectrum are situated at the same location, then their identifications are normally the same.

7.4 Co-ordination and registration

7.4.1 Identifications should be subject to co-ordination and registration in the EUR Region in the same way as frequencies of navigation aids.

8. Non ICAO Standard Systems operating in Part or in total within ARNS bands

RSBN

8.1 RSBN4 is a system that can provide information for APP and En Route Navigation similar as ILS, VOR, DME and TACAN. RSBN4 uses for one system component the same frequencies as DME/TACAN operating below channel 40x which is, why interference with DME and TACAN is possible. This information was already presented as WP12 at the FMG-SG7 meeting in 2004, but unfortunately no conclusion about further actions were reached. Continued operation could have also an impact on a future ARNS system in the band.

Appendix A

Convention for indicating the angular limits of sectorization in range

1. The range values given for ICAO category facilities are the ICAO recommended designated operational ranges and, for national facilities, the declared operational range requirement. In both cases the ranges are normally circular, i.e. of the same value throughout 360°.

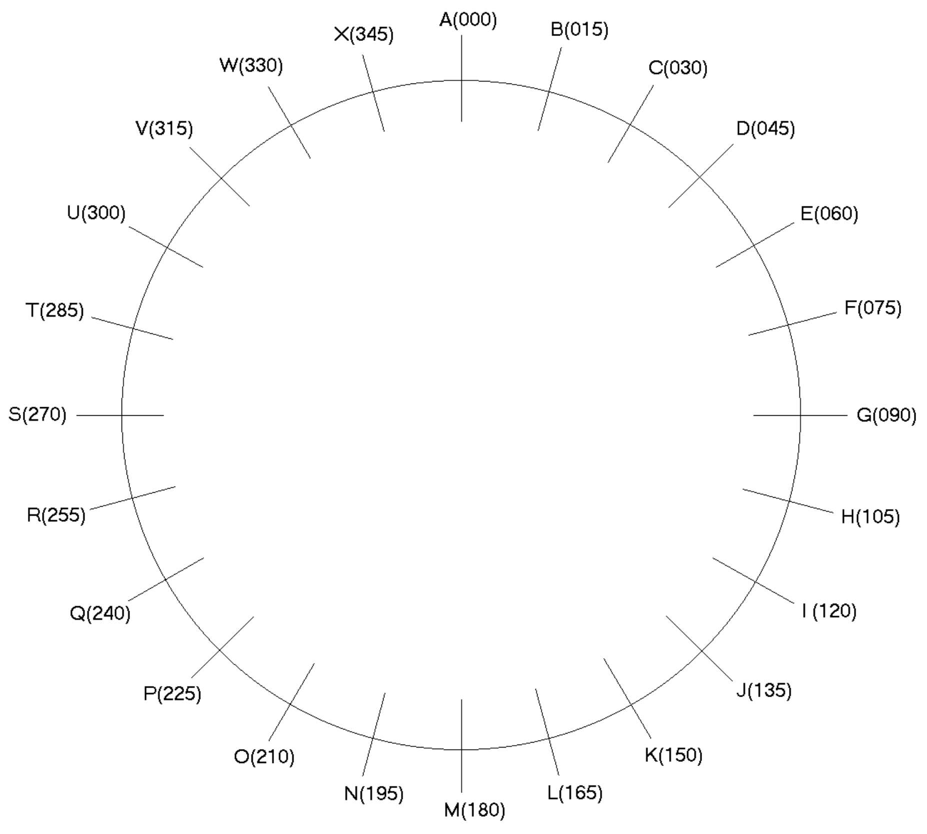
2. Where, however, the designated or declared values of operational range are not the same in all sectors, the following method is used to indicate the angular limits of sectors.

Method

3. The circle is divided into 24 radials, each designated with a letter taken from A to X in accordance with the Table and Figure below. The angular separation between adjacent radials is 15°.

Table - Sector designations

Code	Radials	Code	Radials	Code	Radials	Code	Radials
A	000	G	090	M	180	S	270
B	015	H	105	N	195	T	285
C	030	I	120	O	210	U	300
D	045	J	135	P	225	V	315
E	060	K	150	Q	240	W	330
F	075	L	165	R	255	X	345



Circle depicting the 24 radials

Illustrative examples of sectorization
(Figures below)

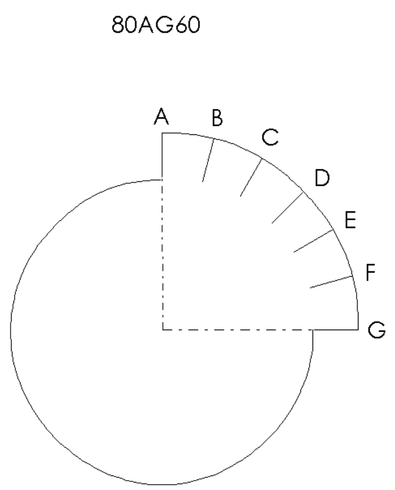
4. The sectorization as denoted is best described by the following examples. It should be borne in mind that a sector is always described by two letters taken from the Table below and that the sector is always drawn from the first letter, clockwise, to the second letter (e.g. GS is the 180° sector centred on South, while SG is the 180° sector centred on North).

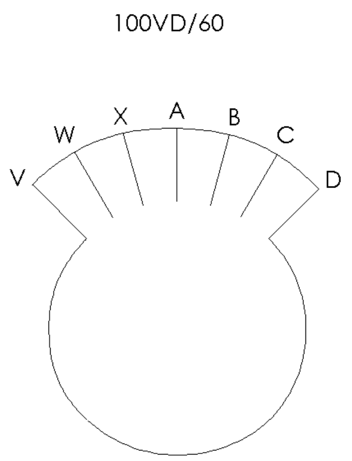
Example 1. 80AG/60 means 80 NM in sector 000° - 090° and 60 NM in other directions.

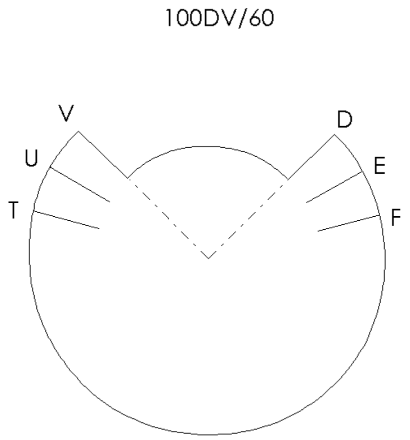
Example 2. 100VD/60 means 100 NM in sector 315° - 045°, clockwise, and 60 NM in other directions.

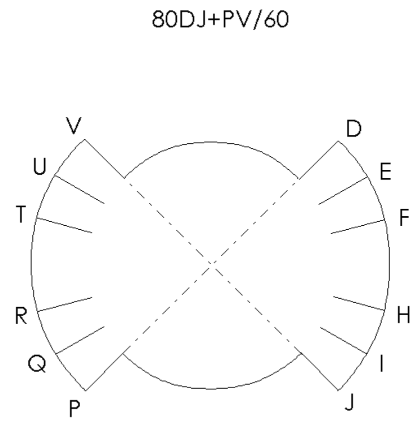
Example 3. 100DV/60 means 100 NM in sector 045° - 315°. Note that this is a sectorization that is the reverse of Example 2.

Example 4. 80DJ+PV/60 means 80 NM in sector 045° - 135 degrees, clockwise, and 225° - 315° also clockwise while 60 NM in what remains, that is the intermediate sectors 135° - 225° and 315° - 045°.







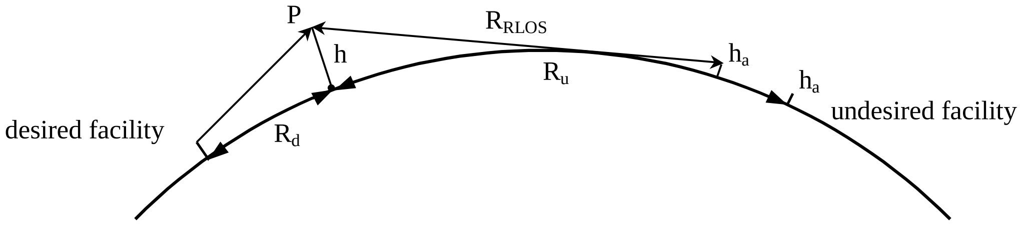


Appendix B

Generic calculation method for geographical separation distances

Propagation characteristics

It is assumed that propagation characteristics along the paths of the desired and undesired signals are identical. Calculation of attenuation is based on free space propagation from the transmitter up to the radio line-of-sight distance and on a constant attenuation factor beyond radio line-of-sight.



P	Critical point at the edge of the DOC of the desired facility
R_d	Operational range of desired facility
R_u	Distance between the edge of the DOC of the desired facility and the undesired facility
h	Height of the DOC of the desired facility
h_a	Antenna height of the undesired facility
R_{RLOS}	Radio line-of-sight distance between P and height h_a (= sum of radio horizon distances from height P and h_a)
R_s	Separation distance between desired and undesired facilities ($R_s = R_d + R_u$)

Note: Radio horizon distances are calculated assuming a smooth Earth with an effective radius of about 4/3 that of the actual radius.

Calculation of required separation distance

The free space propagation formula for the power flux-density:

$$P_{fd} = \frac{EIRP}{4\pi \times d^2} \qquad (1)$$

where
P_{fd} = power flux-density [W/m^2]
EIRP = equivalent isotropically radiated power [W]
d = distance from transmitter [m]

Formula (1) can be expressed in logarithmic terms and using NM instead of m for the distance:

$$P_{fd} = EIRP - 20 \log d - 10 \log 4\pi - 20 \log 1852$$
$$P_{fd} = EIRP - 20 \log d - 76.3 \qquad (2)$$

where
P_{fd} = power flux-density from desired transmitter [dBW/m^2]
EIRP = equivalent isotropically radiated power of the desired transmitter [dBW]
d = distance from transmitter [NM]

The desired facility is protected against the undesired facility if:

$$D/U \leq P_{fdd} - P_{fdu} \qquad (3)$$

where
D/U = protection ratio [dB]
P_{fdd} = power flux-density from desired transmitter [dBW/m^2]
P_{fdu} = power flux-density from undesired transmitter [dBW/m^2]

Applying formula (2) to the critical point P (figure):

$$D/U \leq EIRP_d - EIRP_u - 20 \log R_d + 20 \log R_u$$

$$D/U \leq K + 20 \log \left(\frac{R_u}{R_d}\right) \qquad (4)$$

where
$EIRP_d$ = equivalent isotropically radiated power of the desired transmitter
Note: The value of $EIRP_d$ is derived based on a required minimum field strength at the edge of coverage of the desired facitlity, assuming free space propagation. This value is fictious and does not correspond to the actually required radiated power. For example, for GBAS, the minimum required field strength at the edge of coverage at a range of 23 NM is 215 µV/m (-99 dBW/m^2), which corresponds to 4 dBW (this value can be derived applying formula (2)).
$EIRP_u$ = equivalent isotropically radiated power of the undesired transmitter
K = $EIRP_d$ - $EIRP_u$ [dB]
R_d = operational range of the desired facility [NM]
R_u = distance of the undesired facility from the edge of the DOC of the desired facility [NM]

The required separation distance R_s can be derived from formula (4):

$$D/U - K \leq 20 \log \left(\frac{R_u}{R_d}\right)$$

$$(D/U - K)/20 \leq \log \left(\frac{R_u}{R_d}\right)$$

$$10^{(D/U-K)/20} \leq R_u/R_d \qquad \text{with} \quad R_s = R_d + R_u$$

$$R_s \geq R_d \left(1 + 10^{(D/U-K)/20}\right) \qquad (5)$$

This formula applies, if the undesired transmitter is within radio line-of-sight from the edge of the DOC of the desired facility:

$$R_s - R_d \leq R_{RLOS} \qquad \text{with} \quad R_{RLOS} = 1.23 \left(\sqrt{h} + \sqrt{h_a}\right)$$

$$R_s \leq R_d + 1.23 \left(\sqrt{h} + \sqrt{h_a}\right) \quad [NM]$$

where
h = height of the DOC of the desired facility [ft]
h_a = antenna height of the undesired facility [ft]

Beyond radio line-of-sight, a constant attenuation factor is used to calculate the path loss. Applying formula (2):

$$P_{fdu} = EIRP_u - 20 \log R_{RLOS} - 76.3 - a \times (R_u - R_{RLOS})$$

Applying formula (4):

$$D/U \leq K + 20 \log \left(\frac{R_{RLOS}}{R_d}\right) + a \times (R_u - R_{RLOS})$$

$$D/U - K - a \times (R_s - R_d - R_{RLOS}) \leq 20 \log \left(\frac{R_{RLOS}}{R_d} \right)$$

$$a \times (R_s - R_d - R_{RLOS}) \geq -20 \log \left(\frac{R_{RLOS}}{R_d} \right) + D/U - K$$

$$R_s \geq R_d + R_{RLOS} + [D/U - K - 20 \log \left(\frac{R_{RLOS}}{R_d} \right)]/a$$

$$R_s \geq R_d + 1.23 (\sqrt{h} + \sqrt{h_a}) + [D/U - K - 20 \log (1.23 (\sqrt{h} + \sqrt{h_a})/R_d)]/a \quad (6)$$

where

a = attenuation factor beyond radio line-of-sight [dB/NM]

a can be derived from Recommendation ITU-R P.528-2 Propagation curves for aeronautical mobile and radionavigation services using VHF, UHF and SHF bands.

The following procedure should be applied to determine the required separation distance R_s between two facilities:

(1) Determine $R_s = R_d (1 + 10^{(D/U-K)/20})$;

(2) if $R_s \leq R_d + 1.23 (\sqrt{h} + \sqrt{h_a})$, then R_s is the required separation distance;

(3) if $R_s > R_d + 1.23 (\sqrt{h} + \sqrt{h_a})$, then determine

$$R_s = R_d + 1.23 (\sqrt{h} + \sqrt{h_a}) + [D/U - K - 20 \log (1.23 (\sqrt{h} + \sqrt{h_a})/R_d)]/a;$$

(4) repeat steps (1) to (3) with reversed roles for the desired and undesired facilities; and

(5) the greater separation distance resulting from the two runs desribed above is the required separation distance.

where

R_s = separation distance [NM]

R_d = operational range of the desired facility [NM]

D/U = desired to undesired signal ratio required to protect the desired facility [dB]

K = EIRP of the desired minus EIRP of the undesired transmitter [dB]

h = height of the DOC of the desired facility [ft]

h_a = antenna height of the undesired facility [ft]

a = attenuation factor beyond radio line-of-sight [dB/NM]

PART IV FREQUENCY CO-ORDINATION AND REGISTRATION PROCEDURES

1 Introduction

1.1 Co-ordination and registration procedures for frequency assignments are usually agreed between States under the rules of the ITU. These procedures are agreed between States in order to assure mutual acknowledgement of (the status of) each other's frequency assignments and the corresponding rights and obligations under ITU rules. Within the aeronautical ICAO community in Europe, the FMG has established co-ordination procedures between States, which can be regarded as mirror procedures to the formal ITU versions. Although these procedures do not have the same formal status as the original ITU-ones, in practice they are treated by States concerned in much the same way. This document highlights the main parties involved in these procedures and their mutual relationship/responsibility.

2 General

2.1 The main part of this document contains the basic co-ordination and registration procedure for use in the European Region.

2.2 The implementation of co-ordination and registration procedures is supported by SAFIRE, a dedicated internet-based facility developed and managed by EUROCONTROL on behalf of the FMG and the Registration Office (ICAO EANPG Conclusion 50/20 refers)*. The performance of SAFIRE is regularly reviewed by the FMG. States are strongly encouraged to register as users of SAFIRE in order to increase individual and overall efficiency.

2.3 Co-ordination of new or modified frequency assignments is required with all States concerned that may be affected by the proposed assignment.

2.4 Special procedures apply if it is necessary to change the frequency of an existing assignment in order to satisfy a request for a new assignment or for a modification of another existing assignment. In these circumstances, the co-ordination activity should encompass also the States that may be involved in the required frequency shifts of existing assignments as well as the States that may be concerned with these frequency shifts. EUROCONTROL has established on behalf of the FMG specialized co-ordination mechanisms for the satisfaction of such frequency requests. States are encouraged to request the support of EUROCONTROL when faced with such frequency requests.

2.5 The ICAO Paris Office would be available to assist States in resolving any co-ordination difficulties or disputes.

* EANPG Conclusion 50/20 - Implementation of the SAFIRE for COM2 coordination:
That starting on 1 January 2009, the on-line system SAFIRE be used as the only means of frequency assignments coordination and registration for COM2 Tables in the ICAO EUR Region.

3 Basic co-ordination and registration procedures for aeronautical frequency assignments

3.1 The basic procedure for the co-ordination and registration of aeronautical frequency assignments is depicted in the figure of Section 3 of Part I of this manual (page 3). As can be seen from this, the main parties involved are:

1) **States** *having a requirement for an addition or modification of an assignment to a service;*

2) all **States concerned** *with a proposed new assignment or modification of an existing assignment to a service*;

3) the **Registration Office** (ICAO EUR/NAT Office).

It is clarified that in the co-ordination and registration process participate also States from adjacent ICAO regions.

3.2 For the implementation of the co-ordination and registration procedures described below, the following arrangements apply:

1) States registered to SAFIRE *for a given category (COM2, COM3, COM4) of assignments* (referred to as SAFIRE States henceforth) make mandatorily use of the appropriate utilities of the facility. Under normal conditions,, SAFIRE States are expected to execute their tasks exclusively on SAFIRE.

2) States not registered to SAFIRE *for a given category of assignments* (referred to as non-SAFIRE States henceforth) should exchange co-ordination and registration messages as described in the following paragraph.

3) With the exception of bilateral negotiations, the exchange of information between a SAFIRE State and a non-SAFIRE State or between two non-SAFIRE States is effected through the mediation of the Registration Office. In particular, requests, reactions or notifications of non-SAFIRE States which concern SAFIRE States or other non-SAFIRE States are sent to the Registration Office, which in turn produces the appropriate entries into SAFIRE. Conversely for requests, reactions or notifications of SAFIRE or non-SAFIRE States which concern non-SAFIRE States, the Registration Office retrieves the corresponding information entered in SAFIRE and generates the appropriate messages to the non-SAFIRE States concerned. In their communication with the Registration Office for co-ordination and registration purposes, non-SAFIRE States may usethe dedicated e-mail address icaoeurnat@paris.icao.int.

4) For the distribution of co-ordination-related material entered in SAFIRE to concerned non-SAFIRE States the Registration Office is supported by automation. Unless a non-SAFIRE State informs the Registration Office of the list of SAFIRE States from which it wishes to receive co-ordination-related messages, the Registration Office shall forward to such non SAFIRE State all SAFIRE co-ordination-related messages.

3.3 The various actions and responsibilities of each of the parties in the co-ordination and registration procedures are described in the paragraphs below.

3.4 A State having a requirement for an addition/modification of an assignment to a service is responsible for:

a) the *request for co-ordination* and registration to be submitted to **all States concerned** and the **Registration Office** (Note: Proposals establish priority with respect to their provisional protection according to their time of submission to the Registration Office);

b) in case any objections are raised:
   i) *negotiating* with objecting State(s) on details of the proposed assignment with a view to solving identified incompatibilities; or
   ii) the *withdrawal of the objected proposal* and corresponding *notification* to **all States concerned** and the **Registration Office**

Note 1: In case of objection, requesting States may extend their bilateral negotiations with objecting States beyond the 4-week period of paragraph 3.7 b) up until 3 months from the submission of the co-ordination request.

Note 2: Requests for modifications of the remarks field or of the location name field as well as VHF COM conversions to 8.33 kHz channel spacing on the same frequency may reach the Registration Office ***without prior co-ordination.***

Note 3: Care of the Registration Office, objected proposals, , are deleted from the pertinent databases after the lapse of 3 months from their submission. Objected proposals under investigation by the Registration Office are not subject to removal.

3.5 Deletions of assignments are submitted to the Registration Office and notified to all States concerned.

3.6 All States concerned with a possible impact of a proposed addition/modification of an assignment on one or more of their registered assignments or proposals are responsible for:

a) the *protection of their registered assignments and proposals* against incompatibility with the proposed addition/modification;

b) the *proper reaction* to the **requesting State** and the **Registration Office,** based on the examination of a proposal as above, within 4 weeks from the notification of the co-ordination request (Note: No answer by the target date will be taken as an approval); and

c) the *proper reaction* to the **requesting State** and the **Registration Office** in the eventof an improperly registered proposal.

Note 1: Valid objections can be raised against proposals which do not contain all information required for compatibility assessment or contain implausible data (e.g. frequencies not complying with the appropriate pairing tables, in the case of paired services).

3.7 After the lapse of the 4-week period of paragraph 3.6b), non-objected proposals are registered in the appropriate ICAO EUR COM table of frequency assignments. Objected proposals are registered in the appropriate table only after all objections to these proposals are withdrawn.

Note 1: If bilateral negotiations are foreseen to last longer than 4 weeks, States having valid concerns about a proposal are advised to object this proposal, without prejudice to the outcome of the negotiations.

Note 2: Until SAFIRE supports fully the automation of this step, manual action will be required for the registration of proposals.

3.8 The Registration Office is responsible for:

a) the registration of assignments and in general for the maintenance of the COM tables and associated databases, both in terms of form and content;

b) the archiving of the co-ordination registration requests of non-SAFIRE States; and

c) the publication on the ICAO web-site of the updated COM tables on a semiannual basis;

d) inter-regional co-ordination with adjacent ICAO Region Offices, in the sense of the exchange of critical information for the co-ordination and the registration of assignments;

e) providing the mediation described above in paragraph 3.3.3), as the need of information exchange arises between SAFIRE and non-SAFIRE states; and

f) the oversight of SAFIRE operation.

3.9 The format of the messages used for information exchange over AFTN should follow the guidelines described in the Appendices A, B and C. Appendix D (templates and examples° clarifies the form and the content of the information to be exchanged.

3.10 A proposing State faced with an unwarranted objection may submit a registration request to the Registration Office with the corresponding notification to all States concerned. This request should be accompanied with the appropriate documentation. The Registration Office considers the request on condition that sufficient evidence is provided that the proposing State has diligently sought the withdrawal of the objection by the objecting State(s).

3.11 Taking due account of the views of the parties involved, the Registration Office performs then an examination of the case with respect to the conformity with the procedures, the technical requirements and the general principles governing the safe and efficient use of the aeronautical frequency spectrum.

3.12 In this task the Registration Office may ask the assistance of a group of experts on an ad-hoc or a permanent basis at which the representatives of the concerned parties may be present to introduce their views.

3.13 If the finding of the examination of the registration request is favourable, the proposal is registered by the Registration Office in the appropriate COM table with an indication of the objecting State(s). The assignment then enjoys full protection rights with respect to all States including the objecting States. The outcome of the examination shall be notified to the parties concerned.

3.14 Concerned States disagreeing with a finding of the Registration Office may request the review of it. The review of a finding may also be undertaken on the initiative of the Registration Office itself when it considers it justified.

3.15 On applying FMG decisions, the Registration Office is authorised to relegate a proposal or an assignment to the status of an objected proposal. Such a measure may be for instance required in preserving the rights of States in relation to the priority of submission of co-ordination material

3.16 For the basic steps of the co-ordination and registration procedure, the actions of SAFIRE and non-SAFIRE States are clarified below:

	Non-SAFIRE States	SAFIRE States
Submission of a proposal	Send appropriate message to the Registration Office	Make appropriate entry into SAFIRE
Reaction to a proposal	Send appropriate message to the Registration Office	Make appropriate entry into SAFIRE
Registration request for a proposal	Send appropriate message to the Registration Office	Make appropriate entry into SAFIRE

Appendix A: Country codes and AFTN addresses to be used for frequency co-ordination

Organization/State	*ITU Country Code*	*AFTN address*	*E-mail or fax*
ICAO Regional Office (ICAO Paris)	-	LFPSYAYU	icaoeurnat@paris.icao.int
EUROCONTROL	-	LKINEURO	frequency.management@eurocontrol.int
Albania	ALB	LATIYFYX	illir.bano@dgca.gov.al
Algeria	ALG	DAAAYKYD	
Armenia	ARM		+37 41 228 2066
Austria	AUT	LOWWYNYX	andreas.eberharter@austrocontrol.at
Azerbaijan	AZE		farhan.guliyev@azans.az
Belarus	BLR	UMMDYKYX	kvv@fccc.by
Belgium	BEL	EBVAYTYX	vdh@belgocontrol.be
Bosnia and Herzegovina	BIH	LQBHYATS	jasmina.bogdanic@bhansa.gov.ba
Bulgaria	BUL	LBSFYAYX	freqmng@bulatsa.com
Croatia	HRV	LDZAYATS	frqmng@crocontrol.hr
Cyprus	CYP	LCNCYAYX	cmarouchos@dca.mcw.gov..cy
Czech Republic	CZE	LKPRYAYX	jiri.valenta@mdcr.cz
Denmark	DNK	EKCAYAYX	pejo@slv.dk
Egypt	EGY	HECAYAYX	
Estonia	EST	EETNYTYX	
Finland	FIN	EFHKYAYX	kimmo.urhonen@fcaa.fi
France	F	LFBOYHYF	COM2:patrick.treton@aviation-civile.gouv.fr COM3:david.rojat@aviation-civile.gouv.fr
Georgia	GEO		m.mikhailov@airnav.ge
Germany	D	EDDAYGNA	bodo.eichfrequm@baf.bund.de
Greece	GRC	LGACYAYT	d5c@hcaa.gr
Hungary	HNG	LHBPYAYX	perjesi.attila@nkh.gov.hu
Ireland	IRL	EIDWYAYX	michael.oconnor@iaa.ie
Israel	ISR	LLAAYYYX	
Italy	I	LIIRYTYX	silvio.zappi@enav.it
Jordan	JOR	OJAMYAYX	
Kazakhstan	KAZ		
Kyrgyzstan	KYR		dga@infotel.kg
Latvia	LVA	EVRRYTYX	edgars.dreijers@latcaa.gov.lv
Lebanon	LBN	OLBAYFYX	
Libya	LBY	HLLTYAYX	
Lithuania	LTU	EYVCYTYX	snieckus.v@ans.lt
Luxembourg	LUX	ELLXYAYF	
Malta	MLT	LMMLYAYA	george.borg-mark@gov.mt
Moldova	MDA	LUKKYAYX	toma@caa.md
Morocco	MRC	GMMRYHDT	nmassali@dac-maroc.gov.ma
Netherlands	HOL	EHGGYIEZ	aviation@agentschaptelecom.nl
Norway	NOR	ENCAYAYX	hugo.frivag@caa.no
Poland	POL	EPWAYFMG	t.babut@pata.pl
Portugal	POR	LPPTYVYW	fernando.simoes@nav.pt
Romania	ROU	LRBBYDYT	sergiu.dumitrescu@caa.ro
Russian Federation	RUS	UUUUYTYX	gaynov_ma@fana.ru
Serbia	SRB	LYBBYTYX	radmila.papulic@smatsa.rs
Slovak Republic	SVK	LZIBYQYC	sap@caa.sk
Slovenia	SVN	LJLAYAYX	jure.locniskar@sloveniacontrol.si
Spain	E	LEANZXIC	safire_spain@aena.es
Sweden	S	ESALYAYX	Anders.Erzell@transportstyrelsen.se
Switzerland	SUI	LSSOYAYF	arthur.leibundgut@bazl.admin.ch
Syrian Arab Republic	SYR	OSDSYTYX	
The Former Yugoslav Republic of Macedonia	MKD	LWSKYKYT	patcev@dgca.gov.mk
Tunisia	TUN	DTTCYDNA	malikarekik@yahoo.fr
Turkey	TUR	LTAAYAEM	bdogan@shgm.gov.tr yscetin@btk.gov.tr
Turkmenistan	TKM		
Ukraine	UKR	UKKAYTYD	ukrcns@avia.gov.ua
United Kingdom	G	EGGAYTYF	spectrum@caa.co.uk
Uzbekistan	UZB		

Note 1: E-mail and fax are the only method of communication with ICAO EUR/NAT Office

Note2: Proposals for the assignment of frequencies or identifications have to be addressed to States concerned. However, the following States would like to get copies of all proposals and registration messages: BEL, D, F, G and HRV.

Appendix B: A unique message reference system

The National Co-ordination Reference (NCR)

Field name	***Explanation***	***Number of characters***
Country Code	ITU Country Code (ref. Appendix A)	1 or 3 letters
Type of service (COM Table number)	2 communications (Table COM 2) 3 VHF/UHF/SHF navigation (Table COM 3) 4 LF/MF navigation (Table COM 4)	1 digit (2, 3 or 4)
Sequential number	A unique sequential number for each type of service	4 digits
Co-ordination phase	Indicates the phase of the co-ordination: P – Proposal S – Standard Updating Message	1
Type of amendment	Indicates the different amendments. Addition of a new assignment (ADDITION) Modification of an existing assignment (MODIFICATION) Deletion of an existing assignment (DELETION) Withdrawal of a proposal (WITHDRAWAL)	10, 12 or 14

Note 1: A NCR should be associated with only one assignment. If a co-ordination message refers to more than one assignments then a separate NCR should be used for each one of them.

Note 2: Frequency changes of registered assignments may be co-ordinated in steps – as additions of a new assignment identical to the existing except the frequency and later, after the new frequency has become operational, with a deletion of the old assignment using different sequential numbers for addition and deletion.

Example: HOL 2 0027 S (ADDITION)

Country Code	Type of service	Sequential number	Co-ordination phase	Type of amendment
HOL	2	0027	S	(ADDITION)

This NCR should be used to register an additional assignment to the VHF communications list for the Netherlands. The NCR of the next co-ordination message of the Netherlands for the same type of service should start with HOL 2 0028.

Basic principles for the use of a NCR in the co-ordination process:

- Each addition of a new assignment or modification or deletion of an existing assignment shall be referenced with an individual NCR.
- The same NCR will be used for an assignment during a complete co-ordination process.
- If a proposal is withdrawn then the NCR sequential number of the withdrawal message shall be identical to the one used in the corresponding proposal.

Appendix C: Mandatory Coordination Data

It is mandatory to include the data fields set out in the tables D1 to D3 below in all frequency coordination proposals.

The mandatory data items marked * have no impact on compatibility with other frequency assignments. When modifying existing frequency assignments, changes to these data items are permitted without prior coordination with other States.

COM 2

National Coordination Reference
Country Code
Location name*
Channel
Service type
DOC
Coordinates (not applicable to area assignments)
Service area name (for all area assignments)
Polygon coordinates (for all area assignments)
Climax service and number of legs (for all Climax services)
Coordinates of transmitting and receiving ground stations (applicable to coordinations after 31 December 2015 in specified cases as set out below)

Table D-1 – Table COM 2 Mandatory Data Fields

Coordination of COM 2 ground stations

The location of COM 2 transmitting and receiving ground stations shall be coordinated in the following cases:

- Area services where the transmitting ground stations are outside of the DOC;
- Circular services where the transmitting ground stations are not within 3NM of the DOC centre;
- Transmitting or receiving ground stations that lie within 10 NM of an adjacent State's landmass;
- Cases where the inclusion of the transmitting or receiving ground station location is a precondition for accepting an incompatible proposal.

It is recommended that for Climax services, the position of the ground stations is coordinated where possible.

COM 3

ILS	VOR	DME/TACAN	GBAS	MLS
National Coordination Reference				
Country Code				
Facility type (e.g. ILS, VOR, ILS/DME, VORTAC etc.)				
Location name*				
DOC				
Identification				
Coordinates (not applicable to area assignments)				
Service area name (for all area assignments)				

Polygon coordinates (for all area assignments)				
Frequency	Frequency	Channel	Frequency	Channel
-	EIRP	EIRP (PEP)	EIRP	-
Runway served (required in cases where TRD has not been coordinated)	-	-	-	Runway served (required in cases where TRD has not been coordinated)
-	-	Directional DME (Y/N)	Elevation (amsl)	-
True radiation direction (TRD) required for all new coordinations	-	TRD (required for directional DMEs only)	Antenna polarisation - GBAS/H (default) or GBAS/E	- True radiation direction (TRD) required for all new coordinations
			Time slot number(s)	
			Data selector number(s) (RPDS and RSDS)	

Note: TRD and runway information not applicable to area assignments

Table D-2 – Table COM 3 Mandatory Data Fields

COM 4

National Coordination Reference
Country Code
Location name*
Frequency
Service type – NDB or Locator
Identification
Coordinates (not applicable to area assignments)
Range
Service area name (for all area assignments)
Polygon coordinates (for all area assignments)

Table D-3 – Table COM 4 Mandatory Data Fields

4 Procedure to allocate or request a new UHF Channel for ATC communications in GAT

4.1 General Overview

4.1.1 The UHF band (225-400 MHz) within NATO Member States is collectively managed by the NATO Frequency Management Sub-Committee (FMSC), with the technical and administrative support of the Spectrum Management Branch (**SMB**) which is a permanent Staff located at NATO Headquarters (NATO HQ), Brussels.

4.1.2 When a request for assignment in the UHF band is received at SMB, it will be checked for correctness and run through the NUFAS tool (NATO UHF Assignment Software) that will identify a proper UHF channel taking into account all geographical, technical and administrative details provided in the request. Once the frequency is identified and assigned, the assignment record is stored in the SMB database and a copy is sent back to the national agency (NARFA or equivalent office) of the requesting State (CASE 1 for NATO State or CASE 2 for Non NATO State).

Important Note:

Since the band is managed centrally by SMB which maintains a central database of all UHF Air/Ground/Air assignments, the Nations do not normally nominate or propose frequencies in the requests; SMB assigns directly the best suitable frequency for the request.

4.2 Case 1: For NATO Member States

4.2.1 The procedure for NATO Member States to get a deconflicted frequency assignment in the NATO UHF band (225-400 MHz) is governed by a NATO Agreement which is of application throughout NATO Europe. Every NATO Member State has within its Ministry of Defence a National Radio Frequency Agency (NARFA), or equivalent office, which acts as the point of contact between the Nation and the SMB at NATO HQ. NARFAs collect requests from their National Users, either military or civilian, willing to operate in the UHF band, and forward them to the SMB. The format of the request coming from the national users to its NARFA is a national decision, but the format of the request forwarded to SMB must use the NATO "Spectrum Management Allied Data Exchange Format" (SMADEF). A free software tool (ARCADE), is distributed by SMB to help producing requests in SMADEF form.

4.3 Case 2: For Non NATO Members

4.3.1. These States that are not Member of NATO but that belong to EUR/NAT ICAO Region may also get support from the SMB at NATO HQ in the process of deconflicting UHF channels to be used for Civilian Communications. This deconfliction is necessary due to the large coordination distances involved to avoid interferences.

4.3.2 The **Appendix A** is a simplified request form, based on the information normally provided in SMADEF format. It lists the information that, as a minimum, is necessary to the SMB to run their Frequency Assignment System in order to identify an available UHF channel. This form may be subject to changes that will be notified by NATO as necessary. An example of a filled-in questionnaire is also attached.

Notes:

1. Other information may be required by SMB from those States on a case by case basis and this will be done by bilateral coordination with the Point Of Contact mentioned in the request form.

2. Non NATO Member States who wish it are free to use the full SMADEF format and associated free software tool ARCADE, in place of the simplified form at **Appendix X**.

Appendix A: UHF Request Form:

Items	Data	Example
	Geographical data	
Station Name	*Up to 24 characters*	***ORLY ARPT***
Antenna Location	*dddmmssE/W - ddmmssN/S*	***0022157E - 484352N***
Antenna Site Elevation *(AMSL in meters)*	*MMMMM*	***88 m***
[1/2] Service Radius *(in KM)*	*KKKK*	***78 Km***
[1] Aeronautical Service Height *(in feet)*	*fffff*	***25000ft***
	Technical data	
Transmitter Nomenclature (name)	*Not essential*	***R&S Serie 200***
Tuning lower limit (in MHz)	*Mxxx.xxx*	***M225***
Tuning upper limit (in MHz)	*Mxxx.xxx*	***M399.975***
Tuning increment	*25 or 50kHz*	***25K***
Maximum output power (in dBW)	*xx.x*	***17.0***
Antenna Nomenclature (name)	*Not essential*	***HK001***
Antenna Type	*E.g.UHF Broadband, Whip,..*	***OMNIDIRECTIONAL***
Antenna Polarisation	*V, H, M,..*	***V***
Antenna Gain (in dBi)	*-/+xx.xxdBi*	***+2dBi***
Emission Designator (ITU code)	*E.g. 6K00A3E--*	***6K00A3E--***
VHF Assigned at the site(to avoid harmonics)	*Mxxx.xxx, Mxxx.xxx,…*	***M131.35, M123.875, M124.45, M118.7, M120.5, M121.7, M121.825, M127.75, M128.375, M121.05***
Forbidden or non desirable Freq(or band)	*Mxxx.xxx to Mxxx.xxx*	***M225 to M230 M235.125 M380 to M385 M390 to M395***
	Administrative data	
Owner ITU Country code	*C,CC or CCC*	***F***
Call sign or ICAO Location identifier	*LLLL*	***LFPO***
Point Of Contact Data	*Name, Tel, Fax, E-mail,…*	***M. DUCHEMIN Tel: +33.1.22.33.44.55 m.duchemin@skynet.fr***
Customer Reference Number	*If any*	***-***
Operational Date	*YYYYMMDD*	***20070601***
Expiration Date (*+ 5 Years by default*)	*YYYYMMDD*	***20120630***
Remarks	*All pertinent information not covered by the above item but helpful for the assignment and record process.*	***e.g.: This assignment will be used by ATC in charge of States Aircraft not equiped with 8.33***

Note: **1** Also known as protected range and protected altitude

2 If not a circle but a sector (polygon) please insert the coordinate points that represent the boundary of the polygon.

-- END --