



International Civil Aviation Organization

AFI/FMG/2

2nd Meeting of AFI Frequency Management Group

**AFI Air Navigation Plan (ANP)
and other relevant ICAO provisions**

Presented by the ICAO Secretariat

(Dakar, 18— 19 April 2011)



Outline

- ✈ General Methodology for Compatibility Analysis of Aeronautical Radio Systems
- ✈ Air Navigation Plan (ANP) and other relevant ICAO Provisions
 - Aeronautical Mobile Service
 - Aeronautical Radio Navigation Service
 - Frequency Management



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General methodology for compatibility analysis of aeronautical radio systems

General methodology for compatibility analysis of aeronautical radio systems



- The general methodology is mainly based on ITU-R Recommendation SM.337-4 (Spectrum Management) which is logically combining currently available models and parameters of both desired and undesired systems, e.g.:
 - signal power and spectral distribution,
 - receiver selectivity,
 - antenna patterns,
 - propagation attenuation
 - etc.
- Recommendation ITU-R SM.337-6 provides the procedures for calculating distance and frequency separation for an acceptable (agreed) interference level.

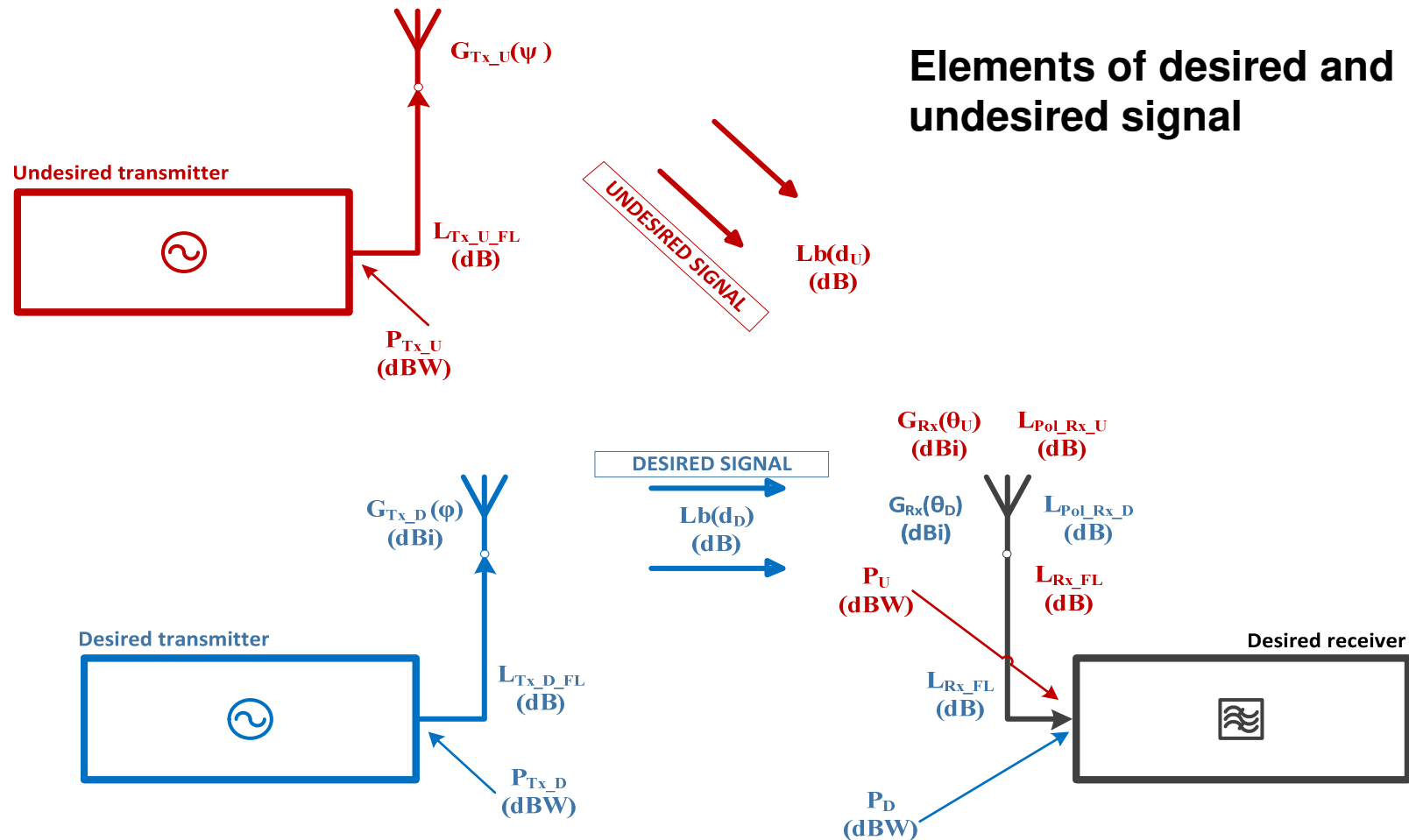


Methodology

The electromagnetic compatibility of radio equipment should be calculated by the following method:

- **Step 1:** determine the desired signal level at the victim receiver front end;
- **Step 2:** determine the resulting level of interference at the victim receiver's front end;
- **Step 3:** determine the interactive effects among wanted signals, interference and receiver characteristics for various frequency or distance separations;
- **Step 4:** determine the appropriate ITU-R propagation model to be used; and
- **Step 5:** determine, from these data, a relationship between the frequency separation and distance separation that the interference is considered tolerable.

Methodology



$$P_D = P_{Tx_D} - L_{Tx_D_FL} + G_{Tx_D}(\phi) + G_{Rx}(\theta_D) - L_{Rx_FL} - L_{POL_Rx_D} - L_b(d_D)$$

$$P_U = P_{Tx_U} - L_{Tx_U_FL} + G_{Tx_U}(\psi) + G_{Rx}(\theta_U) - L_{Rx_FL} - L_{POL_Rx_U} - L_b(d_U) + FDR(\Delta f)$$



- P_D : Desired signal level P_D (dBW) at the victim receiver front end
- P_{TX_D} : Output power of the desired transmitter (dBW)
- $G_{TX_D}(\varphi)$: Gain of the desired transmitting antenna in direction of victim receiver with respect to an isotropic antenna (dBi)
- $L_{TX_D_FL}$: Feeder link losses between output of the desired transmitter and the input of the desired transmitting antenna (dB)
- $G_{RX}(\theta_D)$: Gain of the receiving antenna in direction of desired transmitter with respect to an isotropic antenna (dBi)
- L_{RX_FL} : Feeder link losses between output of the receiving antenna and the input receiver (dB)
- $L_{POL_RX_D}$: Loss due to polarization mismatch of receiving antenna with respect to desired transmitted signal (dB)
- $L_b(d_D)$: Basic transmission loss for a separation distance d_D between desired transmitter and receiver (dB) (see Recommendation ITU-R P.341)
- φ : Angle between boresight of desired transmitting antenna in the direction of the desired receiving antenna
- θ_D : Angle between boresight of the desired receiving antenna in the direction of the desired transmitting antenna



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Aeronautical Mobile Service

AMS



AERONAUTICAL MOBILE SERVICE

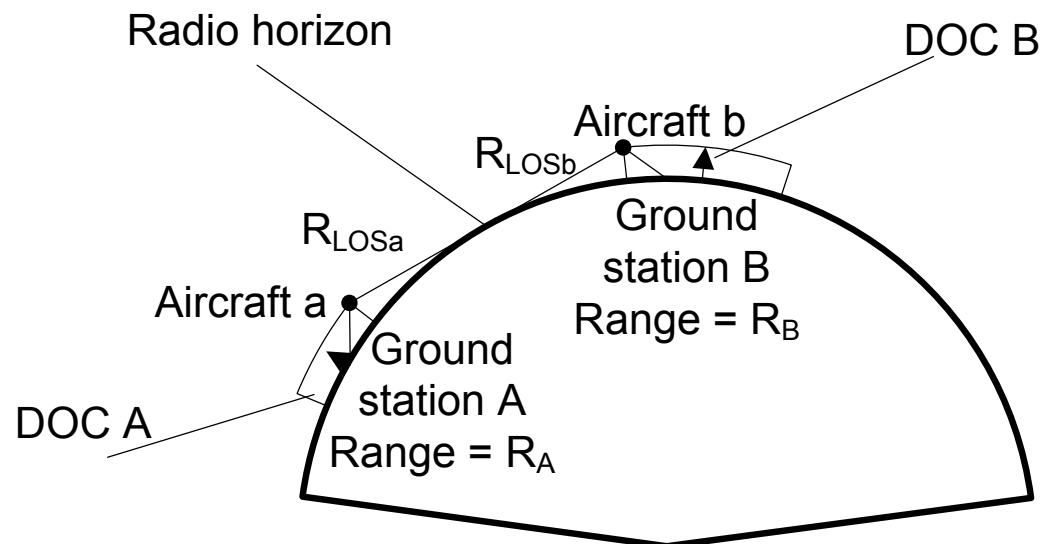
- ✈ The aeronautical mobile service (AMS) communication plan comprises all facilities recommended in respect to air-ground communications for international air navigation, together with the frequencies recommended for assignment to these facilities. The plan is detailed in AFI FASID Table CNS 2A.

Frequency assignment planning criteria for air/ground VHF communication systems



Co-channel frequency

- ✈ Protection of co-channel frequency assignments is normally obtained by securing that the interfering (unwanted) transmitting station (e.g. aircraft) is below the radio horizon (Radio Line Of Sight (R_{LOS})) of the victim aircraft receiver.
- ✈ Protection of the first adjacent channel is obtained by maintaining a minimum separation of 10 NM between the different DOC areas within which aircraft are operating.

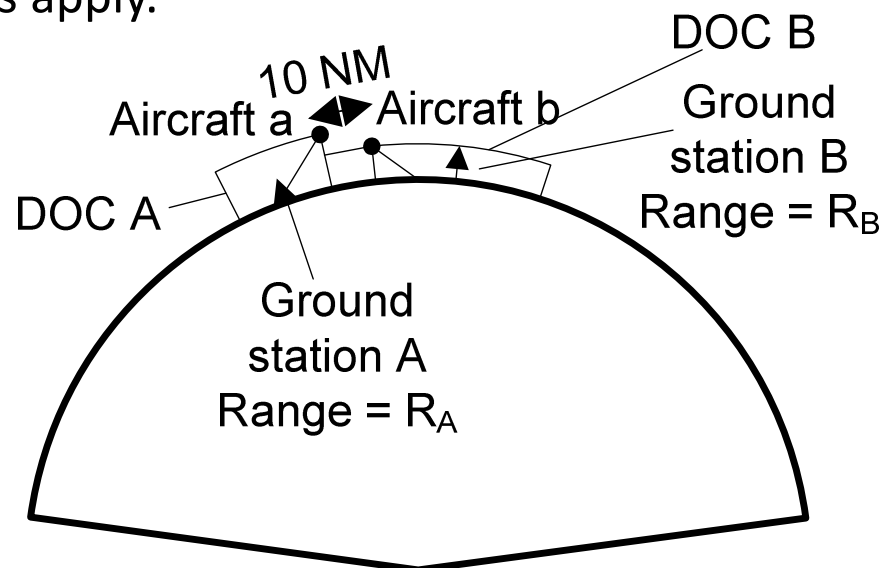


Frequency assignment planning criteria for air/ground VHF communication systems



Adjacent frequency

- ✈ The minimum separation between aircraft operating on the first adjacent 25 kHz channel is 10 NM. This requires the DOC to be separated with at least 10 NM.
- ✈ The minimum separation between two ground stations operating on the first adjacent 25 kHz channel is $D_{\text{minadj}} = R_A + 10 \text{ NM} + R_B$ as shown in figure below.
- ✈ For broadcasting services, such as VOLMET or ATIS different minimum separation distances apply.



Frequency assignment planning criteria for air/ground VHF communication systems



➔ [Table of uniform designated operational coverage.doc](#)



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ANP Provisions for Aeronautical Mobile Service

AMS



AFI FASID Table CNS 2 – AMS (Extract)

Location and function Emplacement et fonction Lugar y función	VHF	HF en-route HF en route HF en ruta
1	2	3

Location and function Emplacement et fonction Lugar y función	VHF	HF en-route HF en route HF en ruta
1	2	3

ALGERIA

DAUA ADRAR/Touat
TWR

1

DAAA ALGER
ACC-U
ACC-L
FIS-L
VOLMET

3-ER

8
5
3
1

AFI-2

DAAG ALGER/Houari Boumediene
SMC
TWR
APP-L

1
1
4

DABS TEBESSA/Tebessa
TWR
APP-L

1
1

DAON TLEMCEM/Zénata
TWR
APP-L

1
1

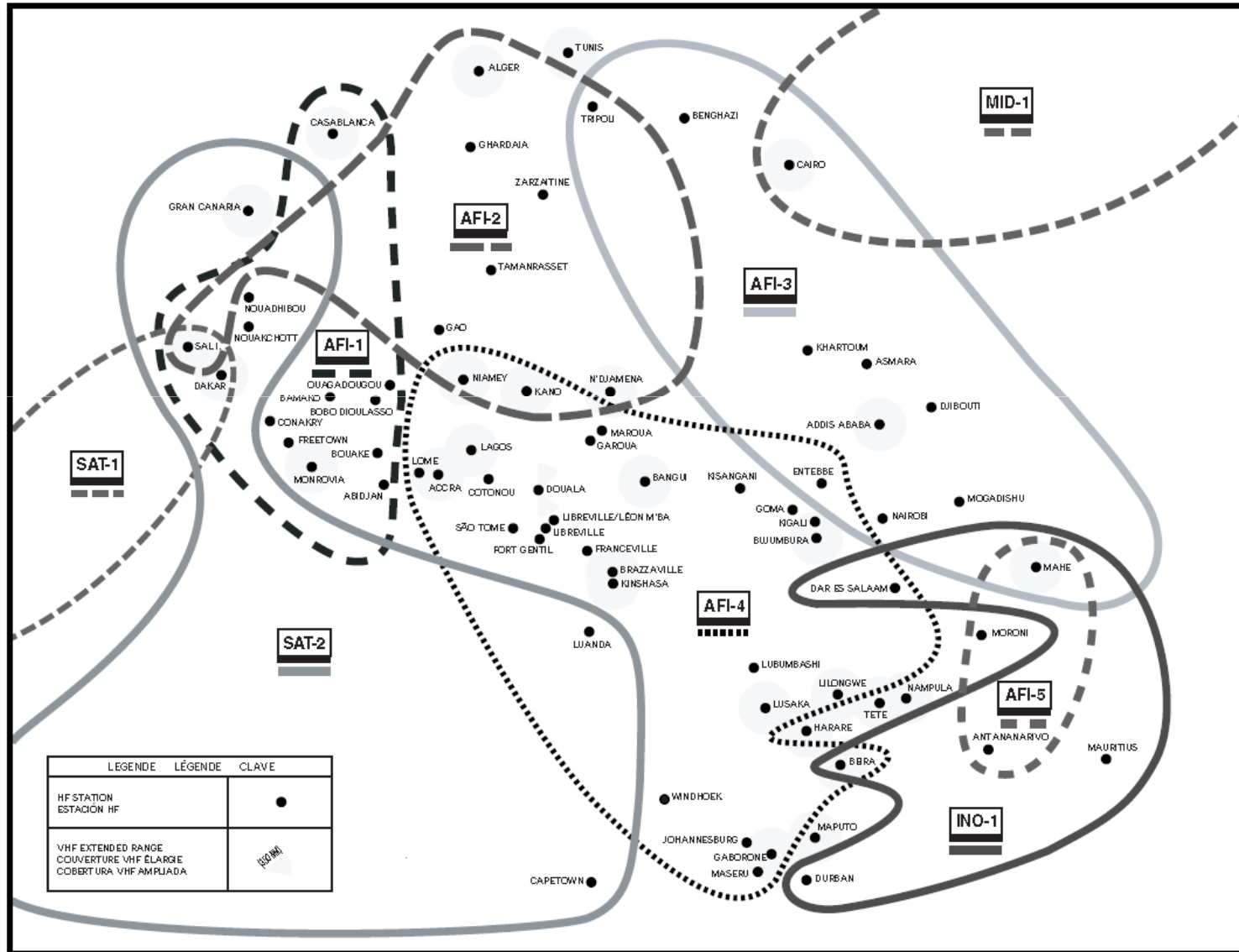
DAUZ ZARZAITINE

AFI-2R

DAUZ ZARZAITINE/In Aménas
TWR
APP-L

1
1

AFI FASID Chart CNS 2



Elimination of interference on AMS frequencies

[LIM AFI, Rec. 8/5]



- ➔ **States should coordinate, on a national basis with the appropriate authorities, a programme directed towards achieving elimination of the interference** currently being experienced on some of the frequencies allocated to the aeronautical mobile (R) service in the region; and, when reviewing methods for developing such a national programme, consideration should be given to the procedures in the International Telecommunication Union (ITU) Radio Regulations and prescribed therein:
 - — Article 15, Section VI — Procedure in a case of harmful interference; and
 - — Article 16 — International Monitoring.
- ➔ In the case of **persistent harmful interference to an aeronautical service which may affect safety, it should immediately be reported to ICAO and the ITU** using the prescribed format (Attachment D refers), for appropriate action.

Measures to reduce harmful interference from carrier systems [LIM AFI, Rec. 8/6]



States should:

- ✈ a) where practicable, **prohibit the use of carrier systems employing frequencies falling within any of the aeronautical radio bands.**
Where this is not practicable, installation and maintenance practices should provide a high degree of assurance that electromagnetic radiated energy will not create harmful interference to aeronautical safety services; and
- ✈ b) **establish national regulations to protect aeronautical radio communications and navigation facilities,** taking into account the maximum permitted interfering field strength levels in the prescribed critical area around the aeronautical radio site.

Measures to reduce harmful interference from VHF broadcast services [LIM AFI, Rec. 8/7]



States should:

- a) **take action to coordinate with the appropriate bodies within their administrations, and to assist in the establishment by the appropriate ITU bodies of adequate technical criteria to avoid harmful interference** to the aeronautical safety services operating in the frequency band 108–137 MHz from broadcast services operating in the adjacent frequency band 100–108 MHz; and
- b) **establish national regulations to protect aeronautical radio communication and navigation services operating in the VHF bands** from harmful interference emanating from broadcast services operating in adjacent VHF bands.



VHF frequency utilization list

States should:

- a) **coordinate, as necessary, with the ICAO Regional Office concerned, all radio frequency assignments** for both national and international facilities in the VHF 117.975–137 MHz bands;
- b) **coordinate frequencies for new requirements and frequency changes** for existing requirements with the ICAO Regional Office concerned prior to implementation of such frequencies; and
- c) **report complete and accurate** data for inclusion in the frequency list of the ICAO Regional Office concerned.
- **The ICAO Regional Office concerned should issue lists of frequencies in the VHF 117.975–137 MHz bands** assigned to national and international aeronautical communication facilities.

Geographical separation criteria currently used in AFI



Service	TWR	AFIS	AS	APP-U	APP-I	APP-L	ACC-U	ACC-L	FIS-U	FIS-L	VOLMET	ATIS
TWR	175											
AFIS												
AS			25 (50)									
APP-U				820								
APP-I					550							
APP-L						370						
ACC-U							520*					
ACC-L								390* (500*)				
FIS-U												
FIS-L												
VOLMET											520	
ATIS												520

Notification of frequency assignments [AFI/6, Rec. 13/13]



States should:

- a) **notify the ITU**, for inclusion in the International Frequency List, **of the aeromobile frequencies assigned to the aeronautical stations** within their jurisdiction; and
- b) **notify the ITU of the cancellation of frequency assignments** which are no longer required for use.



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ANP Provisions for Aeronautical Radio Navigation Service

ARNS



AERONAUTICAL RADIONAVIGATION SERVICE

- ➔ The aeronautical radio navigation plan comprises **all facilities that provide navigation support to en-route, terminal, approach, landing and surface movement operations.**
- ➔ Every single radio navigation facility must operate in strict conformance with the applicable standards.
- ➔ The provision of radio navigation services will gradually transition from a ground-based to a satellite-based system (the Global Navigation Satellite System – GNSS).



AFI FASID Table CNS 3 - NAVAIDS

Station/Territory Station/Territoire Estación/Territorio	Rwy type Type de piste Tipo de pista	Function Fonction Función	ILS	L	DME	VOR	NDB	Coverage Couverture Cobertura	GNSS		Remarks Remarques Observaciones
									GBAS	SBAS	
1	2	3	4	5	6	7	8	9	10	11	12
ETHIOPIA											
ADDIS ABABA/Bole Intl	07 NPA 25 PA1	E A/L A/L	25-II*	X	X X X	X X X		200/500			
MAKALE		E			X	X		200/500			
DIRE DAWA/Dire Dawa Intl	15 NINST 33 NPA	E E A/L A/L		X	X X	X	X#	200/500 150			
GAMBELA		E					X	200/500			
LALIBELA		E					X	200/500			
GABON											
FRANCEVILLE/M'Vengue	15 PA1 33 NPA	E A/L A/L	15-II*	X X	X X X	X X X		200/500			
LIBREVILLE/Léon M'Ba	16 PA1 34 NPA	E A/L A/L	16-II*	X X	X X X	X X X		200/500			
PORT GENTIL/Port Gentil	03 NPA 21 PA1	E A/L A/L	21-I	X X		X X X		200/500			

Notification of frequency assignments to radio navigation aids [AFI/6, Rec. 14/4]



- ✈ States should, in all cases where they assign frequencies to radio navigation aids, **provide full details of these assignments to the relevant ICAO Regional Office**, as well as taking the necessary action for notification to the ITU through the appropriate authorities.

Geographical separation criteria for radio navigation aids in the AFI region



Criteria for VOR and/or VOR/DME installations in the AFI region

- ➔ [AFI/7, Rec. 10/2]
- ➔ States in the AFI region, when assigning frequencies for VOR and/or VOR/DME installations, should use the criteria shown in Appendix A to AFI FASID Table CNS 3.

Criteria for ILS installations in the AFI region

- ➔ [AFI/7, Rec. 10/3]
- ➔ States in the AFI region, when assigning frequencies for ILS installations, should use the criteria shown in Appendix A to AFI FASID Table CNS 3.

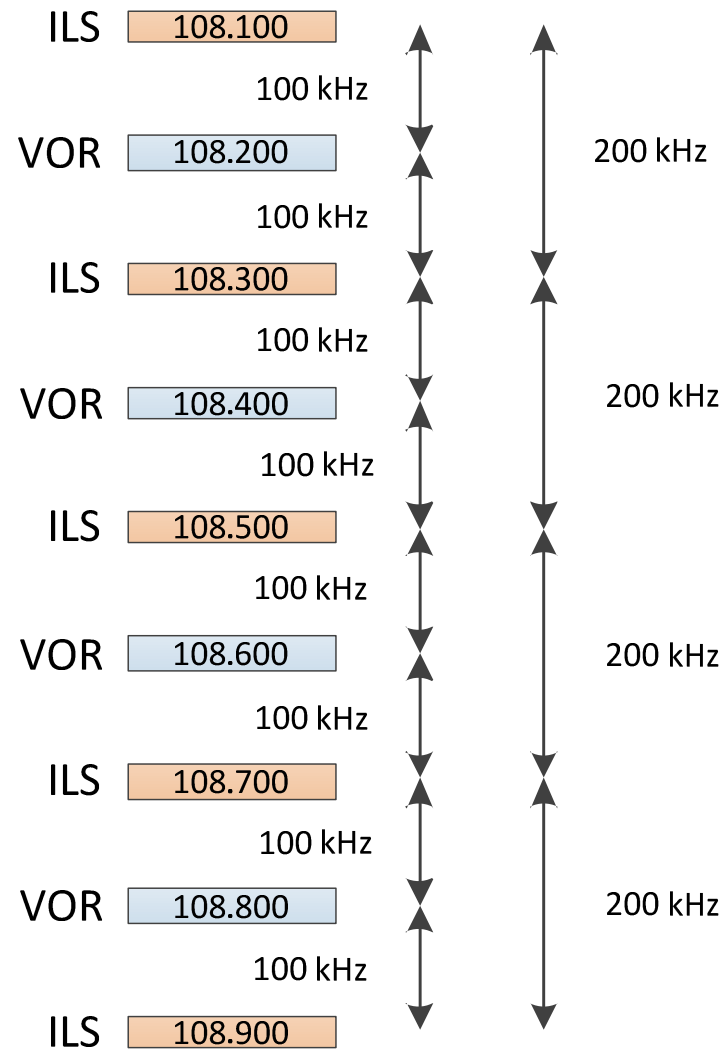


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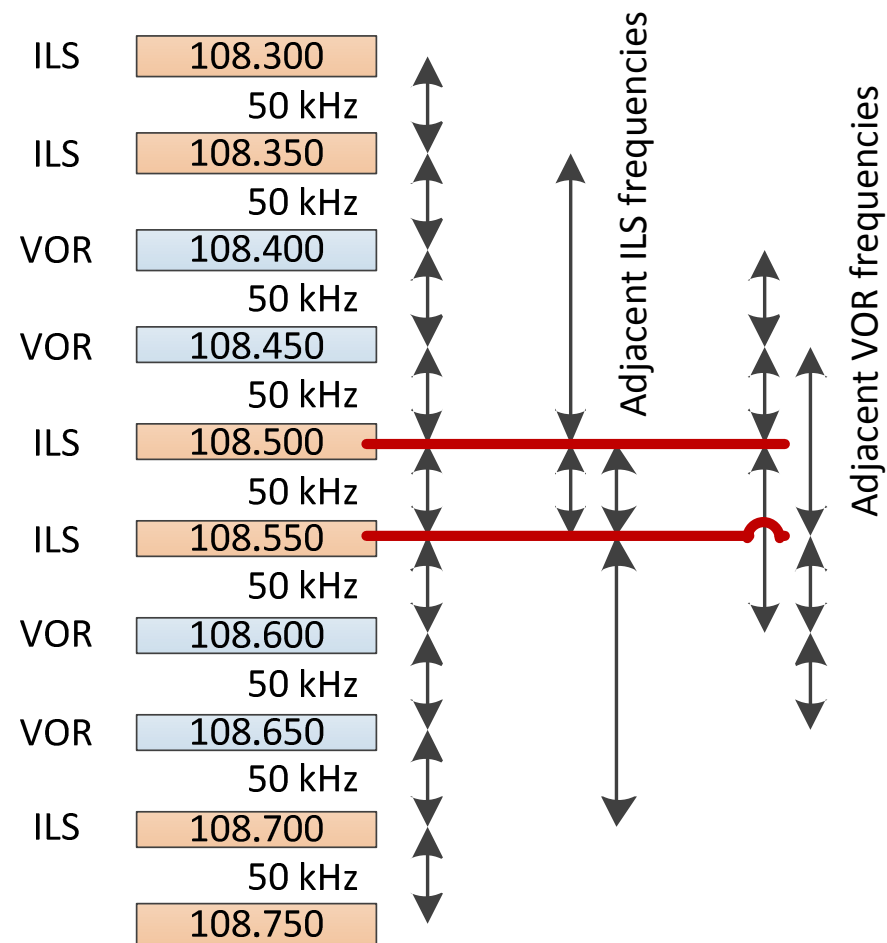
ICAO Annex 10 Criteria

ILS, VOR, DME

Adjacent channels for ILS frequencies with 100 kHz channel spacing



Adjacent channels for ILS frequencies with 50 kHz channel spacing

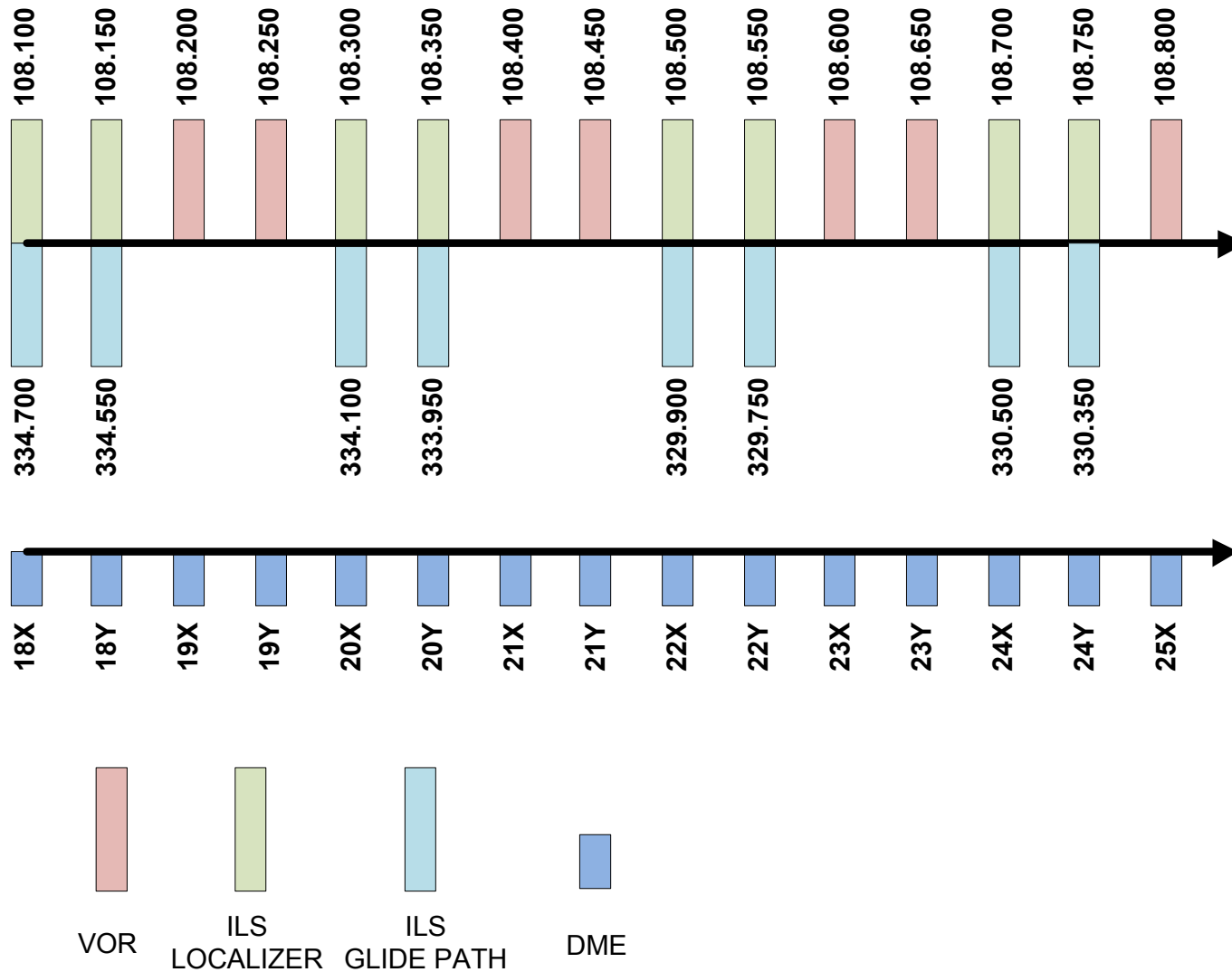


Overview of adjacent glide path frequencies in relation to the localizer frequency



Localizer/VOR	Glide Path
108.950	329.150
108.900	329.300
110.550	329.450
110.500	329.600
108.550	329.750
108.500	329.900
110.750	330.050
110.700	330.200
108.750	330.350
108.700	330.500
110.950	330.650
110.900	330.800
111.950	330.950
111.900	331.100
109.150	331.250
109.100	331.400
111.150	331.550
111.100	331.700
109.350	331.850
109.300	332.000
111.350	332.150
111.300	332.300
109.550	332.450
109.500	332.600
111.550	332.750
111.500	332.900
109.750	333.050
109.700	333.200
111.750	333.350
111.700	333.500
109.950	333.650
109.900	333.800
108.350	333.950
108.300	334.100
110.150	334.250
110.100	334.400
108.150	334.550
108.100	334.700
110.350	334.850
110.300	335.000

Pairing of ILS, VOR and DME frequencies





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ANP Provisions for Aeronautical Radio Frequency Management



General

- ✈ The radio frequency spectrum is a scarce natural resource with finite capacity limits for which demand is constantly increasing.
- ✈ **ICAO** is just one of the entities competing for spectrum allocation on behalf of the aviation community it serves and, like its competitors, ***must continue to justify spectrum requirements.***

...

- ✈ ***The rules of the ITU mechanism for spectrum allocation are such that safety-of-life and other justifying arguments need to be presented with force and States and international organizations have thus been invited by ICAO Assembly Resolution to support ICAO's position at World Radiocommunication Conferences (WRCs) and in regional and other international activities conducted in preparation for WRCs by a number of means.***



Policy statements

- ➔ Given the quasi-triennial pattern of WRC meetings recently adopted by the ITU and the importance of keeping up with the rapid developments in telecommunications, ICAO decided to develop and maintain an ICAO radio frequency document in the form of the ***Handbook on Radio Frequency Spectrum Requirements for Civil Aviation (Doc 9718)*** which contains ICAO policy statements relevant to the aviation requirements for the radio frequency spectrum.
- ➔ **The handbook is intended to assist States and ICAO in preparing for ITU conferences.**



Regional planning criteria

Geographical separation criteria for VHF air-ground communications

- ✈ Annex 10, Volume V provides detailed guidance concerning the required geographical separation criteria between stations operating on co-channel or adjacent frequency assignments. Geographical separation criteria as shown in Attachment F should be used for international VHF frequency assignment in the AFI region.



Radio frequency interference issues

- ➔ The subject of harmful interference to aeronautical communication, navigation and surveillance services has always been of paramount concern to the international civil aviation community. In particular, any interference to the aeronautical services in the band 108–137 MHz has usually been, and needs to be, treated by aviation administrations in an urgent and serious manner.



Conclusion

Mindful of the ICAO provisions presented herein, the meeting is invited to:

- ✈️ Propose amendments to these provisions in terms of additions, deletions, updates (as required); and
- ✈️ Ensure that these provisions are duly reflected in the AFI FMG mandate and work programme (Agenda Item 6 refers).



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Questions?



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Thank you