INTERNATIONAL CIVIL AVIATION ORGANIZATION

SUMMARY REPORT ON THE FREQUENCY MANAGEMENT WORKSHOP
(Dakar, Senegal, 28-30 September 2009)

Prepared by the ICAO Eastern and Southern African Office

The Frequency Management Workshop is as a result of the AFI Planning and Implementation Regional Group (APIRG), Conclusion 16/31.

Its Reports are therefore submitted to APIRG through the CNS Sub-Group for review and action.

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Documentation of the workshop can be accessed at: ftp://wacaf.dyndns.org/CNS/WSCD.zip

Glossary of acronyms

ACARS	Aircraft Communications Addressing and Reporting System
ACAS	Airborne collision avoidance system
ACC	Area Control Centre
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance broadcast mode
ASP	Aeronautical Surveillance Panel
AFI	Africa - Indian Ocean Area
AIDC	ATS Inter-facility data communications
AMHS	ATS messaging handling system
APIRG	AFI Planning and Implementation Regional Group
ATIS	Automatic terminal information service
ATM	Air Traffic Management
CNS	Communications, Navigation, and Surveillance
DCPC	Direct Controller Pilot Communications (voice/data)
GNSS	Global Navigation Satellite System
HF	High Frequency
HFDL	High Frequency Data Link
ITU	International Telecommunication Union
MODE S	Mode S - SSR Data Link
MSAW	Minimum Safe Altitude Warning System
PDC	Pre-departure clearance
RVSM	Reduced Vertical Separation Minimum
SSR	Secondary Surveillance Radar
TMA	Terminal Control Area
VHF	Very High Frequency
WGS-84	World Geodetic Reference System 1984

PART I - HISTORY OF THE WORKSHOP

1. Duration and Venue

1.1 The ICAO Frequency Management Workshop was held in Dakar, Senegal from 28 to 30 September 2009.

2. Objective

2.1 The objective was to introduce the new web-based frequency management software currently being developed by ICAO to manage aviation frequency spectrum and SSR Mode S Interrogator Identifier (II) codes. The seminar focused on HF assignments, coordination and assignment of SSR Mode S Interrogator Identifier codes and Frequency planning tool for CNS COM List 3.

3. Opening

3.1 The workshop was opened by Mr. Amadou Guitteye, ICAO Regional Director for the West and Central African Office, who expressed the need of frequency management in AFI in order to optimize the use of aeronautical frequencies. He stressed that with the growth of air transport in the coming years, international civil aviation will require more frequency spectrum. The Director also urged States to actively participate in ITU activities in their States and to participate on agenda items that will affect civil aviation at WRC-12 workshop. He assured the participants that ICAO on its part will give all the support AFI needs in the participation of WRC-12.

4. Officers and Secretariat

4.1 Ms. Mary Obeng, Regional Officer/Communications, Navigation and Surveillance (RO/CNS) of ESAF Office, was the Secretary of the workshop. Mr Robert Witzen, Consultant to CNS and a former secretary to ACP panel was the facilitator of the workshop. Mr Olov Carlsson, Technical Director of WRAP International, was invited to give complementary presentation to the frequency management software, taking into account the topography of the terrain.

5. Attendance

5.1 The workshop was attended by 17 delegates from Seven States and four international organizations. The list of participants is at **Appendix A** to the report.

6. Working Language and Documentation

6.1 English was used as the working language. Documentation was issued in English. A CD containing all the presentations was distributed to the participants at the end of the workshop. The list of the presentations is at **Appendix B** to the report.

7. List of Conclusions

7.1 During discussions at the workshop, conclusions were arrived at for further discussion at the Frequency Task Force meeting. The draft conclusions were:

DRAFT LIST OF CONCLUSIONS			
Number	**Title**	**Action by**	**Target date**
Concl. 1/1	ICAO to analyze the current assignments in the ICAO frequency list 3 (VHF COM) in order to identify potential harmful interference between COM assignments and submit these to the relevant ICAO contracting States for further consideration		
Concl. 1/2	That from the planning criteria in COM list 3 references to a 50 NM buffer around area services be deleted as well as all references to SST operations.		
Concl. 1/3	That the planning criteria for VDL, as contained in Appendix D be incorporated in COM list 3		
Concl. 1/4	That COM list 3 should be updated with the identification of extended range facilities.		

PART II - SUMMARY OF THE PROCEEDINGS

1. Summary of the Proceedings

1.1 The workshop covered a comprehensive list of topics on communications and surveillance but computer based SSR Mode S interrogator identifier code assignment planning tool was not discussed. The topics discussed were as follows:

- HF Frequency Assignments and Planning
- Progress on Computer Based Frequency Planning Tool for NAV Systems (COM List 2)
- Global Harmonization of COM Tables
- Updating of COM LISTS 1, 2 & C

1.2 The key technologies presented were:

- HF Planning – ICAO Programme for HF Frequency Assignments;` and
- Discussion on the Computer Based Frequency Assignment Planning Tool for COM Systems.

2. HF Frequency assignments and planning

2.1 The Workshop was presented with the provisional Agenda for the Frequency Management Workshop. The provisional Agenda was adopted by the workshop.

2.2 Under agenda item 1, the workshop reviewed details of the provisions governing the use of the aeronautical HF bands. It was pointed out that in the HF bands the coordination and registration of frequency assignments is completely in the hands of the International Telecommunication Union (ITU). These provisions are contained in Appendix 27 of the ITU Radio Regulations, which was revised in 1978. At that revision, single sideband operation was introduced in the aeronautical HF bands. The workshop noted that the aviation community had no desire to revise the provisions of Appendix 27 in the near future. Regulatory provisions in Appendix 27 allow for introducing frequency assignments that are not in accordance with the provisions of Appendix 27 but can receive, under the ITU regime for registration of frequency assignments, adequate protection. A technical change, approved by the ITU Radio Regulatory Board enabled the introduction of HF data link in these bands for use by civil aviation. The workshop noted that HF communications to-date is still in many areas of the world the primary means of communications over remote and oceanic areas.

2.3 The provisions of Appendix 27 provide for a frequency allotment plan whereby frequencies are allotted to certain geographical areas. Under the provisions of ICAO, the use of these frequencies, in particular for long distance international air routes, is coordinated by ICAO through Regional Air Navigation workshops or through the Planning and Implementation Regional Groups (PIRGs). This coordination includes the establishment of “families of frequencies” from different HF frequency bands to secure the availability of radio communications with aircraft over remote and oceanic areas and the (preferred) stations that should operate HF communications facilities. These plans are incorporated in the relevant Air Navigation Plan for each Region. However the coordination (technical) and registration of frequencies has to take place in the ITU through the Radio Regulators of the country in which the relevant radio station is operating.

2.4 The workshop noted that Appendix 27 also provides for frequency allotments to Regional and Domestic air route areas. These frequencies are used in areas where the use of VHF (including VHF extended range facilities) is not practical. The need for such frequency assignments are normally triggered by States and cover relatively small areas; e.g. part of a country or group of countries.

2.5 Appendix 27 also provides for HF frequency allotments for aeronautical operational control; i.e. for use by aircraft operating frequencies such as airlines. In the coordination of such frequency assignments ICAO normally plays no role of importance.

2.6 The workshop noted that the registration of HF frequency assignments in the ITU is far from ideal. Many frequencies in operational use are not registered by the ITU because they are not submitted to the ITU by the radio regulatory authorities; and where frequencies are registered, many errors in the registration are made. The workshop therefore was of the view that ICAO should initiate the development of an HF frequency list for the AFI Region that would be updated through the ICAO Regional Offices. The ICAO Secretariat was invited to initiate such a list (COM List HF) and coordinate with AFI States the currency of that list.

2.7 For the calculation of compatible frequency assignments in the HF bands, ICAO has developed a computer program "HF frequency planning". The workshop received a detailed demonstration of that program that facilitates HF frequency assignment planning. The workshop was informed that this program may be converted into a program which would also be developed by ICAO for the use of VHF frequencies (see Report on agenda item 2).

2.8 A copy of the "HF frequency planning" programme was handed out to the workshop. This program was in particular useful for undertaking compatibility calculation, generating a report on these compatibility calculations and for presenting the results of the compatibility calculations on a geographical map. This program included a detailed user manual. Some generic considerations on HF propagation are in **Appendix C** to this report.

3. Presentation and discussion on the computer based frequency assignment planning tool for COM Systems

3.1 Under this agenda item, the workshop noted that ICAO is in the process of developing a frequency management module for the coordination and planning of frequency assignment for VHF communication systems, operating in the band 117.975 – 137 MHz. This module is based on the availability of a global frequency assignment plan, in contrast to the currently separated Regional Frequency assignment plans. Such a global plan requires that the Regional planning criteria and the different format of the Regional plans be harmonized.

3.2 With regard to the harmonization of the format of the different Regional plans, the workshop noted that such harmonization was mainly editorial and that, from the global frequency assignment plan, Regional frequency list can be extracted in a format similar to the current frequency lists. This is further addressed under agenda item 6.

3.3 The workshop received a detailed presentation on the frequency assignment program "VHF-COM" and detailed exercises in which all participants were engaged. These exercises provided for a very good testing of the program on a number of different computers and computer platforms. The results of the testing provided in a number of areas, feedback from the participants to ICAO included:

- need to present the use of extended range stations on the maps in a better way;
- make the drop-down menus more user friendly;
- change the absolute reference to other files and folders used by the program into relative references in order to introduce the capability to install the program anywhere on a computer;
- rationalize the search for country names (e.g. Guinea and Equatorial Guinea);
- introduce the FIR name for all FIRs;
- introduce the capability to select in a query more than one country or a user defined geographical area;
- introduce the capability to select frequencies with 50 kHz separation only; and
- introduce the identification of inter-modulation products for COM systems.

The Secretariat will take these findings into account for implementation in future versions of the program.

3.4 During the exercises that were undertaken by the workshop it was noted that in some cases, when applying the required minimum separation distances, these were not always met. The workshop agreed that these cases would require further investigation. As a start, ICAO would be in a position, with the presence of the program available, to identify these cases and make details available for further action. Should these cases indeed require re-assignment of frequencies with the view to avoid harmful interference; and in particular, interference involving undesired ground stations through the program new assignments can be identified, as required. It was considered that in particular, coordination with international and regional organizations like ASECNA and IATA could be beneficial to remove harmful interference.

Conclusion 1/1: Presentation and discussion on the computer based frequency assignment planning tool for COM Systems

ICAO to analyze the current assignments in the ICAO frequency list 3 (VHF COM) in order to identify potential harmful interference between COM assignments and submit these to the relevant ICAO contracting States for further consideration.

3.5 The workshop also noted that in some cases the information contained in the COM list was not up to date. The ICAO Regional Offices (ESAF and WACAF) were invited to request States to provide the most recent and up to date information with regard to the frequencies used in their countries. An assessment with regard to the compatibility of such assignments will be undertaken by the relevant Regional Offices.

3.6 With regard to the program itself, the workshop noted that it would provide for useful database management functions such as sorting and querying the data base along a number of parameters. Other functions in the program included the presentation of data such as Designated Operational Coverage (DOC) and interference contours, the calculation of protection margins in NM, the testing of compatibility of new and existing frequency assignments and the identification of potential new frequency assignments.

3.7 An important and useful feature of the program was the capability to print and plot on a map with Google Earth the DOC and interference contours of frequency assignments that gave the opportunity to quickly assess cases of potential interference.

3.8 Finally, the workshop noted that the information contained in the global frequency list could be presented and exported in the format of the Regional VHF COM frequency list. Also, in the same format the results of any query e.g., a list of all frequencies in use by a single country could be selected and printed or exported to Excel.

3.9 The workshop recorded its great appreciation of the work undertaken by ICAO towards the development of the VHF COM computer program and unanimously supported the view that this program should be completed at the earliest opportunity. The workshop also was of the opinion that similar programs addressing the use of NAV frequency assignments including NDB and for SSR Mode S coordination need to be developed.

4. Progress on Computer based frequency planning tool for NAV Systems (COM LIST 2) (including identification of DMEs within range along PBN air routes

4.1 The workshop noted with appreciation that ICAO was planning to complete the available computer programs with another for frequency assignment planning for ILS, VOR, DME and NDB. It was recognized that the development of these programs would require harmonization of frequency assignment planning criteria for these systems in line with the latest provisions of Annex 10.

4.2 The workshop considered that, for:

- VOR planning criteria could be introduced that would allow for frequency assignment planning in line with the specific DOC requirements for VOR. This would include the introduction of key holing for VOR systems.

- ILS Localizer planning criteria, although they seem to overprotect the ILS, can be retained due to the absence of any congestion in the relevant band for ILS systems; and

- DME planning criteria, based on the relevant characteristics contained in Annex 10 needs to be developed.

4.3 The workshop noted that the NAV program could also be used for an elementary assessment of the number of DME's within the line of sighting of an aircraft at any given point in time during a flight.

4.4 Detailed material on the completion of these programs is in **Appendix E.**

4.5 The workshop was informed of an increasing number of cases of interference to ILS and VOR caused by FM broadcasting transmitters. The workshop was advised that ICAO would incorporate a method for assessing these interference cases in the NAV module. This would require an updated list of FM broadcast transmitters being available.

4.6 The workshop stated that this is a very important point. The absence of computer tools for assessing interference caused by FM broadcasting transmitter makes an interference assessment practically impossible.

5. Global Harmonization of COM Tables

5.1 Aspects relating to the global harmonization of the AFI COM tables have been addressed under agenda items 2 and 6.

6. Updating of COM LIST 1, 2, & 3 including a review of frequency assignment planning criteria for VHF COM Systems

6.1 Planning criteria however would need to be expanded. As the planning criteria, geographical separation distances were only established for similar aeronautical services e.g. TWR vs. TWR or APP/L vs. APP/L, the computer program allows for a more flexible assignment of frequencies. This flexibility, which may improve the use of the available radio spectrum, would require a matrix of separation distances **(see Appendix D).** The workshop noted that the APANPIRG had already agreed that the proposed matrix of separation distances should be presented to the Aeronautical Communications Panel for review. After such a review, this matrix should be incorporated in the frequency planning criteria established for each Region. The workshop supported this procedure. It noted that the proposed matrix is based on the planning principles used in all ICAO Regions, e.g. EUR and NAM which includes a 20 dB protection; i.e,. Protection based on the radio horizon. Planning based on a 14 dB protection ratio should not be introduced in the AFI Region.

6.2 With regard to specific elements in the frequency assignment planning criteria in use in the AFI Region, the workshop agreed that the need for a buffer (50 NM) around area services as ACC and FIS should be deleted. Also reference to supersonic transport (SST) operations can be deleted. The workshop felt that the service identifications as currently being used in the AFI Region should be maintained.

Conclusion 1/2: Updating of COM LIST 1, 2, & 3 including a review of frequency assignment planning criteria for VHF COM Systems

That from the planning criteria in COM list 3 references to a 50 NM buffer around area services be deleted as well as all references to SST operations.

6.3 The program for VHF COM frequency assignment planning also provides the capability for testing new or modified and also existing frequency assignments on compatibility with other frequency assignments in the frequency list. The workshop agreed to the incorporation of adjacent frequency protection in the planning criteria.

VDL

6.4 The workshop noted that frequency assignment planning criteria had been developed by the ACP. These planning criteria had been submitted to the various ICAO Regions for incorporation in the Regional Plans. The workshop agreed that these planning criteria should be incorporated in the frequency assignment planning criteria for the AFI Region. These criteria were already approved for use in the EUR and the APAC Regions. These criteria are included in Appendix D**.**

Conclusion 1/3: VDL

That the planning criteria for VDL, as contained in Appendix D be incorporated in COM list 3

6.5 The ICAO VHF COM frequency management tool will follow the principles for assigning frequencies in accordance with the frequency utilization plan contained in **Appendix F.** The frequency utilization plan should wherever possible, be globally harmonized.

6.6 For the software to be effective all VHF assignments within the frequency bands 117.975-137 MHz must be registered in the database. In the case of extended range VHF frequencies, all the repeated stations and their coordinates must be registered in the database.

Conclusion1/4: Updating of COM List 3

That COM list 3 should be updated with the identification of extended range facilities.

7. Use of the ICAO Frequency assignment programmes

7.1 The workshop noted that the ICAO frequency assignment planning programs translate the agreed administrative planning and coordination criteria into the computer programs. As such, the ICAO computer programs have limitations in their use for RF systems implementation. In case a State wants to assess the effect of other parameters such as actual field strength of the radio signal or the effect of the terrain on radio wave propagation, commercially available programs should be used. One such program was presented to the workshop. This program addressed the actual implementation characteristics for the various COM and NAV systems that were considered at the workshop.

7.2 The workshop noted that the availability of such programs would compliment the programs developed by ICAO and could greatly facilitate the implementation of radio systems in aviation.

8. Evaluation of the Worskhop

8.1 On the overall, the participants found the workshop a success and that it responded to their expectations. Participant's comments are attached to this report as **Appendix G.**

APPENDIX A

LIST OF PARTICIPANTS

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APPENDIX B

List of Presentations

Item	Title	Presented by
1.	HF Frequency Assignments and Planning	Secretariat
2.	Radio Regulations	Secretariat
3.	HF Planning – ICAO Porgamme for HF Frequency assignments	Olov Carlsson
4.	WRAP – Porgramme For Implementation and Coordination	Secretariat
5.	Computer Based Frequency Assignment Planning Tool for COM Systems	Secretariat
6.	COM Programme for Frequency Assignments	Secretariat
7.	WRAP – Programme For Implementation And Coordination Of VHF-COM Frequencies	Secretariat
8.	Progress on Computer Based Frequency Planning Tool for NAV Systems (COM List 2) (Including Identification of DMEs within Range along PBN air routes)	Secretariat
9.	Presentation of WRAP on ILS, VOR, DME and NDB Planning	Secretariat Olov Carlsson
10.	Global Harmonization of COM Tables	Secretariat
11.	VHF COM Table Format and Planning	Secretariat
12.	Material from EUR Frequency Manual	Secretariat
13.	Frequency Pool	Secretariat
14.	Generic Presentation on WRAP	Olov Carlsson

APPENDIX C

HF frequency allocations, allotments and assignments used by aviation

1. Introduction

1.1 The use of HF frequency bands that have been allocated to the Aeronautical Mobile (R) Service (AM(R)S) in the frequency range 2850 – 22000 kHz by aviation is primarily regulated through the provisions of the Radio Regulations (RR) of the International Telecommunication Union (ITU). These provisions provide for

a. the allocation of frequency bands to the AM(R)S (RR, Art. 5)
b. the allotment of frequencies to areas (RR, Appendix 27)
c. the coordination and registration (by the ITU) of frequency assignments (RR, Appendix 27).

1.2 Appendix 27 was revised in 1978 at the ITU World Administrative Radio Conference on the Aeronautical Mobile (R) Service in Geneva (WARC-Aer2). At that time, frequency requirements that would satisfy aviation's needs until about 1990 were taken into consideration. No further revisions have been considered since this revision; no revision of Appendix 27 is envisaged in the near future. Appendix 27 can only be amended at a future competent ITU World Radiocommunication Conference. The ICAO view is that no revision of Appendix 27 is either necessary or desired as ITU procedures to satisfy new requirements for HF frequency assignments, even with frequencies that are not in accordance with the allotment plan, are in place.

1.3 The Aeronautical HF bands are intensively used by civil aviation and in the foreseeable future it is not expected that the role of HF air-ground communications will [significantly] diminish. HF communications provide the main mean of communications in areas where the use of VHF communications is not practicable, such as in remote and oceanic areas.

1.4 ICAO has completed SARPs for the introduction of HF data link in the late nineties. Although HF data link is currently mainly being used for Aeronautical Operational Control (AOC), it can be used for all types of air-ground data link communications for all aircraft operations. An HF data link network is in operation by ARINC. This network provides global coverage. Provisions for HF data link are contained in ICAO Annex 10 (Chapter 11) and the ICAO Manual on HF Data link (Doc. 9741). Annex 10 (Volume III) also contains technical provisions for HF voice communication systems

1.5 ITU definition of allocation, allotment and assignment:

RR-1.16 ***allocation*** (of a frequency band)*:* Entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space *radiocommunication services* or the *radio astronomy service* under specified conditions. This term shall also be applied to the frequency band concerned.

RR-1.17 ***allotment*** (of a radio frequency or radio frequency channel)*:* Entry of a designated frequency channel in an agreed plan, adopted by a competent conference, for use by one or more administrations for a terrestrial or space *radiocommunication service* in one or more identified countries or geographical areas and under specified conditions.

RR-1.18 ***assignment*** (of a radio frequency or radio frequency channel)*:* Authorization given by an administration for a radio *station* to use a radio frequency or radio frequency channel under specified conditions.

2. HF frequency allocations

2.1 HF frequency allocations are regulated by the ITU Radio Regulations (Art. 5) as follows:

kHz **2850–22000**		
Allocation to Services		
Region 1	Region 2	Region 3
2 850–3025 AERONAUTICAL MOBILE (R) 5.111 5.115		
3400–3500 AERONAUTICAL MOBILE (R)		
4650–4700 AERONAUTICAL MOBILE (R)		
5450–5480	**5450–5480**	**5450–5480**
FIXED		FIXED
AERONAUTICAL MOBILE (OR)	AERONAUTICAL MOBILE (R)	AERONAUTICAL MOBILE (OR)
5480–5680 AERONAUTICAL MOBILE (R) 5.111 5.115		
6525–6685 AERONAUTICAL MOBILE (R)		
8815–8965 AERONAUTICAL MOBILE (R)		
10005–10100 AERONAUTICAL MOBILE (R) 5.111		
11275–11400 AERONAUTICAL MOBILE (R)		
13260–13360 AERONAUTICAL MOBILE (R)		
17900–17970 AERONAUTICAL MOBILE (R)		
21924–22000 AERONAUTICAL MOBILE (R)		

Footnotes:

5.111 The carrier frequencies 2182 kHz, 3023 kHz, 5680 kHz, 8364 kHz and the frequencies 121.5 MHz, 156.8 MHz and 243 MHz may also be used, in accordance with the procedures in force for terrestrial radio- communication services, for search and rescue operations concerning manned space vehicles. The conditions for the use of the frequencies are prescribed in Article **31** and Appendix **13**.

The same applies to the frequencies 10003 kHz, 14993 kHz and 19993 kHz, but in each of these cases emissions must be confined in a band of ±3 kHz about the frequency.

5.115 The carrier (reference) frequencies 3 023 kHz and 5 680 kHz may also be used, in accordance with Article **31** and Appendix **13** by stations of the maritime mobile service engaged in coordinated search and rescue operations.

2.2 The ICAO policy for these frequency bands is as follows:

ICAO POLICY

- *Retain the current allocations in the HF bands to the aeronautical mobile (route) service (AM(R)S) bands for the foreseeable future for HF voice and data.*
- *Investigate possibilities for expansion into aeronautical mobile (offroute) service (AM(OR)S) bands or other bands.*
- *Support measures facilitating the introduction of HF data links in conformity with ICAO SARPs. Provisional estimates of a further expansion of 30 kHz in the bands above 5 MHz for this use have been stated.*
- *Protect the use of the aeronautical HF bands in accordance with the provisions of Appendix 27. The introduction of non-aeronautical services in these bands cannot be accepted.*
- *No change to Footnotes 5.111 and 5.115.*
- *Support the measures and participate in the technical studies addressed in Resolution 207 (Rev. WRC-2000) concerning the unauthorized use of and interference to frequencies in the bands allocated to the AM(R)S.*
- *Consider technical solutions which can be implemented efficiently without changes to aircraft equipment or disruption of aeronautical services.*

3. **HF frequency allotments.**

3.1 As per Appendix 27 to the Radio Regulations, the (assignable) frequencies in the HF bands have been allotted to areas. The frequency allotment plan in Appendix 27 shows the frequencies that are to be used in these areas (or parts thereof) without specifying the stations to which these frequencies are to be assigned.

3.2 **Allotment areas**

3.2.1 Appendix 27 specifies the following allotment areas:

MWARA: Major World Air Route Area. Frequencies allotted to MWARA are used for air-ground communications to support long-distance, international operation of aircraft. 15 MWARA’s have been identified.

RDARA: Regional and Domestic Air Route Area. Frequencies allotted to RDARA are used for air-ground communications not covered by MWARA. 14 RDARA’s have been identified. These RDARA’s are sub-divided in a number of sub-RDARA’s

VOLMET: VOLMET Allotment Area. Frequencies allotted to VOLMET Reception Areas are used for VOLMET broadcasts. 9 VOLMET areas have been identified.

WW: World-Wide Allotment Area. Frequencies allotted to World-Wide Allotment Areas are used for Aeronautical Operational Control. 5 WW areas have been identified.

Note: The ITU definition for these allotment areas is in Appendix A to this paper.

3.2.2 The description of the boundaries of the allotment areas is in Part II, section I of Appendix 27.

An example of the allotment areas for MWARA is in figure 1

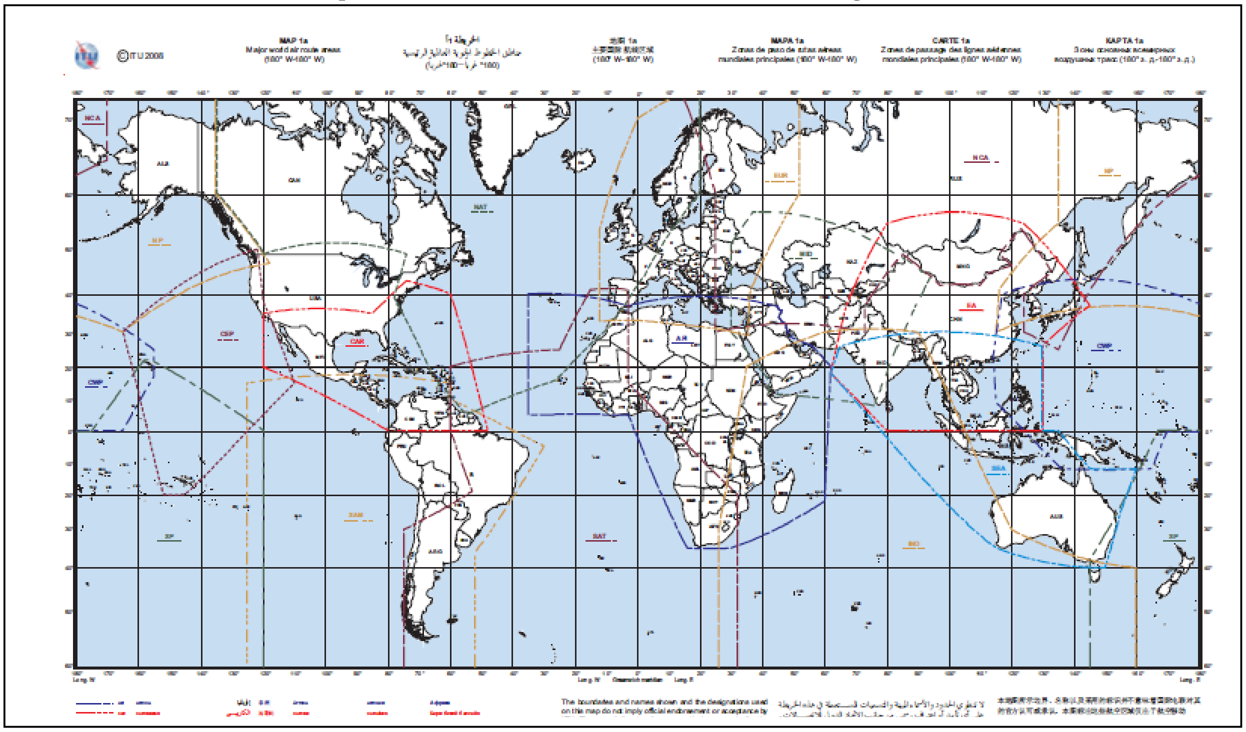


Figure 1
MWARA allotment areas

Note: Maps covering other types of allotment areas (RDARA, VOLMET and WW) are in the Radio Regulations.

3.3 **Frequency allotments**

3.3.1 Appendix 27 has allotted HF frequencies to these allotment areas in Part II, Section II of Appendix 27. This constitutes the factual allotment plan. An example of allotments (to MWARA's) is given in Table 1.

3.3.2 Frequencies that have been allotted to a specific area can be assigned to stations within that area without causing harmful interference to the same frequency in other areas where the same frequency has been allotted.

3.4 **Frequency assignments**

3.4.1 Frequency assignments can be made to stations within the relevant allotment area by Administrations. These frequency assignments need to be coordinated with the ITU for registration in the International Frequency List through the national Telecommunication Administrations.

Area	Frequency bands (MHz)										
	3	3.5	4.7	5.4 (Reg. 2)	5.6	6.6	9	10	11.3	13.3	18
	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz	kHz
AFI	2 851 2 878	3 419 3 425 3 467	4 657		5 493 5 652 5 658	6 559 6 574 6 673	8 894 8 903		11 300 11 330	13 273 13 288 13 294	17 961
CAR	2 887	3 455			5 520 5 550	6 577 6 586	8 846 8 918		11 387 11 396	13 297	17 907
CEP	2 869	3 413	4 657		5 547 5 574	6 673	8 843	10 057	11 282	13 300	17 904
CWP	2 998	3 455	4 666		5 652 5 661	6 532 6 562	8 903	10 081	11 384	13 300	17 904
EA	3 016	3 485 3 491			5 655 5 670	6 571	8 897	10 042	11 396	13 297 13 303 13 309	17 907
EUR		3 479			5 661	6 598		10 084		13 288	17 961
INO		3 476			5 634		8 879			13 306	17 961

………

Table 1 – Partial allotment plan

3.4.2 **Propagation conditions and interference contours**

3.4.2.1 The allotment plan has been developed using certain (specified) propagation conditions and a protection (D/U) ratio of 15 dB. The relevant interference contours for different frequencies (in some case separate for day and night propagation) are specified in Appendix 27, Part I, section II B for the bands between 2.8 and 11400 kHz. An example of such interference contours is in Figure 2. Frequency assignments are protected from transmissions from (unwanted) aeronautical (ground) stations operating on the same frequency.

3.4.2.2 For the frequencies between 13000 and 22000 kHz, a repetition factor between 4 and 6 has been identified. This repetition factor is assumed to be relative to the circumference of the Earth. In this case the repetition factor is the ratio between the minimum (repetition) distance between two aeronautical (ground) stations, operating on the same frequency and the Earth's circumference. *(See Tables 2 and 3 below.)* In this case, protection is based on the prevention of interference between ground stations (aeronautical stations).

3.4.2.3 Potential interference between aircraft stations is not considered in the frequency assignment planning criteria as contained in Appendix 27.

3.4.2.3 **Interference contours**

3.4.2.3.1 Interference contours have been identified in Appendix 27 as follows:

	Propagation by:	
Band:	Day	Night
3 MHz	700 km	3500 km

3.5 MHz	700 km	4000 km
4.7 MHz	1200 km	5500 km
5.6 MHz	1500 km	6500 km
6.6 MHz	1900 km	6500 km
9 MHz	3800 km	-
10 MHz	5500 km	-
11.3 MHz	6000 km	-

Table 2 – interference contours for bands between 2850 – 11400 kHz

For the 13 MHz, 18 MHz and 22 MHz bands, only daytime protection applies. The following repetition factors have been established:

Band:	Repetition factor:
13 MHz	At least 3
18 MHz	At least 4
22 MHz	At least 4

Table 3 – Repetition factor for frequency bands between 13260 – 22000 kHz

Note: repetition factor may be increased (Re. Article 27/18 of Appendix 27)

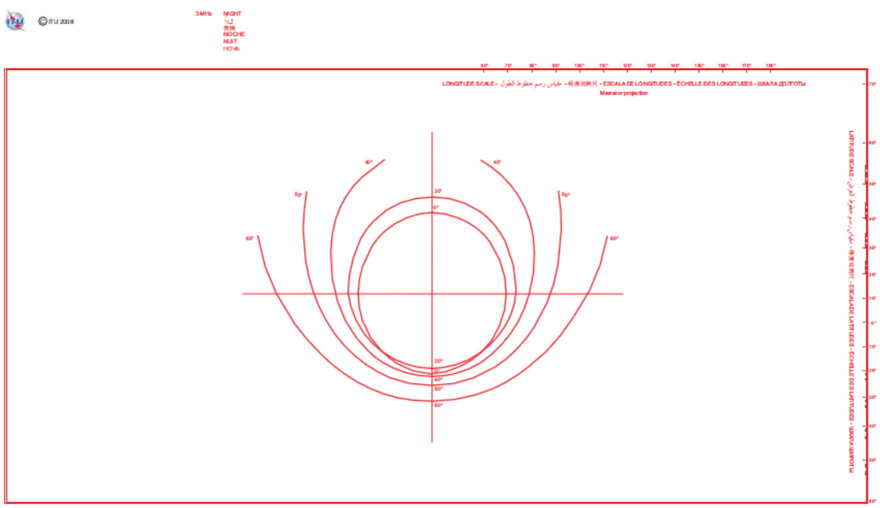


Figure 2

Example of interference contours for 3 MHz; night propagation (for use with map)

Note: The actual propagation(or interference) conditions which depend on a variety of factors may very well differ from these interference contours. However, these interference contours are to be applied when coordinating frequency assignments.

3.4.3 **Frequency assignments**

3.4.3.1 Frequency assignments (to stations) need to be coordinated with the ITU. This coordination is to be exercised by the Telecommunication Administration in each country. ICAO has no role in this coordination procedure.

3.4.4 New frequency assignments (**assignments not in “accordance” with Appendix 27**)

3.4.4 Although primarily frequencies from the allotment plan should be selected to be assigned to stations (within the relevant allotment area), in case particular requirements cannot be met, Administrations may assign frequencies to stations in areas other than to which these have been allotted through the allotment plan. The use of such frequencies must not reduce the protection of the same frequency. This provision (Re. Art. 27/20) would enable the use of other frequencies than those which are allotted to an area, e.g. in case all allotted frequencies are already in use.

3.3.5 **Coordination of radio communications**

3.3.5.1 ICAO coordinates the operational use of the HF frequencies. This coordination is recognized in the ITU Radio Regulations which stipulate in RR 27/19:

> ***27**/19 3 The International Civil Aviation Organization (ICAO) coordinates radiocommunications of the aeronautical mobile (R) service with international aeronautical operations and this Organization should be consulted in all appropriate cases in the operational use of the frequencies in the Plan.*

This coordination however does NOT include the technical and administrative coordination of frequency assignments. Coordination of the operational use in ICAO results in the establishment of “families of HF frequencies” that can be used for communications along major world air routes. The results of this coordination are reflected in the relevant Tables and Charts of the Air Navigation Plan. Figure 3 shows the establishment for the AFI Region of families of HF frequencies and identifies the stations that provide service along these air routes. (Re. Table IV-CNS-2 and chart IV-CNS-2 of the AFI ANP; FASID). This coordination however does NOT replace coordination and registration of frequency assignments with the ITU. The ITU (Radio Regulatory Board) has clarified this provision as follows:

> **Ref. 27/19:**
> This provision specifies the role of ICAO in performing voluntary coordination (“should”) in the operational use of the frequencies. The Board considers such a coordination as an internal ICAO activity, intended to concluding operational agreements between the international operators (e.g. timesharing arrangements). Therefore the Bureau will not take into account such agreements between operators, unless they are communicated to the Bureau by their national telecommunications administration.

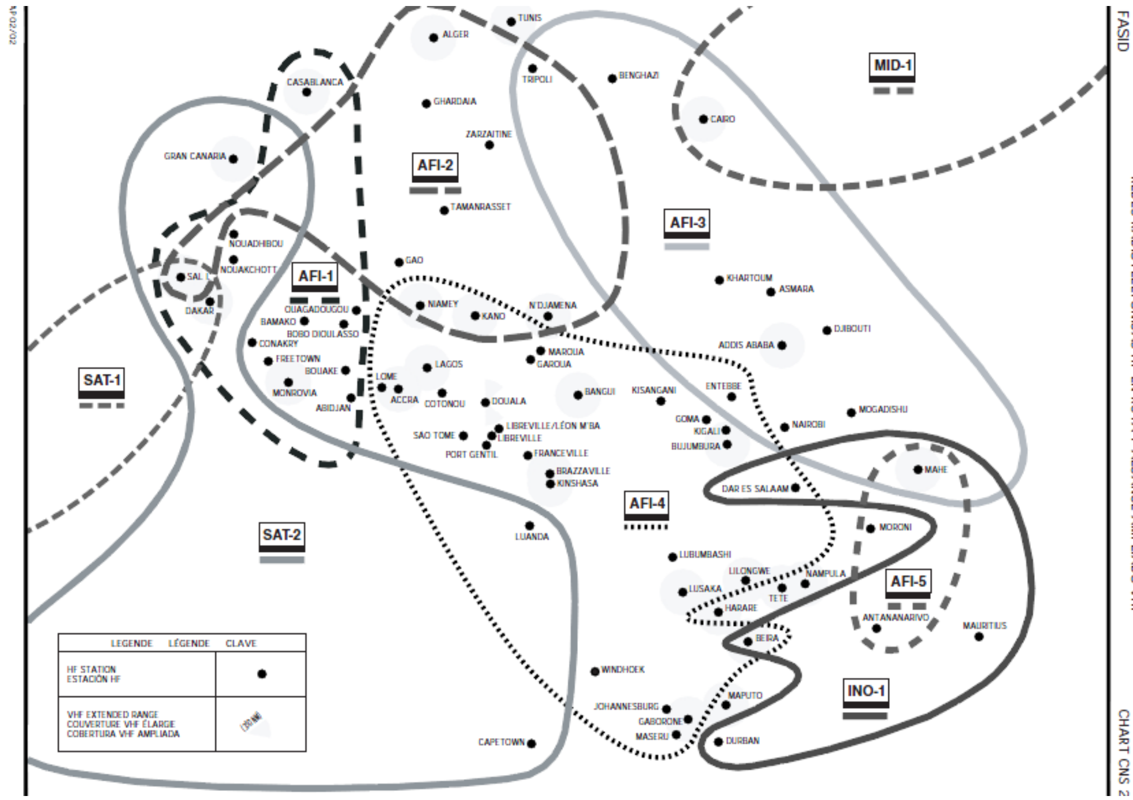


Figure 3

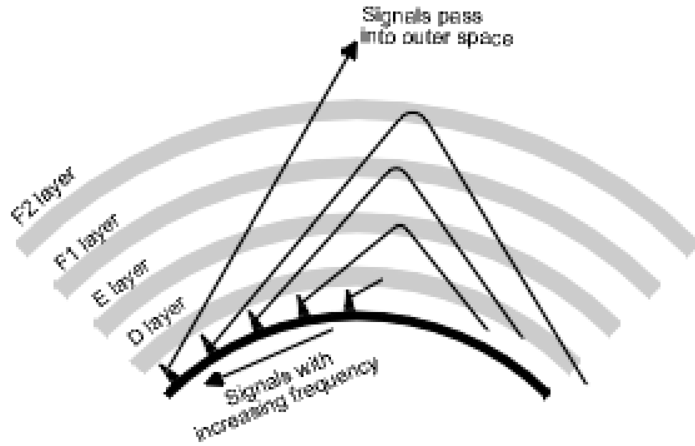
4. Calculation of compatible frequency assignments

4.1 At the timing of the revision of Appendix 27 (1978) computers were not readily available within Administrations to perform the calculations necessary to assess whether or not a new (or modified) frequency assignment is compatible with the frequency allocations in Appendix 27. A manual method, using maps and overlays was established and this method is still to be used when assessing compatibility.

4.2 ICAO has developed the program “HF Planning” which translates this (administrative) method into a computer program that can be used for assessing compatibility of new (or modified) frequency assignments instead of the manual method, as identified in Appendix 27.

5. **HF propagation and families of frequencies**

5.1



Signals reflected by the E and F regions

Figure 4

Radio signals with increased frequency will be reflected by higher layers in the ionosphere. The higher the frequency, the higher the reflection layer and the larger the distance over which radio stations can communicate. The aeronautical HF bands are in particular responsive to reflections in the E and F layers as shown in Figure 4.

5.2 In order to provide communications over a long distance, families of frequencies have been established (by ICAO) that provide for frequency assignments that allow air-ground communications over shorter as well as longer distances.

5.2.1 As an example, for the area AFI-4 (see Figure 3), the following HF frequencies have been identified in the ICAO Air Navigation Plan (AFI; FASID) in the Table" HF En-Route radiotelephony networks and VHF extended range"

2851 kHz
2878 kHz
5493 kHz
6559 kHz
6586 kHz *
8873 kHz *
8888 kHz *
8903 kHz
Frequencies with * are not allotted to the MWARA AFI but to RDARA 4 or 7, which covers parts of Africa.

Actual operational use of these frequencies at the stations shown in Figure 3 has been coordinated, from an operational perspective, in ICAO (see also 3.3.5.1 above).

6. **Summary**

6.1 HF frequencies providing long distance communications using the propagation characteristics of the ionosphere are still a widely used as the main form of long distance radio communications in aviation. While not as reliable as satellite communications, it is not nearly as expensive, and can provide a useful back-up in case the satellite communications fail. It is also widely used as the primary form of radio communications by many organisations from radio broadcasters to radio amateurs, as well as ship to shore, air to ground and many other forms of point to point communications. As a result of the benefits of the particular HF propagation characteristics, using the ionosphere, it is likely to remain in use indefinitely as a [primary] form of radio communications technology in aviation.

Appendix 1

Definition of allotment areas as per ITU Radio Regulations

27/3 3 *A major world air route* is a long-distance route, made up of one or more segments, essentially international in character, extending through more than one country and requiring long-distance communication facilities.

27/4 4 *A major world air route area (MWARA)* is an area embracing a certain number of major world air routes, which generally follow the same traffic pattern and are so related geographically that the same frequency families may logically be applied.

27/5 5 *Regional and Domestic Air Route* are all those using the Aeronautical Mobile (R) Service not covered by the definition of a Major World Air Route in No. **27**/3.

27/6 6 *Regional and Domestic Air Route Area (RDARA)* is an area embracing a certain number of the air routes defined in No. **27**/5.

27/7 7 *A VOLMET Allotment Area* is an area encompassing all points where an HF broadcast facility might be required to operate on a family of frequencies common to the area.

27/8 8 *A VOLMET Reception Area* is an area within which aircraft should be able to receive broadcasts from one or more stations in the associated VOLMET Allotment Area.

27/9 9 *A World-Wide Allotment Area* is one in which frequencies are allotted to provide long-distance communication between an aeronautical station within that allotment area and aircraft operating anywhere in the world[1].

27/10 10 *Family of Frequencies in the Aeronautical Mobile (R) Service* contains two or more frequencies selected from different aeronautical mobile (R) bands and is intended to permit communication at any time within the authorized area of use (see Nos. **27**/213 to **27**/231) between aircraft stations and appropriate aeronautical stations.

[1] **27**/9.1 The type of communication referred to in **27**/9 may be regulated by administrations.

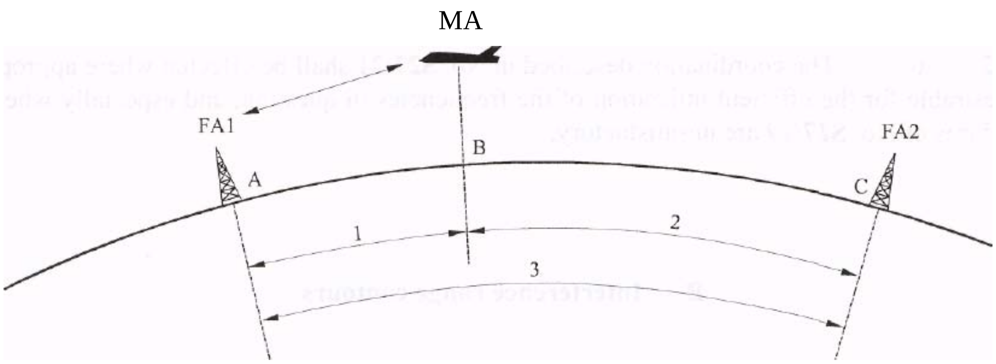
Appendix B

Implementation of the protection rules of Appendix27

Frequency bands below 13 MHz.

The protection rules for frequency bands below 13 MHz are for the most part of them straightforward to apply. From figure 1 in Article 27/27 of the Radio Regulations:

FIGURE 1
Service range, interference range, repetition distance



FA1 : aeronautical station in communication with aircraft station MA
FA2 : aeronautical station in communication with aircraft stations other than MA
MA : aircraft station in communication with aeronautical station FA1
1 : service range AB
2 : interference range CB
3 : repetition distance AC

AP**S27**/27-01

It is clear that compatibility between radio station FA1 and FA1 exists if at *all points of the service range AB* of station FA1 the distance to radio station FA2 is more than the interference range CB for the frequency band involved. So we simply have to draw a circle around radio station FA2 and check whether this circular area intersects somewhere with the service range of radio station FA1.

The only complication is coming from Article 27/44 regarding the effects of radio waves traveling through an auroral zone. This article implies that whenever a certain portion of the service range AB of radio station FA1 is intersected by the interference area around radio station FA2, we still may have a compatible situation provided the radio waves involved have been crossing an auroral zone. Since it is not stated in AP27 what kind of radio propagation path we are dealing with, we will *assume* here that we may use the shortest distance path between the two points involved. For a

spherical earth this amounts to say that all propagation paths may be taken as great circles between the two points involved. Although this is a simplification, its application seems reasonable in view of:

- **the overall accuracy of the graphical method described in AP27 combined with**
- **the relative poor accuracy with which the auroral areas are known (only given as a shaded area in certain Maps of AP27).**

Finally, a remark is appropriate about the Table in 27/35 where sharing conditions between areas are given for a number of frequency bands below 13 MHz. Comparison of the combinations of different areas quoted there with the actual allotments in Section II, Article I(27/210 through /238) show that not all possible combinations are covered by that Table. The software does not conform to this Table but treats *all* combinations of different areas solely on the basis of the criteria valid for the frequency band involved.

Frequency bands of 13 MHz and above.

The relevant text in Appendix 27 for the frequency bands of 13 MHz and above is only 3 items long: Articles 27/37 - /39. The sharing possibilities are explained to be dependent upon "the repetition factor". However, nowhere in AP27 such a factor is defined or further explained. A factor is dimensionless in general and represents the ratio of two quantities expressed in the same unit. Combined with the "repetition distance" quoted in Figure 1 of 27/27 for the frequency bands below 13 MHz, one might define the repetition factor as the ratio of some distance value and the repetition distance between two aeronautical (ground) stations. The fact that 27/38 quotes a *decreasing longitudinal separation* to correspond to an *increasing repetition factor* indicates that the repetition factor should be the denominator of the factor as such. It is *assumed* here that the other distance property involved is the earth circumference: the repetition factor is taken to be the ratio of the earth circumference to the minimum (repetition) distance of radio stations which can be operating on the same channel without causing interference to each other's operations. Although in this way a very simple compatibility/distance criterion has been defined, the effect of this criterion in practical situations might be unexpected as can be seen on the map in Figure B-1:

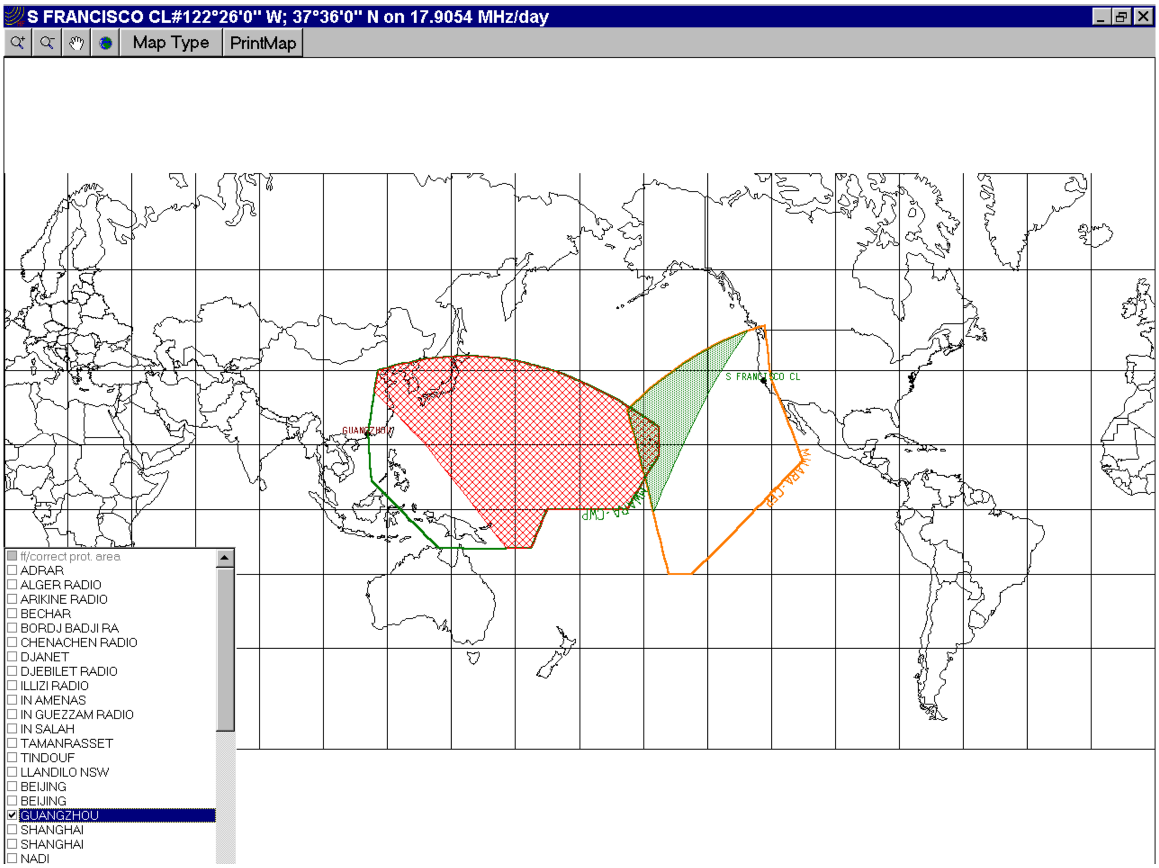


Figure B-1
Coverage and interference contours

The red cross-hatched area represents the repetition factor of 4 for the 17 MHz band involved, seen from San Francisco. The light green shaded area represents the same repetition factor seen from Guangzhou. Clearly, San Francisco and Guangzhou are further apart from each other then required according to the repetition factor criterion.

But it is hard to imagine that operation of both stations to the limits of their respective service areas (MWARA-CEP for San Francisco and MWARA-CWP for Guangzhou) will be without mutual interference. In other words, the interpretation taken here for the repetition factor may be simple to implement in an algorithm, but it does not give any clue as to where interference is likely to occur in a given situation. This fact seems to be recognized in S27/39 where it is stated that "the sharing takes into account the likely locations of aeronautical stations rather than the area boundaries" but this statement in itself does not help much in the practical application of the repetition factor criterion.

In the ICAO program HF Planning, the compatibility *calculation* for frequency bands of 13MHz and above is done by applying the repetition distance criterion between both (ground) stations involved. For *display on a Map* however, the circular area around a ground station with radius equal to the repetition distance is taken as "area where

possible interference might occur" and displayed as if such interference was a fact.

HF PROPAGATION – SUMMARY

Appendix D

HF Ionospheric Radio Signal Propagation

The basics of HF ionospheric radio propagation and how the ionosphere enables radio communications links to be established over large distances around the globe using what are termed sky waves or skywaves.

HF radio communications is dependent for most of its applications on the use of the ionosphere. This region in the atmosphere enables radio communications signals to be reflected, or more correctly refracted back to earth so that they can travel over great distances around the globe. Ionospheric propagation is normally though of as an HF propagation mode, although, it use can extend above and below the HF portion of the spectrum on many occasions.

The fact that radio communications signals can travel all over the globe on the HF bands is widely used by many by broadcasters, news agencies, maritime, radio hams and many other users. Radio transmitters using relatively low powers can be used to communicate to the other side of the globe. Although radio propagation using the ionosphere may not be not as reliable as that provided by satellites, it nevertheless provides a very cost effective and efficient form of radio communication. To enable the most to be made of ionospheric propagation many radio users make extensive use of HF propagation programmes to predict the areas of the globe to which signals may travel, or the probability of them reaching a given area.

These HF propagation prediction programmes utilise a large amount of data, and many have been developed over many years, along with data about the prevailing conditions. However it is still useful to gain a view of how signals travel when using ionospheric propagation and to understand why signal conditions change. In this way the best use can be made of ionospheric propagation.

Radio communications signals in the medium and short wave bands travel by two basic means. The first is known as a ground wave (covered on a separate page in this section), and the second a sky wave using the ionosphere.

Skywaves

When using ionospheric radio propagation, the radio signals leave the Earth's surface and travel towards the ionosphere where some of these are returned to Earth. These radio signals are termed sky waves for obvious reason. If they are returned to Earth, then the ionosphere may (very simply) be viewed as a vast reflecting surface encompassing the Earth that enables signals to travel over much greater distances than would otherwise be possible. Naturally this is a great over simplification because the frequency, time of day and many other parameters govern the reflection, or more correctly the refraction of signals back to Earth. There are in fact a number of layers, or more correctly regions within the ionosphere, and these act in different ways as described below.

D region

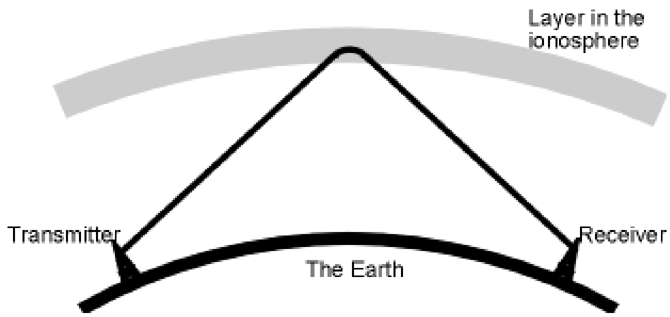
When a sky wave leaves the Earth's surface and travels upwards, the first region of interest that it reaches in the ionosphere is called the D region. This region attenuates the signals as they pass through. The level of attenuation depends on the frequency. Low frequencies are attenuated more than higher ones. In fact it is found that the attenuation varies as the inverse square of the frequency, i.e. doubling the frequency reduces the level of attenuation by a factor of four. This means that low frequency signals are often prevented from reaching the higher regions, except at night when the region disappears.

The D region attenuates signals because the radio signals cause the free electrons in the region to vibrate. As they vibrate the electrons collide with molecules, and at each collision there is a small loss of energy. With countless millions of electrons vibrating, the amount of energy loss becomes noticeable and manifests itself as a reduction in the overall signal level. The amount of signal loss is dependent upon a number of factors: One is the number of gas molecules that are present. The greater the number of gas molecules, the higher the number of collisions and hence the higher the attenuation. The level of ionisation is also very important. The higher the level of ionisation, the greater the number of electrons that vibrate and collide with molecules. The third main factor is the frequency of the signal. As the frequency increases, the wavelength of the vibration shortens, and the number of collisions between the free electrons and gas molecules decreases. As a result signals lower in the radio frequency spectrum are attenuated far more than those which are higher in frequency. Even so high frequency signals still suffer some reduction in signal strength.

E and F Regions

Once a signal passes through the D region, it travels on and reaches first the E, and next the F regions. At the altitude where these regions are found the air density is very much less, and this means that when the free electrons are excited by radio signals and vibrate, far fewer collisions occur. As a result the way in which these regions act is somewhat different. The electrons are again set in motion by the radio signal, but they tend to re-radiate it. As the signal is travelling in an area where the density of electrons is increasing, the further it progresses into the region, the signal is refracted away from the area of higher electron density. In the case of HF signals, this refraction is often sufficient to bend them back to earth. In effect it appears that the region has "reflected" the signal.

The tendency for this "reflection" is dependent upon the frequency and the angle of incidence. As the frequency increases, it is found that the amount of refraction decreases until a frequency is reached where the signals pass through the region and on to the next. Eventually a point is reached where the signal passes through all the regions and on into outer space.



Refraction of a radio signal as it enters an ionised region

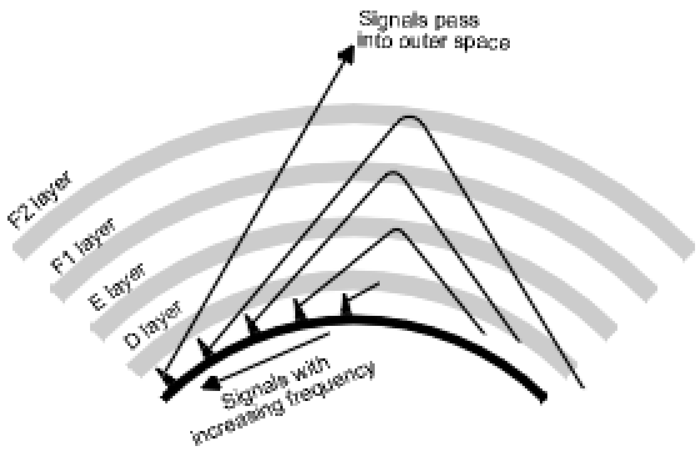
Different frequencies

To gain a better idea of the characteristics of HF propagation using the ionosphere, it is worth viewing what happens to a radio communications signal if the frequency is increased across the frequency spectrum. First it starts with a signal in the medium wave broadcast band. During the day signals on these frequencies only propagate using the ground wave. Any signals that reach the D region are absorbed. However at night as the D region disappears signals reach the other regions and may be heard over much greater distances.

If the frequency of the signal is increased, a point is reached where the signal starts to penetrate the D region and signals reach the E region. Here it is reflected and will pass back through the D region and return to earth a considerable distance away from the transmitter.

As the frequency is increased further the signal is refracted less and less by the E region and eventually it passes right through. It then reaches the F1 region and here it may be reflected passing back through the D and E regions to reach the earth again. As the F1 region is higher than the E region the distance reached will be greater than that for an E region reflection.

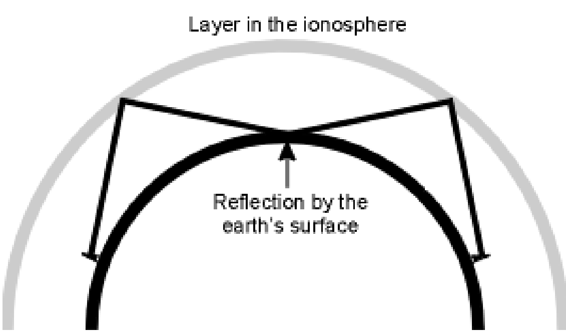
Finally as the frequency of the radio communications signal rises still further the it will eventually pass through the F1 region and onto the F2 region. This is the highest of the regions in the ionosphere and the distances reached using this are the greatest. As a rough guide the maximum skip distance for the E region is around 2500 km and 5000 km for the F2 region.



Signals reflected by the E and F regions

Multiple hops

Whilst it is possible to reach considerable distances using the F region as already described, on its own this does not explain the fact that radio signals are regularly heard from opposite sides of the globe using HF propagation with the ionosphere. This occurs because the signals are able to undergo several "reflections". Once the signals are returned to earth from the ionosphere, they are reflected back upwards by the earth's surface, and again they are able to undergo another "reflection" by the ionosphere. Naturally the signal is reduced in strength at each "reflection", and it is also found that different areas of the Earth reflect radio signals differently. As might be anticipated the surface of the sea is a very good reflector, whereas desert areas are very poor. This means that signals that are "reflected" back to the ionosphere by the Pacific or Atlantic oceans will be stronger than those that use the Sahara desert or the red centre of Australia.



Multiple reflections

It is not just the Earth's surface that introduces losses into the signal path. In fact the major cause of loss is the D region, even for frequencies high up into the HF portion of the spectrum. One of the reasons for this is that the signal has to pass through the D region twice for every reflection by the ionosphere. This means that to get the best signal strengths it is necessary signal paths enable the minimum number of hops to be used. This is generally achieved using frequencies close to the maximum frequencies that can support communications using ionospheric propagation, and thereby using the highest regions in the ionosphere. In addition to this the level of attenuation introduced by the D region is also reduced. This means that a radio signal on 20 MHz for example will be stronger than one on 10 MHz if propagation can be supported at both frequencies.

HF propagation summary

HF propagation using the ionosphere is still a widely used as a form of radio communications. While not as reliable as satellite communications, it is not nearly as expensive, and can provide a useful back-up in case the satellite communications fail. It is also widely used as the primary form of radio communications by many organisations from radio broadcasters to radio amateurs, as well as ship to shore and many other forms of point to point communications. As a result HF propagation using the ionosphere is likely to remain in use indefinitely as a form of radio communications technology.

Appendix D
Rev 7/7/2009

Frequency Management Workshop
28 – 30 September 2009; Dakar, Senegal

Agenda item:
Format of Com Table 3 *(List of facilities in the band 117.975 – 137 MHz)*
(Presented by the Secretary)

SUMMARY

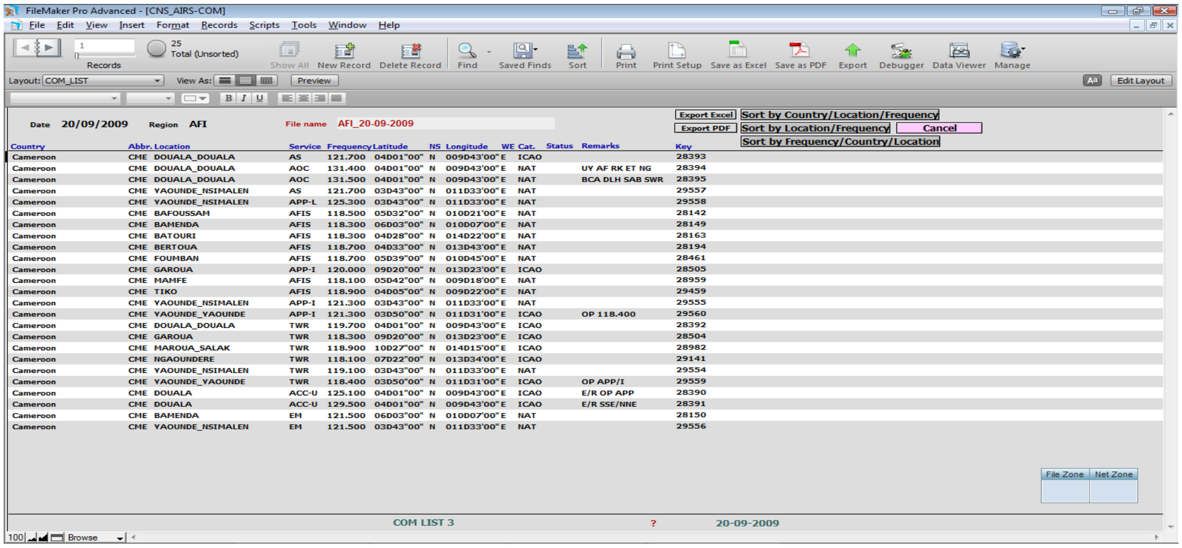
1. Introduction

1.1 ICAO is progressing the generation of a global list of frequencies in the band 117.975 – 137 MHz. This global table will be incorporated in the program CNS/AIRS VHF COM FREQUENCY ASSIGNMENT PLANNING, which manages the global table and provides assistance in assessing compatibility between frequency assignments.

1.2 In order to generate one single global table, which is a combination of the various regional COM lists 3, differences between these regional COM lists 3 have to be removed. Most of these differences are of an editorial nature.

2. Format of the global COM list 3

2.1 The global COM list 3, as currently generated by the program, contains information as in Figure 1. (The Regional COM list 3 is a sub-set of the information contained in the global database). As the development of the frequency assignment planning program for VHF COM frequencies, including the development of a globally harmonized COM list is work in progress, comments from the Regions, for incorporation in the final version is invited.



FileMaker Pro Advanced - [CNS_AIRS-COM]

Date 20/09/2009 Region AFI File name AFI_20-09-2009

Country	Abbr.	Location	Service	Frequency	Latitude	NS	Longitude	WE	Cat.	Status	Remarks	Key
Cameroon	CME	DOUALA_DOUALA	AS	121.700	04D01"00"	N	009D43'00"	E	ICAO			28393
Cameroon	CME	DOUALA_DOUALA	AOC	131.400	04D01"00"	N	009D43'00"	E	NAT		UY AF RK ET NG	28394
Cameroon	CME	DOUALA_DOUALA	AOC	131.500	04D01"00"	N	009D43'00"	E	NAT		BCA DLH SAB SWR	28395
Cameroon	CME	YAOUNDE_NSIMALEN	AS	121.700	03D43"00"	N	011D33'00"	E	NAT			29557
Cameroon	CME	YAOUNDE_NSIMALEN	APP-L	125.300	03D43"00"	N	011D33'00"	E	NAT			29558
Cameroon	CME	BAFOUSSAM	AFIS	118.500	05D32"00"	N	010D21'00"	E	NAT			28142
Cameroon	CME	BAMENDA	AFIS	118.300	06D03"00"	N	010D07'00"	E	NAT			28149
Cameroon	CME	BATOURI	AFIS	118.300	04D28"00"	N	014D22'00"	E	NAT			28163
Cameroon	CME	BERTOUA	AFIS	118.700	04D33"00"	N	013D43'00"	E	NAT			28194
Cameroon	CME	FOUMBAN	AFIS	118.700	05D39"00"	N	010D45'00"	E	NAT			28461
Cameroon	CME	GAROUA	APP-I	120.000	09D20"00"	N	013D23'00"	E	ICAO			28505
Cameroon	CME	MAMFE	AFIS	118.100	05D42"00"	N	009D18'00"	E	NAT			28959
Cameroon	CME	TIKO	AFIS	118.900	04D05"00"	N	009D22'00"	E	NAT			29459
Cameroon	CME	YAOUNDE_NSIMALEN	APP-I	121.300	03D43"00"	N	011D33'00"	E	NAT			29555
Cameroon	CME	YAOUNDE_YAOUNDE	APP-I	121.300	03D50"00"	N	011D31'00"	E	ICAO		OP 118.400	29560
Cameroon	CME	DOUALA_DOUALA	TWR	119.700	04D01"00"	N	009D43'00"	E	ICAO			28392
Cameroon	CME	GAROUA	TWR	118.300	09D20"00"	N	013D23'00"	E	ICAO			28504
Cameroon	CME	MAROUA_SALAK	TWR	118.900	10D27"00"	N	014D15'00"	E	ICAO			28982
Cameroon	CME	NGAOUNDERE	TWR	118.100	07D22"00"	N	013D34'00"	E	ICAO			29141
Cameroon	CME	YAOUNDE_NSIMALEN	TWR	119.100	03D43"00"	N	011D33'00"	E	NAT			29554
Cameroon	CME	YAOUNDE_YAOUNDE	TWR	118.400	03D50"00"	N	011D31'00"	E	ICAO		OP APP/I	29559
Cameroon	CME	DOUALA	ACC-U	125.100	04D01"00"	N	009D43'00"	E	ICAO		E/R OP APP	28390
Cameroon	CME	DOUALA	ACC-U	129.500	04D01"00"	N	009D43'00"	E	ICAO		E/R SSE/NNE	28391
Cameroon	CME	BAMENDA	EM	121.500	06D03"00"	N	010D07'00"	E	NAT			28150
Cameroon	CME	YAOUNDE_NSIMALEN	EM	121.500	03D43"00"	N	011D33'00"	E	NAT			29556

COM LIST 3 ? 20-09-2009

Figure 1

Although in principle, this list is consistent with the current COM list3 for the AFI Region, the following differences have been introduced:

2.1.1 Separate columns for country and location indication have been introduced (editorial).

2.2.2. Service.

The global COM list 3 contains only reference to the service(s) that is (are) provided. These services are:

TWR	Aerodrome control service	(25NM/4000ft)
AS	Aerodrome surface movement control	(limits of aerodrome)
APP-U	Approach – Upper (up to FL 450)	(150NM/45000ft)
APP-I	Approach – Intermediate (up to FL 250)	(75NM/25000ft)
APP-L	Approach – Low (up to FL 120)	(50NM/12000ft)
ACC-U	Area Control service – Upper (up to FL 450)	(area + 50NM/45000ft)
ACC-L	Area Control service – Low (up to FL 250)	(area + 50 NM/25000ft)
FIS-U	Flight Information Service – Upper (up to FL 450)	(area + 50 NM/45000ft)
FIS-L	Flight Information Service – Low (up to FL 250)	(area + 50 NM/25000ft)
VOLMET	VOLMET broadcasts	(onmidirectional/45000ft)
ATIS	Automated Terminal Information Service	(onmidirectional/45000ft)
AFIS	Aerodrome Flight Information Service	*(25NM/4000ft)*
AOC	Airline Operational Control	(not protected)

Table 1

Note 1: The values between brackets contain the fixed Designated Operational Coverage (DOC) of these services as per COM table 3 used in the Regional Offices.
Note 2: Currently the program for calculating compatibility between frequency assignments does not include a buffer of 50 NM for ACC frequency assignments.(See Appendix A). Should it be considered necessary, this can be included.
Note 3: Because of the expected introduction of supersonic aircraft in aviation in the early seventies protection for ACC/FIS/VOLMET up to 65000 ft was incorporated in the protection requirement to support SST (super sonic transport) operations. Since the introduction of supersonic aircraft has not materialized, this could be deleted.
Note 4: DOC for AFIS currently not specified.
Note 5: VOLMET and ATIS are broadcast only services; aircraft do not respond on these frequencies;
Note 6: A combination of service identification with different services (e.g. TWR/APP or ACC/L/U is being considered to be introduced in the program.

2.2.2.1 The AFI COM list 3 (like other Regional lists) identifies the service while including certain operational details; e.g. TWR/DF (direction finding) or APP-SR-LU (for stations providing both APP-L and APP-U services as well as Surveillance Radar (SR)). This information is not really relevant to frequency assignment planning and coordination and can be considered as additional information regarding the use of the frequency. With the view to rationalize service identification in the COM list 3, it is proposed that such additional information be transferred to the column “Remarks” (e.g. in case of TWR/DF the COM list identifies TWR; the Remarks column provides the information “Direction Finding”. Alternatively, in the COM list, the current identification can be maintained in the COM list, if desired, but may not be shown when using the computer program for VHF frequency assignment planning (in this case the additional information will be shown in a special box). Table CNS 2 in the Air Navigation Plan also includes references to certain operational details in the service identification. These are not addressed in this paper.

2.2.2.2 With regard to the service volume, the Regional COM lists currently use a system with predetermined service volumes (see DOC figures within brackets in Table 1). It is proposed to change this into a method where the actual DOC is part of the service indication. This provides for flexibility in making frequency assignments as the DOC can be tailored to the operational requirements (e.g. TWR 30/40 provides a TWR service within a range of 30 NM up to 4000 ft). Should it be agreed, this service indication, which is standard in the EUR COM table, can be introduced for the AFI Region as well.

2.2.2.3 In summary, proposals for rationalizing the service indication and the use of the DOC in frequency assignment planning are:

(i) review the need for a 50 NM buffer around the DOC for ACC frequency assignments (see also Appendix A);

(ii) review the need to keep reference to an upper flight level of 65000 ft for FIS and VOLMET;

(iii) consider the benefits of a flexible structure in identifying the DOC for a frequency assignment;

(iv) consider the possibility for moving additional information regarding the operational use of frequency assignments from the service identification to the “Remarks” column in the table.

2.2.3. **Key number**

For easy reference of frequency assignments in the COM list 3 and those used in the global list 3, it is proposed to add the (unique) key or registration number that has been given to each frequency assignment in the global list to the Regional COM list 3.

2.3 COM list 3, as generated by the frequency assignment planning program can be saved in Excel or PDF format.

3. **Frequency assignment planning criteria**

Note: frequency assignment planning criteria and other relevant material used in the AFI Region are contained in the foreword to AFI Frequency List No. 3

3.1 Frequency assignment planning criteria for co-channel VHF assignments for use in the AFI Region have been developed at the ????? Regional Air Navigation Workshop (????). These planning criteria include a (predetermined) set of Designated Operational Coverage areas (DOC) and provide for co-channel separation distances. The separation distances used are the distance between the transmitter sites for circular services like TWR or APP. For area services (ACC and FIS) separation distance are given relative to the distance between limits of service area (or DOC). The separation distances are based upon a desired to undesired (D/U) signal ratio of 20 dB, which requires that the interfering (or undesired) station is located beyond the radio horizon of the interfered (or desired) station. The minimum co-channel separation distance between transmitter/receiver locations can be calculated by adding the relevant distances (DOC-range) to the radio horizon (DOC-altitude) of the two frequency assignments (see Figure 2). These criteria are incorporated in the computer for VHF COM frequency assignment planning. The program however introduces also the option to test a new frequency assignment against adjacent channel interference.

3.1.1 With regard to frequency assignment planning for area services, ICAO is working on introducing the concept of area service planning. This is work in progress and will hopefully be introduced soon. This method is consistent with the current protection requirements and may result in more efficient frequency assignment planning.

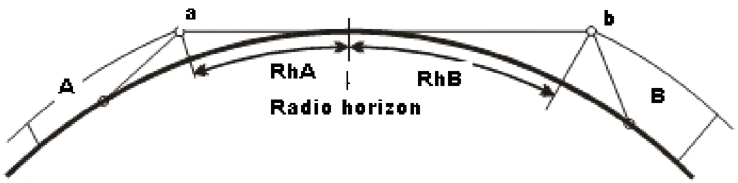


Figure 2

3.3.2 Applying the methodology as described in paragraph 3.1, separation distances between the edges of the DOC have been calculated and, using the distance to the radio horizon as in Table 2A, been summarized in Table 2B.

Symbol	Service range (NM)	Service height	Radio horizon
TWR	25 NM / 46km	4000 ft /1200 m	78 NM
AFIS	25 NM / 46km	4000 ft /1200 m	78 NM
AS	Limits of aerodrome	Surface	N/A
APP-U	150 NM / 280 km	45000 ft/ 13700 m	260 NM
APP-I	75 NM / 140 km	25000 ft / 7600 m	195 NM
APP-L	50 NM / 93 km	12000 ft /3650 m	134 NM
ACC-U	Specified area	45000 ft /13700 m	260 NM
ACC-L	Specified area	25000 ft / 7600 m	195 NM
FIS-U	Specified area	45000 ft /13700 m	260 NM
FIS-L	Specified area	25000 ft / 7600 m	195 NM
VOLMET	260 NM / 480 km	45000 ft / 13700m	260 NM
ATIS	150 NM / 280 km	45000 ft /13700 m	260 NM

Table 2A – distance to radio horizon with aircraft at maximum altitude

Note: Radio horizon of the aircraft from the edge of DOC.

3.3.2.1 Automatic Terminal Information Service, or ATIS, is a continuous broadcast of recorded information in busier terminal (i.e. airport) areas. ATIS broadcasts contain essential information, such as weather information, which runways are active, available approaches, and any other information required by the pilots, such as important NOTAMs.

As a terminal service, ATIS may not require a DOC greater than APP/U.

Service	TWR	AFIS	SMC	APP-U	APP-I	APP-L	ACC-U	ACC-L	FIS-U	FIS-L	VOLMET	ATIS
TWR	156 (206)	156 (206)	103 (128)	338 (513)	273 (373)	212 (287)	338 *	273 *	338 *	273 *	338 (623)	338 (623)
AFIS	156 (206)	156 (206)	103 (128)	338 (513)	273 (373)	212 (287)	338 *	273 *	338 *	273 *	338 (623)	338 (623)
AS	103 (128)	103 (128)	50	285 (435)	220 (295)	159 (209)	285 *	220 *	285 *	220 *	285 (310)	285 (310)
APP-U	338 (513)	338 (513)	285 (435)	520 (820)	455 (680)	394 (594)	520 *	455 *	520 *	455 *	520 (930)	520 (820)
APP-I	273 (373)	273 (373)	220 (295)	455 (680)	390 (540)	329 (454)	455 *	390 *	455 *	390 *	455 (790)	455 (680)
APP-L	212 (287)	212 (287)	159 (209)	394 (594)	329 (454)	268 (368)	394 *	329 *	394 *	329 *	394 (704)	394 (594)
ACC-U*	338	338	285	520	455	394	520	455	520	455	520	520
ACC-L*	273	273	220	455	390	329	455	390	455	390	455	455
FIS-U*	338	338	285	520	455	394	520	455	520	455	520	520
FIS-L*	273	273	220	455	390	329	455	390	455	390	455	455
VOLMET	338 (623)	338 (623)	285 (545)	520 (930)	455 (790)	394 (704)	520 *	455 *	520 *	455 *	13 (533)	10 (413)
ATIS	338 (513)	338 (513)	285 (435)	520 (820)	455 (680)	394 (594)	520 *	455 *	520 *	455 *	10 (413)	13 (313)

Table 2B – Minimum geographical co-channel separation distances **between limits of DOC**

Note: All distances are in NM; values in brackets are separation distances between facilities for (circular) services

* Area services; only distances between limits of DOC are given.

3.3.3 VOLMET and ATIS are one-way transmissions from a ground transmitter to the aircraft. Since the VOLMET DOC has been calculated upon the maximum coverage that can be obtained at 45000 ft (260 NM), protection between VOLMET stations can be secured if the separation distance between these service volumes is 13 NM, assuming a VOLMET transmitter height of 100ft. This distance would also be sufficient for the protection of ATIS from VOLMET transmissions.

3.3.4 AS (aerodrome surface movement control) separation distances are calculated with an antenna height of 30 m (100ft). At 100 ft the radio horizon is 12.3 NM to which a buffer (12.7 NM) has been added (total 25 NM). Co-channel operation between AS assignments is 50 NM. Should the difference in height between the two aerodromes be significantly different, additional margins need to be added. Separation distances (between facilities) with airborne services have been calculated as the sum of 25 NM (AS) plus radio horizon plus DOC-range (or the airborne service). In case the airborne service is an area service (ACC or FIS), only the distance of the radio horizon to the nearest limit of the airborne service has been provided (25 NM plus range airborne service). Sharing with airborne services however is unlikely to occur since an (exclusive) sub-band has been allotted by ICAO for AS communication (121.600-121.975 MHz).

3.4 Adjacent channel utilization.

3.4.1 The geographical separation between two aircraft operating on the first adjacent 25 kHz channel is 10 NM throughout the service area. This implies that the first adjacent 25 kHz channel cannot be deployed in the same DOC plus 10 NM.

3.4.2 In cases where DSB-AM equipment is being in use with 50 kHz channel spacing, the first adjacent channel geographical separation between a 50 kHz frequency assignment and a 25 kHz assignment is 100 NM throughout the coverage areas. The first adjacent channel separation between two 50 kHz assignments is 10 NM. Should such protection be required (currently frequency assignment planning throughout the AFI Region is based on 25 kHz channel spacing for all frequency assignments) relevant information needs to be included in the COM list and the program be amended accordingly.

4. **Frequency planning for VDL**

4.1 Frequency assignment planning criteria for VDL Mode s 2 and 4 have already been agreed in the Aeronautical Communications Panel. (Re. Report ACP WG M 12 http://www.icao.int/anb/panels/acp/wgdoclist.cfm?WorkshopID=242)

4.2 The following material is proposed to be added to the frequency assignment planning criteria in the AFI Region for the VHF COM band for VDL frequency assignment planning.

4.3 **Co-channel separation**

4.3.1 Co-channel separation between VDL and DSB-AM assignments as well as between VDL Mode 4 and VDL Mode 4 is based on a desired to undesired signal protection ratio of 20 dB (line of sight).

4.3.2 Adjacent channel separation between VDL and DSB-AM systems in the same geographical area is in accordance with the following table:

Vs.		Interference source		
		DSB-AM	VDL 2	VDL 4
Victim	DSB-AM		1	2
	VDL 2	1	1	1
	VDL 4	2	1	1

Table 4. 25 kHz guard channels between DSB-AM, VDL mode 2 and VDL mode 4

Note: The number in Table 4 are guard channels. The next channel that can be used without and frequency planning constrain is 1 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 channel, 50 kHz away can be used in the same designated operational coverage without any frequency assignment planning constraint.

4.3.3. Attention is drawn to the possibility of interference between DSB-AM and VDL Mode 2/4 when these systems are used on the surface of an airport. Interference can occur if the channel separation (guard band) is four or less. In this case interference between aircraft stations can be prevented through securing that the minimum field strength of these systems is 70 dBm at the antenna. Any interference that may be caused in ground based receiving stations (i.e. not aircraft stations) can be mitigated through using cavity filters that block in these receivers the reception of unwanted signals from transmissions from aircraft operating on the surface of an airport.

APPENDIX D

Extension of the DOC for ACC and FIS with 50 NM
(Use of a 50 NM buffer between ACC and FIS assignments (co-frequency))

1 For ACC/FIS the service range used for frequency assignment planning is the specified area (polygon) plus 50 NM. This is not necessary as the ACC/FIS service volume specified would not need an extension of 50 NM. In addition, from an operational perspective, creating an area of uncertainty with a band of 2x50 NM where the aircraft can operate on a frequency assigned to two either of two adjacent ACC areas (or adjacent FIR's) may not be safe.

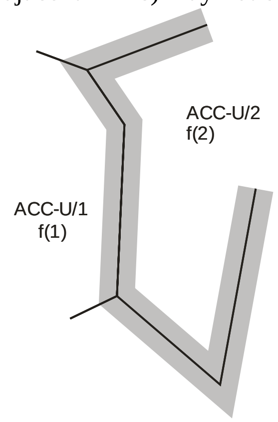


Figure 1

2 It is therefore proposed to remove the additional 50 NM from the (frequency protected) DOC's for FIS and ACC services.

Attachment E

Progress on computer based frequency assignment planning tool for NAV systems (COM list 2)

1. ICAO is progressing the development of a Navigation module (program) for the frequency assignment planning for ILS, VOR and DME and a separate module for NDB frequency assignment planning. This work has recently been started and is expected to be completed by mid-2010. The first phase of this work, which is the incorporation and harmonization of the different Regional data bases, is in progress.

2. The module will follow the same principles and methodology as those developed for VHF COM systems frequency assignment planning and for SSR Mode S II code assignment planning, as well as the international coordination of the relevant assignments.

2.1 The data base will be a global data base; the module will offer data base functionality and the coverage and interference areas will be printed on a map.

2.2 The module will incorporate the frequency assignment planning criteria as agreed on a Regional basis. In order to operate the program on a global basis, these planning criteria need to be harmonized between the different ICAO Regions. This is currently work in progress

3. **Planning criteria for VOR**

3.1 Planning criteria for VOR, to be applied in the AFI/IO Region are contained in the Air Navigation Plan, Volume II, Part IV, Attachment H (Doc. 7474). These criteria were confirmed at the 7th Africa-Indian Ocean Region Regional Air Navigation Workshop (1997).

These criteria stipulate:

(i) VOR in operation for flight up to FL 500 (using 100 kHz channel spacing in odd tenths of a megahertz in the band 112 – 117.975 MHz) the following geographical separation should be used:

Co-channel: 550 NM
Adj-channel: 220 NM

(ii) VOR on congested areas and operating in a mixed 50 kHz / 100 kHz channel separation environment the adjacent channel separation should be at least 500 NM

Note: the planning criteria in (i) and (ii) do not take into account the actual designated operational coverage (DOC) of the VOR

(iii) For VOR operating in terminal areas (DOC: 25/250) the following geographical separation should be used:

Co-channel: 200 NM
Adj-channel: 60 NM

(iv) For VOR operating for use in final approach and landing (DOC: 25/100) the following geographical separation should be used:

Co-channel: 130 NM
Adj-channel: 30 NM

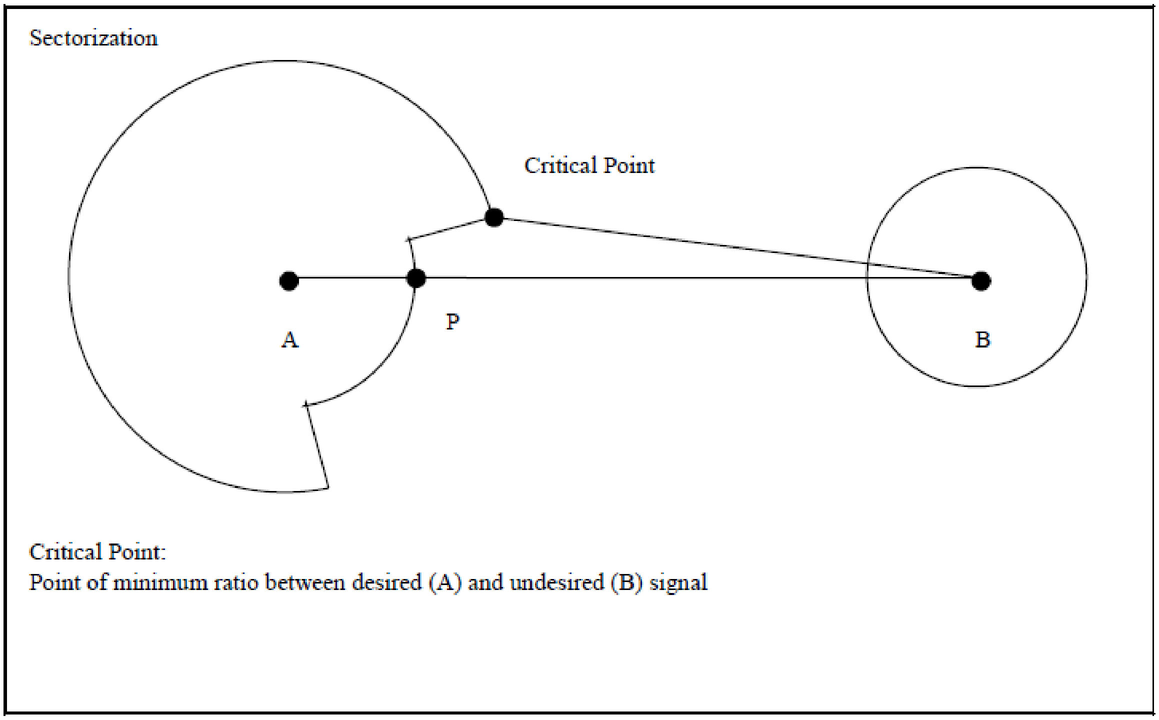
Note: the planning criteria in (iii) and (iv) recognize two DOC areas. On a case-by-case basis, different DOC areas can be used.

3.2 Annex 10 – Volume V – aeronautical Spectrum utilization contains provisions concerning the use of specific frequencies.

3.3 Annex 10 – Volume I, Attachment C, section 3.4 contains criteria (guidance material) to establish separation distances that can be applied for a variety of designated operational coverage areas (DOC) for VOR.

3.3.1 These separation criteria are planned to be incorporated in the frequency assignment planning module for VOR. They would provide for a more flexible identification of DOC areas and corresponding separation distances and result in a more efficient frequency assignment planning.

3.3.2 Another method, to be incorporated in the frequency assignment planning module for VOR is the use of key-holing. Using this method, the DOC can be tailored to the operational requirements for the VOR coverage and further improve the efficiency of the frequency assignment plan.



3.3.3 Some of the Material in Annex 10 has been amended and becomes applicable in November 2009. This material needs to be reviewed in order to be implemented in the VOR planning criteria with respect to the Regional Planning Criteria in all Regions.

3.4 Detailed planning criteria, closely following the principles as identified in Annex 10 have been developed and used for many years in the EUR Region. These criteria are contained in the EUR Frequency Management Manual. It is the intention that these planning criteria, which allow for maximum flexibility and efficiency in frequency assignment planning for VOR be implemented in the VOR frequency assignment planning module. These criteria also need to be reviewed or updated with the recent amendments to VOR frequency assignment planning in Annex 10.

3.5 As required, the NAV module will also be capable to assess interference from FM broadcasting stations into VOR. For this to be incorporated, an updated list of existing and new FM broadcasting stations needs to be available. ICAO does, at this moment, not have such an updated list. However, for the AFI Region, the frequency lists for FM broadcasting stations, as developed and updated under the ITU Geneva 84 agreement, can be used initially.

4. **DME frequency assignment planning**

4.1 No specific material for DME frequency assignment planning has been developed for use in the AFI/IO Region (and other Regions). The Air Navigation plan refers to the material contained in Annex 10. In this regard it should be noted that in cases where a DME is co-located with a VOR, the protection requirements for DME are met if those for VOR are also met. However, this does not apply for stand-alone DME installations, such as are being used in RNAV (DME-DME navigation).

4.2 The frequency assignment planning criteria for DME, as contained in Annex 10, will be implemented in the NAV module.

4.3 **PBN and DME-DME navigation**

4.3.1 For DME-DME navigation it is necessary to identify the number (minimum is 3) of DME’s that are within line-of sight with the aircraft flying in a particular area or along a particular route.

4.3.2 The NAV module will be able to identify all DME’s within line-of-sight of a particular air route at intervals set by the user. Also the angle of transmission from the DME station can be set. The NAV module however does not [yet] takes into account the effect of the terrain. In order to test the effect of the terrain, other programs are required, that are commercially available.

4.3.2.1 For assessing the number of DME’s within line of sight from the aircraft (at different altitudes), the NAV module can be used with the following steps:

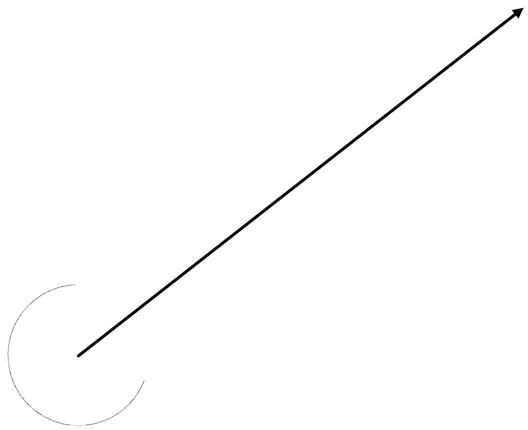


Figure 1

(i) Along the air route, the program identifies the DME’s that are within the radio horizon seen from the aircraft for each test point (and circle around the test point) along the route (Re. Figure 1). The range of the circles (which normally corresponds to the radio horizon seen from the aircraft) can be set by the user of the NAV module. Also the distance between the circles can be set. The results will be presented in a list and can also be plotted on a map.

Note: for an area service (ACC, FIS), a number of test points can be generated. For each of the test points, the number of DME's can be identified.

(ii) Setting the range of the circles also affects the angle of transmission for the DME (Re. Figure 2). At the radio horizon, reception of signals from the DME may be locked by terrain conditions. Setting the angle at an (arbitrary) value of x degrees may reduce the effect of the terrain:

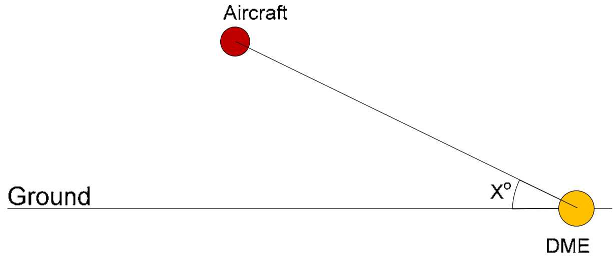


Figure 2

Note: In case the angle X = 0, the distance to the DME is equal to the distance to the radio horizon. This is, as an example, for an aircraft at FL 450 equal to 260 NM and for an aircraft at FL 250 the radio horizon is at 195 NM. In these cases, the local terrain surrounding the DME needs to be considered carefully. When the angle X is set at 10°, the effect of the local terrain becomes less prominent in many cases. As a consequence, the number of DME's identified will be less because the (horizontal) distance between the aircraft and the DME's identified will be smaller.

4.3.2.2 The mechanism offered by the NAV module can initially determine if the number of DME's that can be contacted along an air route is sufficient for RNAV purposes. However, in most cases, for a detailed assessment of the DME capacity along an air route (or within a certain area), a program that is capable of assessing the effect of the terrain may be necessary. The assessment that can be offered by the NAV module therefore needs to be used with caution and as a low cost tool.

5. ILS frequency assignment planning

5.1 For ILS, the separation criteria to be applied are:

Co-channel: 175 NM

Adj-channel: 45 NM

Reference is included to the planning criteria as contained in Annex 10, Volume i, Attachment C, paragraph 3.5. These criteria are different from the criteria above. Also, Annex 10 includes separation criteria between ILS and VOR as VOR can operate in the ILS sub-band (108-112 MHz) on channels interleaved with ILS channels.

5.2 Geographical separation between ILS stations, as per Annex 10 (Volume I, Attachment C) should be at least 80 NM from the ILS protection point. The ILS protection point is a 25 NM from the ILS in the direction of the azimuth of the ILS antenna (coverage). In this case, the co-channel separation should be at least 105 NM. As the ILS protection point is at an altitude of 6250 ft above the ILS antenna, the distance to the radio horizon is 97 NM. This means that, at the ILS protection point, signals from the unwanted ILS may be received and interfere with those from the wanted ILS. The difference in distance (25 NM and 97 NM) however would secure a D/U ratio of at least XXX dB between the two signals.

5.2.1 In case the use of a much larger than necessary separation distance between ILS station does not affect the implementation of new (100 kHz) ILS frequency assignments, no changes to the frequency planning criteria as deployed in the AFI Region are necessary. In case with these criteria congestion is experienced, rather than moving to the implementation of 50 kHz channel separation in the AFI Region, revision of the current planning criteria could be considered. When the NAV module is completed, certain assessments of future availability of ILS frequency assignments can be tested (this applies also for other radio systems)

5.2.2 Similarly as indicated above in paragraph 3.5, the NAV module will be able to assess interference that can be caused by FM broadcasting transmitters operating in the bad between 100 MHz and 108 MHz.

6. NDB frequency assignment planning

6.1 The final module will address frequency assignment planning for Non directional Beacons (NDB) and Locators.

6.2 Like in the previously identified modules, the data base management for NDB frequency assignment planning will follow the same methodology as for VHF COM frequency and SSR Mode S II code coordination and assignment.

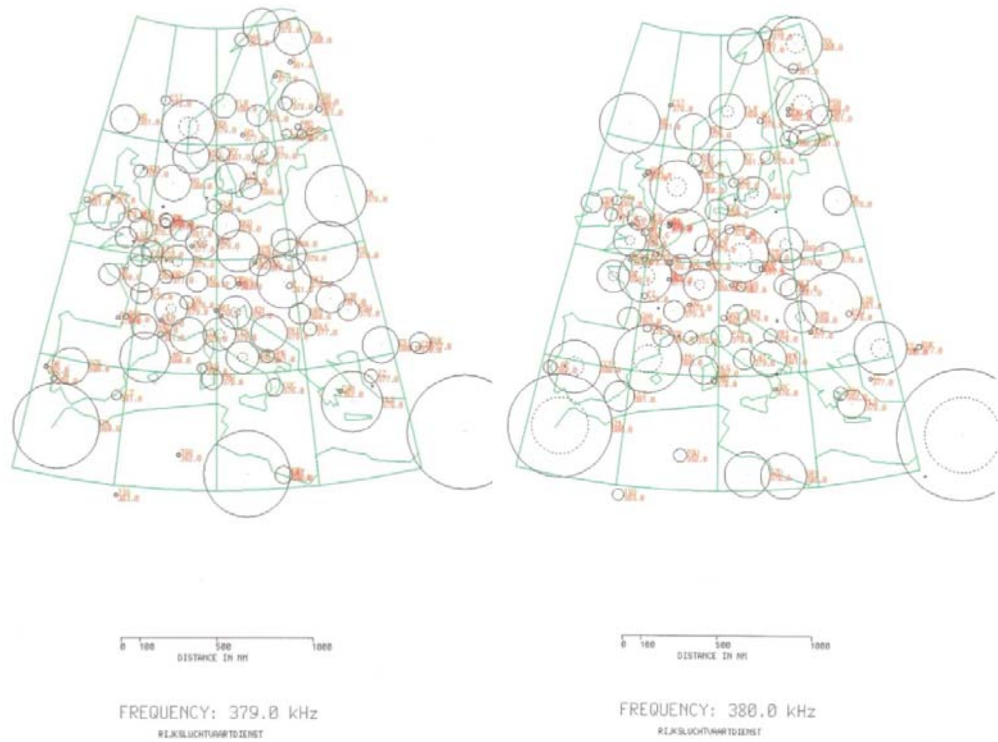
6.3 Planning principles for NDB

6.3.1 The planning principles for NDB, as contained in the Report of the African-Indian Ocean Region Regional Air Navigation Workshop (1997) indicates that, because of the low overall efficiency, NDB (LF/MF beacons should be discouraged and these beacons should be replaced with VOR/DME.

6.3.2 Detailed frequency assignment criteria for NDB are contained in Annex 10, Volume 1, Chapter 3. The basic criteria, as agreed, are in line with the material contained in Annex 10. It is the intention to develop a program that allows for flexibility in setting the DOC for the NDB, as operationally required.

6.4 The NDB module will provide the same data base functionality as for VHF COM systems. Compatibility can be assessed through calculations and the results can be plotted on a map.

An example of such a map is in Figure 3 below.



Appendix F

VHF COM FREQUENCY UTILIZATION PLAN

1. INTRODUCTION

1.1 The ICAO VHF COM frequency management tool, will in cooperate Frequency Assignment planning tool which manages and provides assistance in assessing compatibility between frequencies in the band 117.975- 137 MHz global.

1.2 For the software to be effective all VHF assignments within the frequency bands 117.975-137 MHz must be registered in the database. In the case of extended range VHF frequencies, all the repeater stations and their coordinates must be registered in the database.

2. DISCUSSION

2.1 Assignment planning criteria for AFI is as in **Table 1** below.

VHF FREQUENCY UTILIZATION PLAN

PLAN D'UTILISATION DES FRÉQUENCES VHF

PLAN DE UTILIZACIÓN DE FRECUENCIAS VHF

Function Fonction Función	Frequencies/Bands Fréquences/Bandes Frecuencias/Bandas (MHz)			
	A	C	B	D
TWR	118.000	118.025	118.050	118.075
	118.100	118.125	118.150	118.175
	118.200	118.225	118.250	118.275
	118.300	118.325	118.350	118.375
	118.400	118.425	118.450	118.475
	118.600	118.625	118.650	118.675
	118.700	118.725	118.750	118.775
	118.800	118.825	118.850	118.875
	118.900	118.925	118.950	118.975
	120.800	120.825	120.850	120.875
SMC	121.600	121.625	121.650	121.675
	121.700	121.725	121.750	121.775
	121.800	121.825	121.850	121.875
	121.900	121.925	121.950	121.975
APP-PAR	119.500	119.525	119.550	119.575
	119.900	119.925	119.950	119.975
	120.100	120.125	120.150	120.175
APP-L	119.000	119.025	119.050	119.075
	119.100	119.125	119.150	119.175
APP-L (../..)	119.200	119.225	119.250	119.275
	119.400	119.425	119.450	119.475
	119.600	119.625	119.650	119.675
	119.700	119.725	119.750	119.775
	119.800	119.825	119.850	119.875
	126.000	126.025	126.050	126.075
APP-I, APP/SR/I	120.000	120.025	120.050	120.075
	120.300	120.325	120.350	120.375
	120.400	120.425	120.450	120.475
	120.700	120.725	120.750	120.775
	121.100	121.125	121.150	121.175
	121.200	121.225	121.250	121.275
	121.300	121.325	121.350	121.375
	121.400	121.425	121.450	121.475
	123.700	123.725	123.750	123.775
	124.000	124.025	124.050	124.075
	124.300	124.325	124.350	124.375
	125.300	125.325	125.350	125.375
APP-H	125.700	125.725	125.750	125.775
	127.200	127.225	127.250	127.275
	128.200	128.225	128.250	128.275
	128.600	128.625	128.650	128.675

Function Fonction Función	Frequencies/Bands Fréquences/Bandes Frecuencias/Bandas (MHz)			
	A	C	B	D
APP-U	123.900	123.925	123.950	123.975
	124.400	124.425	124.450	124.475
	124.500	124.525	124.550	124.575
	124.900	124.925	124.950	124.975
	127.800	127.825	127.850	127.875
	128.000	128.025	128.050	128.075
ACC-L	123.800	123.825	123.850	123.875
	125.400	125.425	125.450	125.475
	128.400	128.425	128.450	128.475
	129.000	129.025	129.050	129.075
	129.600	129.625	129.650	129.675
	131.200	131.225	131.250	131.275
ACC-U	118.500	118.525	118.550	118.575
	119.300	119.325	119.350	119.375
	120.500	120.525	120.550	120.575
	120.600	120.625	120.650	120.675
	120.900	120.925	120.950	120.975
	124.600	124.625	124.650	124.675
	124.700	124.725	124.750	124.775
	125.100	125.125	125.150	125.175
	125.500	125.525	125.550	125.575
	125.600	125.625	125.650	125.675
ACC-U (../..)	125.900	125.925	125.950	125.975
	126.100	126.125	126.150	126.175
	126.500	126.525	126.550	126.575
	126.700	126.725	126.750	126.775
	127.100	127.125	127.150	127.175
	127.300	127.325	127.350	127.375
	127.700	127.725	127.750	127.775
	128.100	128.125	128.150	128.175
	128.300	128.325	128.350	128.375
	128.500	128.525	128.550	128.575
	128.700	128.725	128.750	128.775
	128.800	128.825	128.850	128.875
	128.900	128.925	128.950	128.975
	129.100	129.125	129.150	129.175
	129.200	129.225	129.250	129.275
	129.300	129.325	129.350	129.375
	129.400	129.425	129.450	129.475
	129.500	129.525	129.550	129.575
	130.900	130.925	130.950	130.975
	132.100	132.125	132.150	132.175
FIS-L	124.200	124.225	124.250	124.275
	125.200	125.225	125.250	125.275
FIS-L (../..)	127.500	127.525	127.550	127.575
	131.100	131.125	131.150	131.175
FIS-U, GP	124.800	124.825	124.850	124.875
	125.800	125.825	125.850	125.875
	126.300	126.325	126.350	126.375
	126.900	126.925	126.950	126.975
	127.400	127.425	127.450	127.475
	131.300	131.325	131.350	131.375
	132.300	132.325	132.350	132.375
OPC	131.400 – 131.900			

Function Fonction Función	Frequencies/Bands Fréquences/Bandes Frecuencias/Bandas (MHz)			
	A	C	B	D
VOLMET, ATIS	126.200 126.400 126.600 126.800 127.000 127.600	126.225 126.425 126.625 126.825 127.025 127.625	126.250 126.450 126.650 126.850 127.050 127.650	126.275 126.475 126.675 126.875 127.075 127.675
DATA LINK/ LIAISON DE DONNÉES/ ENLACE DE DATOS	136.900 – 136.975			
EMERGENCY/ URGENCE/ EMERGENCIA	121.500			
AUXILIARY SAR/ SAR AUXILIAIRE/ SAR AUXILIAR	123.100			
AIR-TO-AIR/ AIR-AIR AIRE-A-AIRE	123.450			

Notes/Notas.—

A — First choice/ Premier choix/Primera opción
B — Second choice/Deuxième choix/Segunda opción
C — Third choice/Troisième choix/Tercera opción
D — Third choice/Troisième choix/Tercera opción

For global frequency planning and management, the planning criteria must be harmonized. Care should be taken so that undue stringent measures should not be posed on AFI where there is no high saturation of VHF frequencies.

Planning criteria for:

GEOGRAPHICAL SEPARATION CRITERIA FORVOR, VOR/DME AND ILS INSTALLATIONS

VHF omnidirectional radio range (VOR)/distance measuring equipment (DME)

1. In the selection of frequencies for VOR and/or VOR/DME the following criteria are to be applied:

a) for VOR required to serve en-route flight operations up to FL 500, geographic separations should be:

   1) for co-channel: 1 020 km (550 NM) between 200 NM/FL 450 facilities;

   2) for adjacent channel: 410 km (220 NM);

b) for VORs required for use in terminal areas (40 NM/FL 250) geographic separation should be:

   1) for co-channel: 370 km (200 NM);

   2) for adjacent channel: 110 km (60 NM);

c) for VORs required for use in final approach and landing (25 NM/FL 100) geographic separation should be:

   1) for co-channel: 240 km (130 NM);

   2) for adjacent channel: 55 km (30 NM);*

2 Detailed frequency assignment criteria for VOR are provided in Annex 10, Volume I, 3.3.2 with related guidance material in Attachment C, 3.4 and 3.5, and in Annex 10, Volume V, 4.2.

3 Detailed frequency assignment criteria for DME are provided in Annex 10, Volume I, 3.5.3.3 and Attachment C, and in Annex 10, Volume V, 4.3.

Instrument landing system (ILS)

3. In the selection of frequencies for ILS the following criteria are to be applied:

a) for co-channel: 175 NM;

b) for adjacent channel: 45 NM.

4. Detailed frequency assignment criteria for ILS are provided in Annex 10, Volume I, 3.1.3.2 with related guidance material in Attachment C, 3.5, and in Annex 10, Volume V, 4.2.

* Based on 100 kHz channel spacing.

Action to be taken by the workshop:

a) The workshop to note the above information
b) To update the COM List
c) The management group to coordinate and harmonize the planning criteria for assignments in 117.975-137 MHz band

APPENDIX G

COMMENTS FROM PARTICIPANTS

ASECNA

1. We attended a very interesting seminar and got familiar with useful software tools for planning and managing aeronautical mobile frequencies;

2. To take advantage of these tools, it is highly recommended to update the COM Lists from the ANSP and States (extended VHF, Operational frequencies in use);

3. It will be suitable to be able to export the maps in pdf or other format; and

4. It will be suitable to be able to update the data online from a fiche form to be filled by the appropriate person from the ANSP/States (user name, password delivered by ICAO.)

Zimbabwe

1. The programme seems to be very useful. However, it needs more development and refinement on the developed parts.

2. The programme needs to have the current database. May be the developer should make physical visits to States to cover all entries correctly in the database

3. The programme should be made user friendly

4. The link of the programme to the Google earth should be looked at once again, because the Google earth comes with many noise windows and warnings.

Sudan

1. It was very interesting and useful. The Aviation Software for CNS is a very good programme that covers all CAA activities.

2. We recommend that we register all aviation frequency in CNS and in future to have approval from ICAO Regional Office

3. We also recommend that ICAO Regional Office to advise all members in the region to participate in every workshop and exchange the knowledge attained from the workshop.

Nigeria

1. The programme was very instructive and usable but there is room for improvement. In terms of data entry capability multitasking

2. The time was short to go through the whole features of the programme.

Zambia

1. The programme is well thought out and covers the current needs in the communication requirements.
2. It must be loaded into a complete package other than in several files
3. Looking forward to its use
4. There is need for countries to update their information if it has to serve as Global data bank
5. To be operational before WRC 12.

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