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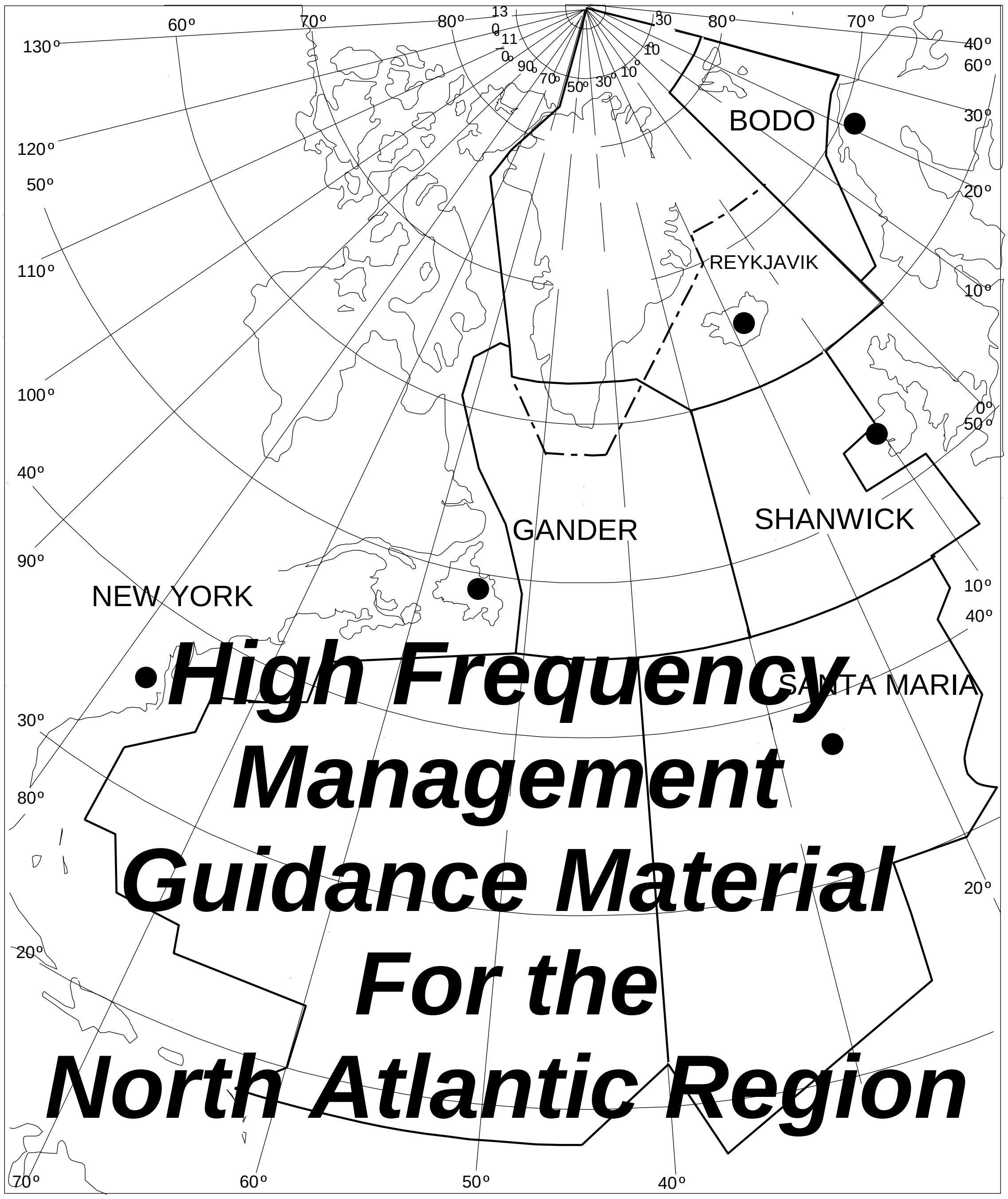
North Atlantic Systems Planning Group
Aeronautical Communications Sub Group



High Frequency Management Guidance Material For the North Atlantic Region

Version 3.0.0
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Change Record

This chart provides records of changes to Version 0.1 and forward.

	Paragraph(s)	**Explanation**
Version 0.2	1.1.3	Deleted, re-numbering paragraphs from 1.1.4 through 1.1.9
	1.1.3	New numbering, paragraph redrafted
	1.1.4	New numbering, paragraph redrafted
	1.1.7	New numbering, paragraph redrafted
	1.1.8	New numbering, paragraph redrafted
Version 0.3	List of Acronyms	New entries added
	Section 3	New section added
Version 0.4	Table of contents	Updated
	List of Acronyms	New entries added
	Section 4	New section added
	Section 5	New section added
	Annexes	New section added
Version 0.5	All document	Change KHz to kHz
	Section 1	Redrafted paragraphs 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.1.6, 1.1.7, 1.2.1, and 1.2.2
	Section 2	Redrafted paragraphs 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.3.1.1, 2.3.2.1, 2.3.2.2, 2.3.2.3, 2.3.2.4, 2.5.2.1, 2.5.2.2, 2.5.2.3, and 2.5.4.1. Removed references to Annex 10 in 2.3.3, 2.3.4, 2.3.5, 2.3.6, 2.3.7, and 2.4. Removed 2.5.2.3
	Section 3	Redrafted paragraphs 3.1.3.1, 3.1.4.1, 3.1.4.2, 3.1.4.3, 3.1.5.1, 3.2.1, 3.2.2.4.1, 3.2.2.5.1 and 3.2.2.5.2.
	Section 4	Redrafted paragraphs 4.1.1, 4.1.4, 4.1.5, 4.1.6, 4.1.7, 4.2.1.1, 4.2.1.2, 4.2.1.3, 4.2.2.1, 4.2.2.2, 4.2.2.3, 4.2.3.1, 4.2.3.2, 4.2.3.3, 4.2.4.1, 4.2.4.2, 4.2.4.3, 4.2.5.1, 4.2.5.2, 4.2.6.1, 4.2.6.2, 4.2.6.3, 4.3.1, 4.3.2, 4.3.3 and 4.3.4. New paragraphs 4.2.2.4, 4.2.3.4 and 4.3.5

	Paragraph(s)	Explanation
	Section 5	Redrafted paragraphs 5.1.2, 5.2.1, 5.3.1, 5.3.2 and 5.4.1
	Annexes	Updated
Version 0.6	Table of contents	Update. Removed references to VOLMET
	Section 1	Removed references to VOLMET on 1.2.2
	Section 2	Review 2.2, correction on 2.3.2.2, removed references to VOLMET on 2.2.4 – Table 1, delete 2.5
	Section 3	Correction on 3.1.5.1, delete 3.2
	Section 4	Redrafted 4.2.2. Deleted 4.2.3. Renumbering of 4.2.3 to 4.2.6
	Section 5	Reviewed 5.1, 5.2, and 5.3, delete 5.4.
	Appendixes	Renamed to Appendixes. New section format. New Appendix A. Delete old Annexes 7, 8 and 9 related to VOLMET Broadcast Plan.
Version 1	Header Preface List of Acronyms Section 5 Appendixes	Renamed ACSG to ACG Renamed ACSG to ACG Renamed ACSG to ACG Insert new 5.4 and 5.4.1 regarding Poor HF propagation conditions Changes on Appendixes B-1 to 6, inclusion of SATCOM numbers on all stations, address information on Gander Information, several changes on Bodo Station as proposed. Changes on Appendix C-5, hours of operation to Santa Maria Station as it will be publish on State AIP after the evaluation trials. Renamed ACSG to ACG.
Version 2.0	Header Preface List of Acronyms Section 2	Renamed ACG to ACSG Renamed ACG to ACSG Renamed NAT OPS Manual to NAT Doc.007 Renamed ACG to ACSG Redrafted 2.2.4, 2.3.2.3 and 2.3.2.4. Definition of MWARA and RDARA frequency allotment plan.

	Paragraph(s)	Explanation
		Inserted new 2.3.2.5 about NAT family H in Santa Maria FIR. Inserted new 2.4.2 and 2.4.3 about duplicate SELCAL codes and procedures for radio operators.
	Section 3	Redrafted 3.1.1, 3.1.3, 3.1.5 , 3.1.6.3 and 3.1.7. Definitions on RDARA frequencies and NAT family H in Santa Maria FIR.
	Section 4	Redrafted 4.2.6. Inserted NAT Family H.
	Appendices B	Created new template and updated data.
	Appendices C	Updated the hours of operation where required.
Version 3.0	3.1.7.1	Remove reference to Artic Radio from Table 5
	5.1.2	Updated to refer that hours of utilization of frequencies will be published in State AIP’s
	Appendix B	Changes in contact details
	Appendix C	Deleted

Preface

This Document is published by the North Atlantic Systems Planning Group, and managed by the Aeronautical Communications Sub Group, and is for guidance. Regulatory material relating to North Atlantic communications procedures is contained in relevant ICAO Documents and Annexes. Annex 10 – Volume II, ITU Radio Regulations, Regional Supplementary Procedures (Doc. 7030), FASID, NAT Doc.007, State AIP and current NOTAM's, which should be read in conjunction with the guidance material contained in this document.

To assist with the editing of this document and to ensure the currency and accuracy of future editions, comments and suggestions for possible amendments should be sent to the editor, to the contact information included in the document identification section.

List of Acronyms

ACARS	Aircraft Communication Addressing and Reporting System
ACC	Area Control Centre
ACID	Aircraft Identification
ACSG	Aeronautical Communications Sub Group
AIP	Aeronautical Information Publication
AFTN	Aeronautical Fixed Telecommunication Network
AMS	Aeronautical Mobile Service
ARINC	Aeronautical Radio INC.
ARP	Air Report Message
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSMP	Air Traffic Services Message Processor
ATSU	Air Traffic Services Unit
CAA	Civil Aviation Authority
CNS	Communications, Navigation and Surveillance
EMG	Emergency Message
FAP	Frequency Allotment Plan
FDPS	Flight Data Processing System
FIR	Flight Information Region
FMC	Flight Management Computer
FMS	Flight Management System
GP	General Purpose
GPS	Global Positioning System
HF	High Frequency (3 to 30 MHz)
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ITU	International Telecommunications Union
LDOC	Long Distance Operations Control
kHz	Kilohertz
LF	Low Frequency (30 to 300 kHz)
LUF	Lowest Usable Frequency
MET	Meteorological
MF	Medium Frequency (300 to 3000 kHz)
MHz	Megahertz
MUF	Maximum Usable Frequency
MWAR	Major World Air Route
MWARA	Major World Air Route Area
NAT	North Atlantic
NAT SPG	North Atlantic Systems Planning Group
NOTAM	Notice to Airmen
OCA	Oceanic Control Area
POS	ICAO Position Report Message
RDAR	Regional and Domestic Air Routes

RDARA	Regional and Domestic Air Route Area
R/T	Radio-Telephony
SARPS	Standards and Recommended Practices
SELCAL	Selective Calling System
VHF	Very High Frequency (30 to 300 MHz)
VLF	Very Low Frequency (3 to 30 kHz)
WP	Waypoint Position
WPR	Waypoint Position Reporting

1 Introduction

1.1 Purpose of the document

1.1.1 The purpose of this document is to provide a guidance methodology for the utilisation of the Families and Frequencies employed by the Aeronautical Communication Stations on the North Atlantic, to support a better management plan of the available families, frequencies and human resources, in order to increase the efficiency and capacity of the Communications Network.

1.1.2 It will also include information about HF frequencies for air-ground communications. In addition, it will contain contact information for Aeronautical Stations.

2 Operational concept

2.1 Overview

2.1.1 The Aeronautical Mobile Service is a service reserved for air-ground communications related with the safety and regularity of flights, flying primarily along national or international civil air routes.

2.1.2 In areas like the North Atlantic, where VHF coverage is insufficient due to range limitation to cover all portions of the routes flown, the use of HF frequencies are necessary because they provide long range communications coverage, not only for air-ground voice communications, but also for the broadcast of ATS or Meteo information.

2.1.3 For various reasons, some technical, others economical, environmental, physical, natural, etc., coverage of a wide area by a single station with equipment located in a single place are impractical.

2.1.4 Taking these factors into account, the most practical option is to employ a number of stations sharing a range of frequencies and working as a network to provide the facilities and services required for the AMS.

2.1.5 To work as a network the AMS should follow appropriate principles of operation, in order to achieve the highest possible level of capacity and efficiency, otherwise, its purpose will not be achieved and the safety and regularity of flights will be affected.

2.2 HF medium characteristics

2.2.1 This section presents only a short description on the HF medium characteristics, a more detail description can be found in Appendix A.

2.2.2 As a general rule, radio signals travel in straight lines, that is, they follow great circle paths over the surface of the earth. Under certain circumstances, however, the path of a signal may change direction, this change of direction is called refraction. Refraction examples are coastal, atmospheric and ionospheric, and the amount of refraction varies considerably, depending on certain conditions. Those conditions could be a change in direction when a signal crosses a coastline (coastal refraction), a change in direction due to a variation in temperature, pressure and humidity, particularly at low altitude (atmospheric refraction), or a change in direction when the radio wave passes through an ionised layer (ionospheric refraction).

2.2.3 The ionosphere is still under investigation but it is known that several definite ionised layers exist within it. During daytime hours there are four main ionisation layers designated D, E, F_1 and F_2 in ascending order of height. At night, when the sun's radiation is absent, ionisation still persists but it is less intense, and fewer layers are found (D and F layers). Factors that affect the ionosphere layers is strength of the sun's radiation, since it varies with latitude causing that the structure of the ionosphere varies widely over the earth's surface, and the state of the sun, since sunspots affect the amount of ultra-violet radiation.

2.2.3.1 Maximum Usable Frequency (MUF) at night is much less than by day, because the intensity of ionisation in the layer is less so than lower frequencies have to be used to produce the same amount of refractive bending and give the same critical angle and skip distance as by day. However, the signal attenuation in the ionosphere is also much less at night so the lower frequency needed is still usable. Hence the night frequency for a given path is about half of the day frequency, and shorter distances can be worked at night than by day while still using a single reflection from the F layer.

2.2.3.2 The MUF not only varies with path length and between day and night, but also with season, meteor trails, sunspot state, and sudden ionospheric disturbances produced by eruptions on the sun. Because of the variations of MUF, HF transmitting stations have to use frequencies varying widely between about 2 and 20 MHz.

2.2.4 As consequence of this conditions, frequency band usage can be viewed in the following table:

Areas	Bands between: (MHz)	Sharing conditions
MWARA area RDARA area	3 and 6.6	Night propagation
	9 and 11.3	Day propagation
	Higher than 13	Day propagation

Table 1 – Frequency band usage (ref. ITU Appendix 27 Aer2)

2.3 Radiotelephony Network

2.3.1 Definition

2.3.1.1 A radiotelephony network is defined as a group of radiotelephony aeronautical stations which operate on and guard frequencies from the same family and which support each other in a defined manner to ensure maximum dependability of air-ground communications and dissemination of air-ground traffic

2.3.2 NAT Radiotelephony Network Composition

2.3.2.1 In the NAT there are six aeronautical stations, one per each of the Oceanic FIR's, responsible for the provision of air-ground communications as part of the Aeronautical Mobile Service. They are: Bodo Radio (Norway, Bodo ACC), Gander Radio (Canada, Gander OACC), Iceland Radio (Iceland, Reykjavik ACC), New York Radio (USA, New York OACC), Santa Maria Radio (Portugal, Santa Maria OACC) and Shanwick Radio (Ireland, Shanwick OACC).

2.3.2.2 In addition to those six aeronautical stations, there are two other stations that operate NAT frequencies. They are Canarias Radio which serves Canarias ACC and Arctic Radio serving Edmonton, Winnipeg and Montreal ACC's.

2.3.2.3 To support the air-ground communications of the AMS in the NAT, twenty-four frequencies were allocated by the ITU (Appendix 27 Aer2), in different bands to ensure NAT MWARA, continuous coverage. Additionally to the NAT MWARA frequencies, the aeronautical stations may make use of RDARA frequencies, according to operational requirements and agreements between stations

2.3.2.4 All NAT MWARA HF frequencies are organized into six groups known as Families, The families are identified as NAT Family A, B, C, D, E and F. Each Family contains a range of frequencies from each of the HF frequency bands allocated to the Network.

2.3.2.5 . From the possible sub network RDARA frequencies for Portugal and Ireland (Region 1/1E), Santa Maria Radio has defined a range of frequencies for use within Santa Maria FIR, named as Family H.

2.3.3 Principles of Network Operation

2.3.3.1 The aeronautical stations of a radiotelephony network should assist each other in order to provide the air-ground communication service required of the network by aircraft flying on the air routes for which the network is responsible.

2.3.3.2 When the network comprises a large number of stations, network communications for flights on any individual route segment should be provided by selected stations, termed “regular stations” for that segment. In principle, the regular station will be those serving the locations immediately concerned with flights on that route segment, i.e. points of take-off and landing and appropriate flight information centres or area control centres.

2.3.3.3 In areas or on routes where radio conditions, length of flights or distance between aeronautical stations require additional measures to ensure continuity of air-ground communications throughout the route segment, the regular stations should share between them a responsibility of primary guard whereby each station will provide the primary guard for that portion of the flight during which the messages from the aircraft can be handled most effectively by that station.

2.3.3.4 During its tenure of primary guard, each regular station should, among other things:

a) be responsible for designating suitable primary and secondary frequencies for its communications with the aircraft;
b) receive all position reports and handle other messages from and to the aircraft essential to the safe conduct of the flight;
c) be responsible for the action required in case of failure of communication.

2.3.4 Frequencies to be used

2.3.4.1 Aircraft stations shall operate on the appropriate radio frequencies.

2.3.4.2 The air-ground radio station shall designate the frequency(ies) to be used under normal conditions by aircraft stations operating under its control.

2.3.4.3 In network operation, the initial designation of primary and secondary frequencies should be made by the network station with which the aircraft makes pre-flight check or its initial contact after take-off. This station should also ensure that other network stations are advised, as required, of the frequency(ies) designated.

2.3.4.4 An aeronautical station when designating frequencies, should take into account the appropriate propagation data and distance over which communications are required .

2.3.4.5 If a frequency designated by an aeronautical station proves to be unsuitable, the aircraft station should suggest an alternative frequency.

2.3.5 Establishment of communications

2.3.5.1 Aircraft stations shall, if possible, communicate directly with the air-ground control radio station appropriate to the area in which the aircraft are flying. If unable to do so, aircraft stations shall use any relay means available and appropriate to transmit messages to the air-ground control radio station.

2.3.5.2 When normal communications from an aeronautical station to an aircraft station cannot be established, the aeronautical station shall use any relay means available and appropriate to transmit messages to the aircraft station. If this efforts fail, the originator shall be advised.

2.3.5.3 When, in network operation, communication between an aircraft station and a regular station has not been established after calls on the primary and secondary frequencies, aid should be rendered by one of the other regular stations for that flight, either by calling the attention of the station first called or, in case of a call made by an aircraft station, by answering the call and taking the traffic.

2.3.5.4 Other stations of the network should render assistance by taking similar action only if attempts to establish communication by the regular stations have proved unsuccessful.

2.3.6 Transfer of communications

2.3.6.1 The transfer of primary guard from one station to the next will normally take place at the time of the traversing of flight information region or control area boundaries, this guard being provided at any time, as far as possible, by the station serving the flight information centre or area control centre in whose area the aircraft is flying.

2.3.6.2 An aircraft station should be advised by the appropriate aeronautical station to transfer from one radio frequency or network to another. In the absence of such advice, the aircraft station should notify the appropriate aeronautical station before such transfer takes place.

2.3.6.3 In the case of transfer from one network to another, the transfer should preferably take place while the aircraft is in communication with a station operating in both networks to ensure continuity of communications. If, however, the change of network must take place concurrently with the transfer of communication to another network station, the transfer should be co-ordinated by the two network stations prior to advising or authorizing the frequency change. The aircraft should also be advised of the primary and secondary frequencies to be used after the transfer.

2.3.7 Communications failure

2.3.7.1 When an aircraft station fails to establish contact with the aeronautical station on the designated frequency, it shall attempt to establish contact on another frequency appropriate to the route. If this attempt fails, the aircraft station shall attempt to establish communication with other aircraft or other aeronautical stations on frequencies appropriate to the route. In addition, an aircraft operating within a network shall monitor the appropriate VHF frequency for calls from nearby aircraft.

2.3.7.2 When an aeronautical station has been unable to establish contact with an aircraft station after calls on the frequencies on which the aircraft is believed to be listening, it shall:

a) Request other aeronautical stations to render assistance by calling the aircraft and relaying traffic, if necessary;
b) Request aircraft on the route to attempt to establish communication with the aircraft and relay traffic, if necessary.

2.3.7.3 The air-ground control radio station shall notify the appropriate air traffic services unit and the aircraft operating agency, as soon as possible, of any failure in air-ground communications.

2.4 SELCAL operation

2.4.1 With the selective calling system known as SELCAL, the voice call is replaced by the transmission of coded tones to the aircraft over the radiotelephony channels. A single selective call consists of a combination of four pre-selected audio tones whose transmission requires approximately two seconds. The tones are generated in the aeronautical station coder and are received by a decoder connected to the audio output of the airborne receiver. Receipt of the assigned tone code activates a cockpit call system in the form of light and/or chime signals.

2.4.2 There is a critical shortage of possible 4-letter codes, which has required re-use of the same code by more than one aircraft. Duplicate codes are usually assigned to aircraft operated in widely separated areas of the world, and usually do not have the same HF radio frequency assignment. However, there are occasions when two or more aircraft having the same code may be operating in the same general area, and may respond to the same transmission. Therefore, SELCAL should not be used as a substitute for proper voice identification procedures.

2.4.3 Any radio operator who detects two or more aircraft with duplicate SELCAL flying in the same area, should put the flights on separate frequencies and advise the downstream aeronautical stations which will assume the primary guard in the future.

3 NAT Families and Frequencies Allotment Plan

3.1 Frequency Allotment Plan for the Aeronautical Mobile Service (AMS)

3.1.1 The frequencies allocated for use in the NAT, are based on the Frequency Allotment Plan, for the MWARA - NAT and the RDARA's 1, 1B, 1Eand 10E, as defined on the "Appendix 27 Aer2 to the Radio Regulations – Frequency Allotment Plan for the Aeronautical Mobile (R) Service and Related Information".

3.1.2 Major World Air Route Area – North Atlantic (MWARA - NAT)

3.1.2.1 The MWARA - NAT is an area defined as the area from the North Pole through the points 60N135W, 49N120W, 49N074W, 39N078W, 18N066W, 05N055W, 16N026W, 32N008W, 44N002E, 60N020E, to the North Pole, and can be viewed on Figure 3 (Ref. ITU Appendix 27 Aer2).

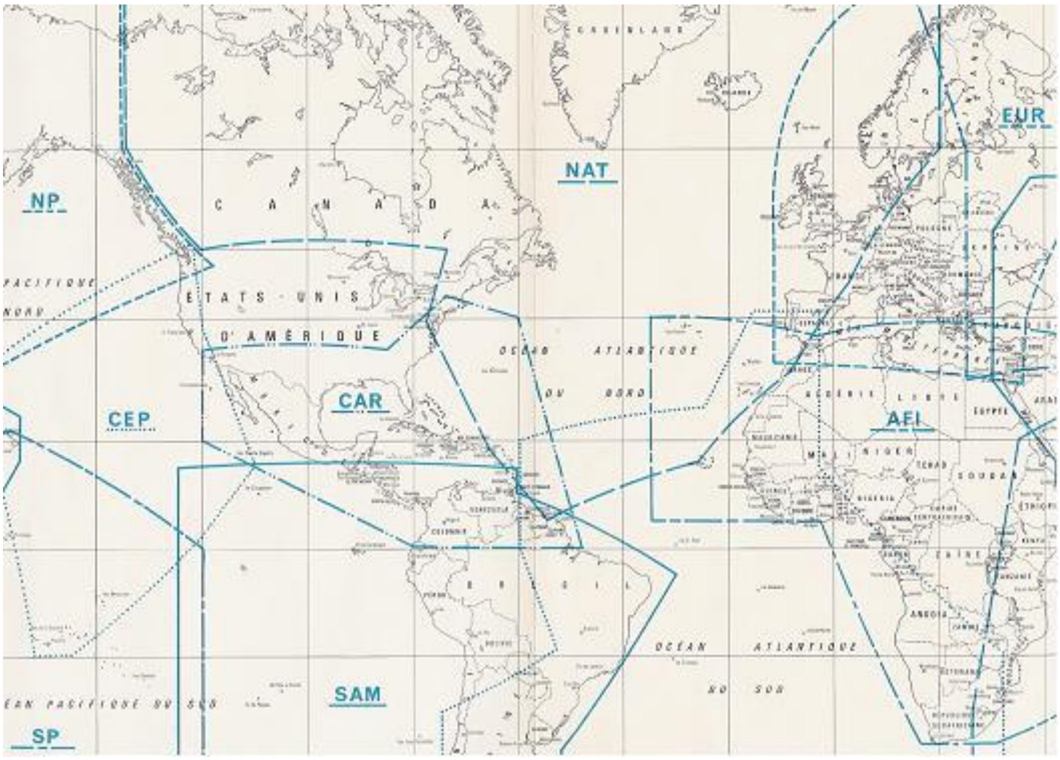

Figure 1 – MWARA – NAT (Ref. ITU Appendix 27 Aer2)

3.1.3 Regional and domestic Air Route Area – North Atlantic (RDARA - NAT)

3.1.3.1 The RDARA - NAT is a set of regions within the NAT area with allotted frequencies which were found to be suitable to be used, either individually or by common agreements between the NAT aeronautical stations, and can be viewed on Figure 2 (Ref. ITU Appendix 27 Aer2).

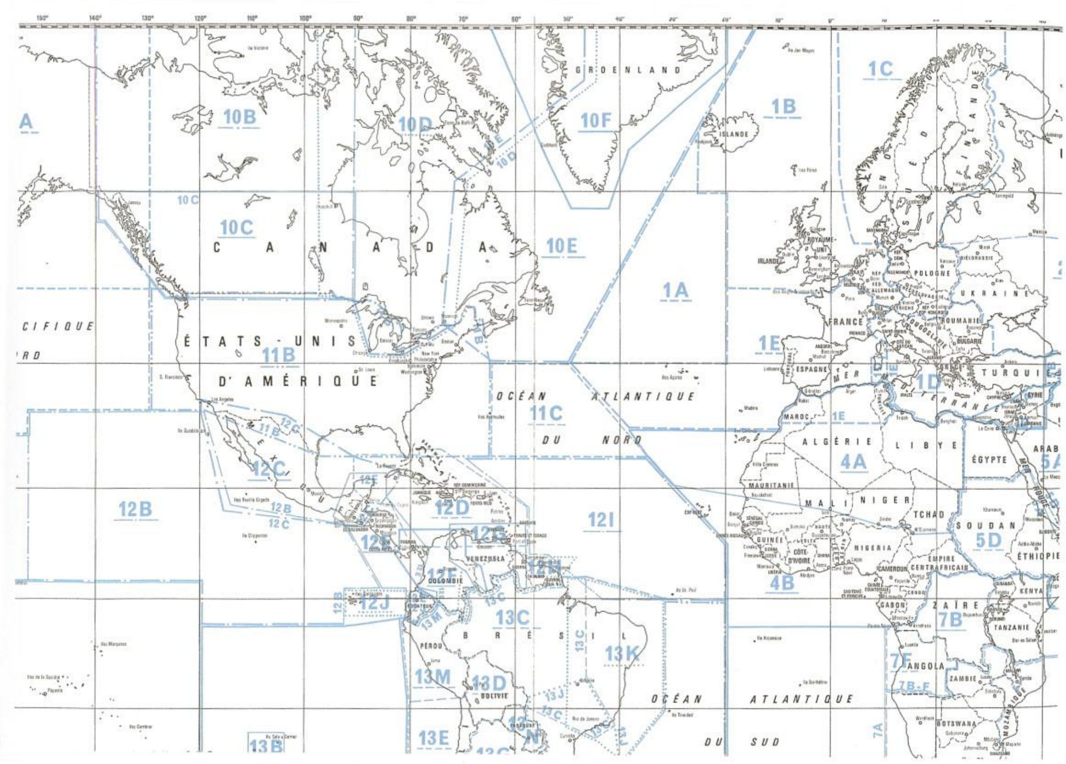

Figure 2 – RDARA – NAT (Ref. ITU Appendix 27 Aer2)

3.1.4 MWARA – NAT Frequencies

3.1.4.1 The frequencies allocated to the MWARA – NAT includes a number of frequencies in a range of bands designed to provide twenty-four hour area coverage and are contained in Table 2.

Area	Frequency Bands								
	3 kHz	**3.5 kHz**	**4.7 kHz**	**5.6 kHz**	**6.6 kHz**	**9 kHz**	**11.3 kHz**	**13.3 kHz**	**18 kHz**
NAT	2872 2899 2962 2971 3016	3476	4675	5598 5616 5649	6622 6628	8825 8831 8864 8879 8891 8906	11279 11309 11336	13291 13306 13354*	17946
* Frequency shared with RDARA 5 and 7									

Table 2 – Frequency bands of FAP for the MWARA – NAT
(Ref. ITU Appendix 27 Aer2)

3.1.5 RDARA – NAT Frequencies

3.1.5.1 The frequencies allocated to the RDARA – NAT includes a number of frequencies in a range of bands designed to provide twenty-four hour area coverage and are contained in Table 3.

Region	Frequency Bands								
	3 kHz	**3.5 kHz**	**4.7 kHz**	**5.6 kHz**	**6.6 kHz**	**9 kHz**	**11.3 kHz**	**13.3 kHz**	**18 kHz**
1/1E		3491		5583	6667		10021 10036		
1B	2890			5484 5568	6550 6595				
10E	2944	3446	4651	5460 5481 5559 5577	6547				

Table 3 – Frequency bands of FAP for the RDARA – NAT
(Ref. ITU Appendix 27 Aer2)

3.1.6 NAT Families

3.1.6.1 The NAT Families were defined utilising the frequencies allocated for the purpose of providing an AMS throughout the coverage area required.

3.1.6.2 Each Family comprises a range of frequencies drawn from each frequency band and selected in such a way as to provide, to the extent possible, continuous service in the area of responsibility at all times of day and under varying propagation conditions.

3.1.6.3 The organisation of the NAT HF Families and corresponding frequencies are contained in Table 4.

NAT Family	Frequencies
A	3016, 5598, 8906, 13306 and 17946 kHz
B	2899, 5616, 8864, 13291 and 17946 kHz
C	2872, 5649, 8879, 11336, 13306 and 17946 kHz
D	2971, 4675, 8891, 11279, 13291 and 17946 kHz
E	2962, 6628, 8825, 11309, 13354 and 17946 kHz
F	3476, 6622, 8831, 13291 and 17946 kHz
H	3491, 6667
Frequency 13306 kHz is shared between Families A and C Frequency 13291 kHz is shared between Families, B, D and F Frequency 17946 kHz is shared by all the Families Frequency 13354 kHz is shared with RDARA 5 and 7	

Table 4 – NAT families and frequencies

3.1.7 NAT Sub-networks

3.1.7.1 Based on the definition of a radiotelephony network as described in paragraph 2.3.1.1 above, the NAT Radiotelephony Network comprises six sub-networks, one per each of the NAT Families. These sub-networks are described in Table 5.

NAT Family	Sub-network	Stations
A	A	Gander Radio New York Radio Santa Maria Radio Shanwick Radio
B	B	Gander Radio Iceland Radio Shanwick Radio
C	C	Gander Radio Iceland Radio Shanwick Radio
D	D	Bodo Radio Gander Radio Iceland Radio Shanwick Radio
E	E	Canarias Radio (*) New York Radio Santa Maria Radio
F	F	Gander Radio Shanwick Radio
H	H	Santa Maria Radio
(*) Canarias Radio is not a NAT Station. Included as interface between NAT and AFI		

Table 5 – NAT Sub-networks

4 NAT Families and Frequencies Allocation Principles

4.1 General principles

4.1.1 In accordance with the principles of network operation, as described in paragraph 2.3.3, the frequencies assigned to an aircraft should belong to the same sub-network, which includes all the stations that may be affected by the aircraft flight route.

4.1.2 The frequency assignment should always take into account the propagation conditions, route of flight, distance from station, possible affected stations and even distribution over network frequencies, especially during peak periods.

4.1.3 Frequency assignment should, whenever possible, be done in such a way that radio stations could take advantage of all the available operational frequencies, and thereby avoid or shorten the delay time usually associated with the current system.

4.1.4 Frequencies should be guarded only during the periods when they are usable, as described in paragraph 2.2, instead of maintaining the current twenty-four hour watch practice.

4.1.5 During off-peak periods, when it is unnecessary to guard all frequencies and families, radio stations should use common families to achieve more efficient use of staff resources.

4.1.6 There should be regular tactical co-ordination of network resources between sub-network stations to meet changing operational requirements.

4.1.7 Stations experiencing peak demand should, following co-ordination with other network stations, be facilitated in sharing available network frequencies.

4.2 Family allocation principles

4.2.1 Family A or Sub-network A

4.2.1.1 This family should, whenever possible, be assigned to aircraft whose route or portion of route transits Gander, New York, Santa Maria and Shanwick areas, especially those aircraft flying routes with reporting point coordinates between 43N and 47N.

4.2.1.2 Stations should not assign Family A to aircraft flying routes outside the area defined in 4.2.1.1, due to overloading of other families or for other operational reasons, without prior co-ordination with and agreement of other sub-network stations in order to minimise adverse impact on existing sub-network traffic.

4.2.1.3 During off peak periods, and when watch is reduced on other families, Family A should remain the primary assignment for aircraft flying southerly routes.

4.2.2 Family B and C or Sub-networks B and C

4.2.2.1 This Family should, whenever possible, be assigned to aircraft flying on eastbound or westbound tracks whose route or portion of route lies within the Gander, Iceland and Shanwick areas, particularly aircraft flying routes with reporting point coordinates between 47N and 64N.

4.2.2.2 Stations should not assigned Family B and C to aircraft flying routes outside the area defined in 4.2.2.1, due to overloading of other families or for other operational reasons, without prior co-ordination with and agreement of the other sub-network stations in order to minimise adverse impact on existing sub-network traffic.

4.2.2.3 At all times Family B and C should remain the primary assignment for aircraft flying central routes.

4.2.2.4 In order to ensure even peak-time distribution of traffic between Family B and C, aircraft may be assigned to either family on the basis of; state of registry, Airline Company or other such criteria as agreed between Shanwick Radio and Gander Radio.

4.2.3 Family D or Sub-network D

4.2.3.1 This Family should, whenever possible, be assigned to aircraft whose route or portion of route lies within the Bodo, Gander, Iceland and Shanwick areas, particularly those aircraft flying routes with reporting point coordinates north of 62N.

4.2.3.2 Stations should not assign Family D to aircraft flying routes outside the area defined in 4.2.3.1, due to overloading of other families or for other operational reasons, without prior co-ordination with and agreement of other sub-network stations in order to minimise adverse impact on existing sub-network traffic.

4.2.3.3 During off peak periods, and when watch is reduced on other families, Family D should remain the primary assignment for aircraft flying northerly routes.

4.2.4 Family E or Sub-network E

4.2.4.1 This Family should, whenever possible, be assigned to aircraft whose route or portion of route transits New York and Santa Maria areas, especially those aircraft flying routes with reporting point coordinates south of 43N.

4.2.4.2 Stations should not assign Family E to aircraft flying routes outside the area defined in 4.2.4.1, due to overloading of other families or for other operational reasons, without prior co-ordination with and agreement of other sub-network stations in order to minimise adverse impact on existing sub-network traffic.

4.2.4.3 During off peak periods, and in the case of reduction of the number of available families, the guard of this family should be discontinued.

4.2.5 Family F or Sub-network F

4.2.5.1 This Family should, whenever possible, be assigned to aircraft flying routes entirely within the Gander and Shanwick areas.

4.2.5.2 Stations should not assign Family F to aircraft flying routes outside the area defined in 4.2.5.1, due to overloading of other families or for other operational reasons, without prior co-ordination with and agreement of other sub-network stations in order to minimise adverse impact on existing sub-network traffic.

4.2.5.3 Hours of operation of Family F shall be co-ordinated on a tactical basis between Shanwick Radio and Gander Radio.

4.2.6 Family H or Sub-network H

4.2.6.1 This Family should, whenever possible, be assigned to aircraft flying routes entirely within Santa Maria area.

4.3 Frequency allocation principles

4.3.1 Taking into account the characteristics of the HF medium, the general principles for frequency assignment used by radio station personnel is as outlined in 2.2.4 and contained in Table 7.

Bands between: (MHz)	Sharing conditions
3 and 6.6	Night propagation
9 and 11.3	Day propagation
Higher than 13	Day propagation

Table 7 – General principles for frequency assignment

4.3.2 As a general rule, when assigning primary and secondary frequencies, radio station personnel should assign lower frequencies as primary and higher frequencies as secondary for aircraft flying away from the Station. Conversely, for aircraft routing towards the station, the higher frequencies should be assigned as primary and lower frequencies as secondary.

4.3.3 In circumstances were sunspot or solar flare activity is expected to affect propagation conditions, the radio station personnel should always inform the flight crews and in addition to assigning the primary and secondary frequencies, they should advise the highest frequencies in use at the station as a precautionary measure.

4.3.4 In accordance with the principles governing transfer of communications as defined in paragraph 2.3.6, stations sharing a common boundary should, whenever possible, assign common frequencies for the transfer of communications.

4.3.5 Aircraft routing along common boundaries, or flying a route or portion of a route within 60 NM of a common boundary, should be assigned frequencies common to the stations sharing those boundaries.

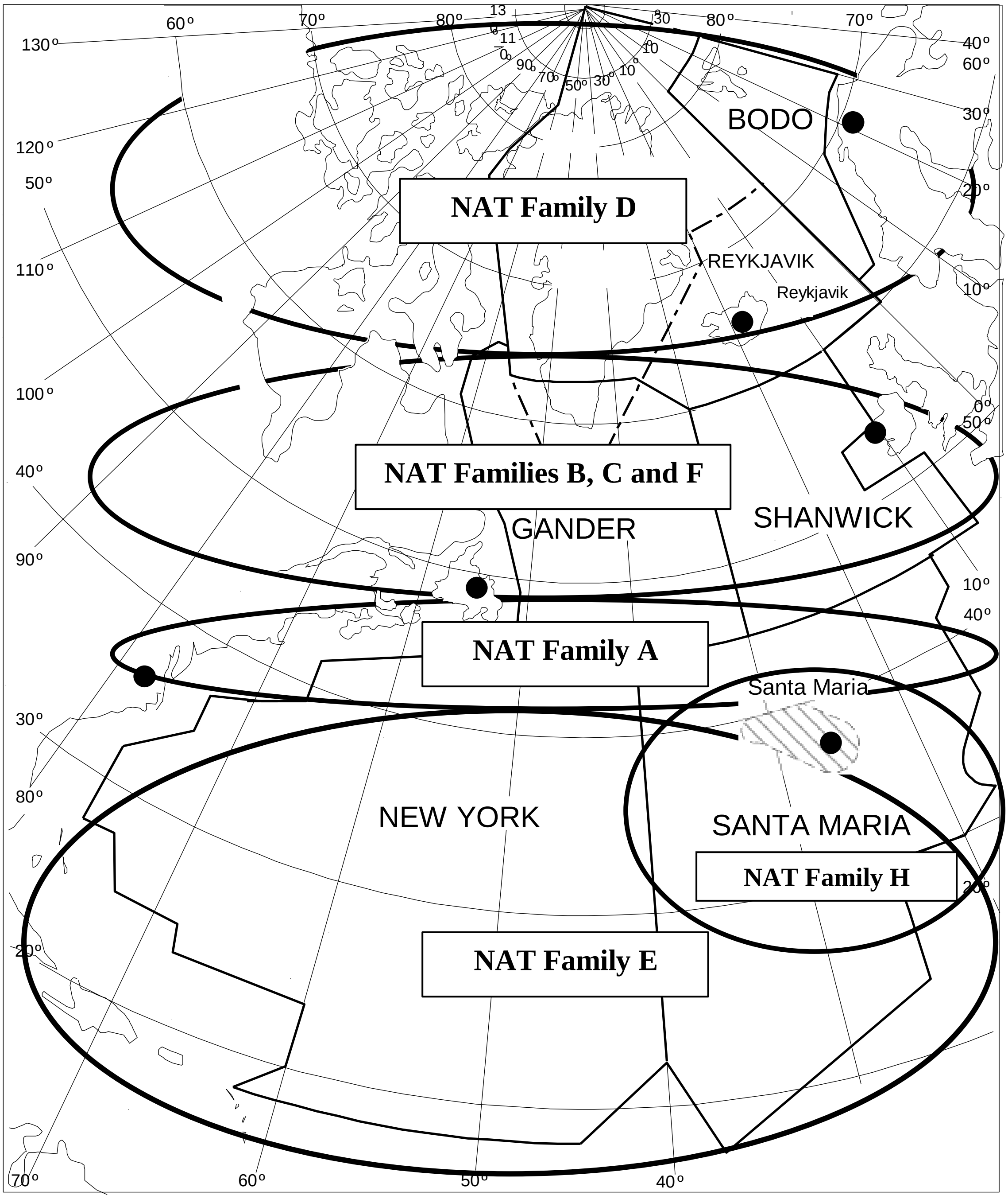

Figure 3 – NAT Family usage areas

5 General notes

5.1 Hours of service

5.1.1 Each station should define the frequencies hours of service, taking into account the general principles defined on paragraph 4.1.

5.1.2 The defined hours of service will be published and updated in State AIP's as required.

5.2 Points of contact

5.2.1 Contact details of the station managers and watch supervisors for each radio station are contained in the Annexes section as follows: Appendix B-1 (Bodo), Appendix B-2 (Gander), Appendix B-3 (Iceland), Appendix B-4 (New York), Appendix B-5 (Santa Maria) and Appendix B-6 (Shanwick).

5.3 Coordination principles

5.3.1 For routine day-to-day operations such as inter-station tactical co-ordination of frequency and family assignments, network co-operation and support, etc., contact should be made with the duty supervisor/watch manager using the contact means specified in Appendixes B-1, 2, 3, 4, 5 and 6.

5.3.2 When the coordination between stations involves subjects such as procedures, institutional issues, or issues affecting the Network as a whole, etc., the contact to the station or stations should be made to the station manager through the points of contact defined in Appendixes B-1, 2, 3, 4, 5 and 6.

5.4 Poor HF propagation conditions

5.4.1 Whenever a radio station duty supervisor/watch manager have access to information or warnings regarding poor HF propagation conditions or high levels of solar activities, that will affect the normal HF operations, he should notify the on duty Supervisor of the ATC unit in which the station provide the service.

Appendices

Appendix A - HF medium characteristics

1.1 The term frequency is used to state the number of cycles occurring in one second, taking into account that cycle means a complete oscillation of the alternating current. The distance travelled by a radio signal during the transmission of one cycle is called wavelength. Wavelength is inversely proportional to frequency, so that if frequency is increased the wavelength will decrease.

1.2 If an alternating current of suitably high frequency is fed to a transmitting aerial, the energy is not confined to the metal of the aerial but radiates out into space in the form of electro-magnetic waves (radio waves). This radiation of energy through space comprises alternating and magnetic fields at right angles to each other.

1.3 As a general rule, radio signals travel in straight lines, that is, they follow great circle paths over the surface of the earth. Under certain circumstances, however, the path of a signal may change direction, this change of direction is called refraction. Refraction examples are coastal, atmospheric and ionospheric, and the amount of refraction varies considerably, depending on certain conditions. Those conditions could be a change in direction when a signal crosses a coastline (coastal refraction), a change in direction due to a variation in temperature, pressure and humidity, particularly at low altitude (atmospheric refraction), or a change in direction when the radio wave passes through an ionised layer (ionospheric refraction).

1.4 The path of a radio wave from a transmitter to a receiver many miles away is not necessarily direct, and in many cases, the signal may be reaching the receiver by more than one path at the same time. Because of the different path lengths there will be phase differences between the signals, and this fact will affect the resultant signal strength, phenomenon known as fading.

1.5 The main propagation paths between a transmitter and a receiver are, direct wave, ground-reflected wave, space wave, surface wave, ground wave and sky wave.

1.5.1 When a signal travels in a straight line between the transmitter and receiver it is called direct wave and its use is limited because of the earth curvature. If the radio wave arrive to the receiver after reflection at the earth's surface it is called ground-reflected wave. These two waves are jointly known as the space wave and under normal conditions it's the only propagation path for frequencies above 30 Mhz.

1.5.2 When a signal follows the curvature of the earth, this path is called surface wave, and is normally caused by a phenomenon called diffraction. Diffraction occurs for all types of wave motion, and allows the wave to pass round earth obstacles and depends on the wavelength in relation to the radius of the earth. The range of surface wave depends on the wavelengths, with longer wavelengths (lower frequencies) the diffraction effect becomes more pronounced with consequently improved surface wave range, the type of surface, because different surfaces absorb different amounts of radio energy resulting in different rates of attenuation, being higher over land than over sea, and the frequency used, with lower frequencies suffering less attenuation along the surface and therefore providing better surface wave range.

1.5.3 The combination of direct, ground-reflected and surface waves can be described has the ground wave. However, not all of those types of waves have to be necessarily present together.

1.5.4 When signals are reflected or refracted down from ionised layers above the earth the path is called sky waves, also sometimes called ionosphere waves.

1.6 Ultra-violet light from the sun can cause electrons to become separated from their parent atoms of the gases in the atmosphere. The atoms are left with resultant positive charges and are then known as ions. The intensity of the ionisation depends on the strength of the ultra-violet radiation and the density of the air. The part of the atmosphere in which this process occurs is called the ionosphere, extending from about 50 Km to as high as 500 Km above the earth's surface. When a radio wave enters such a layer, refraction occurs causing the wave to be bent away from its straight path. The amount of refraction depends on the frequency, the angle at which the wave enters the layer, and the intensity of ionisation.

1.7 The ionosphere is still under investigation but is known that several definite ionised layers exist within it. During daytime hours there are four main ionisation layers designated D, E, F_1 and F_2 in ascending order of height. At night, when the sun's radiation is absent, ionisation still persists but it is less intense, and fewer layers are found (D and F layers). Factors that affect the ionosphere layers is strength of the sun's radiation, since it varies with latitude causing that the structure of the ionosphere varies widely over the earth's surface, and the state of the sun, since sunspots affect the amount of ultra-violet radiation.

1.7.1 The D layer is only significant during daylight hours, dispersing soon after sunset. It is the lowest layer and its intensity of ionisation is not great, in which VLF waves are reflected from the base of the layer, LF and MF waves enter the layer and are severely attenuated without being appreciably refracted, and higher frequency signals pass through the layer with less attenuation.

1.7.2 The E layer is strong ionised by day and remains weakly ionised by night, producing strong sky waves in the LF and MF bands by night, but during the daytime due to the attenuation caused by the D layer the sky waves produced are too weak to used in these bands. Usable HF sky waves may be produced by this layer during nigh and day, and VHF signals usually pass through this layer, and if refraction exist it is insufficient to generate sky waves, unless under "freak" conditions, duct (or super-refraction) and scatter (or sporadic-E reflections) propagation. Ionospheric refraction is negligible with UHF, SHF and EHF signals and sky waves do not occur in these bands.

1.7.3 The F layer is the highest and more intensely ionised layer. At night there is only one F layer, but during the daytime is divided into two layers, the F_1 and F_2. Strong sky waves are produced in the LF, MF and HF bands at night but only the HF band has usable F layer sky waves by day. Signals in the VHF and higher bands escape through the F layer into space with, normally, no sky waves produced.

1.8 Sky wave propagation in the HF band (3 to 30 MHz) is complicated, because there are many variable factors, which decide whether or not there is a propagation path open between transmitter and receiver for long-range radiotelephony.

1.8.1 For a given frequency and state of the ionosphere, the amount of refractive “bending” of the wave will depend on the angle at which the wave penetrates the layer. Waves travelling nearly vertically may escape through a layer, but may be returned to earth if a higher more intensely ionised layer exists.

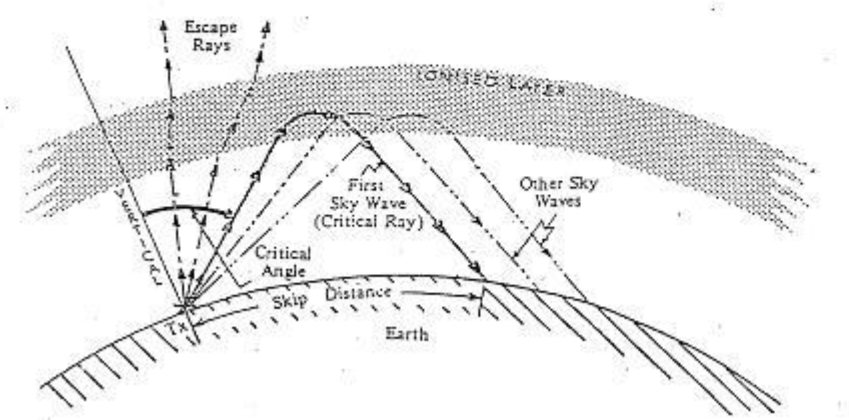

Figure 4 – Critical angle (HF band)

1.8.2 As can be seen on Figure 1, waves ascending with an increased angle with the vertical, the amount of bending is greater and when the angle with the vertical is increased to the critical angle, the path is bent enough for the wave to return to earth as the first sky wave. Waves making an angle with the vertical greater than the critical angle will also produce sky waves, coming down to earth at greater ranges than that of the first sky wave. The range from the transmitter and the first sky wave for a given frequency and set of conditions is called the skip distance. If the surface wave from a HF transmitter become completely attenuated at a shorter range than that at which the first sky wave returns to earth, leaves an area in which neither ground wave nor sky waves are received and which is none as dead space (Figure 2).

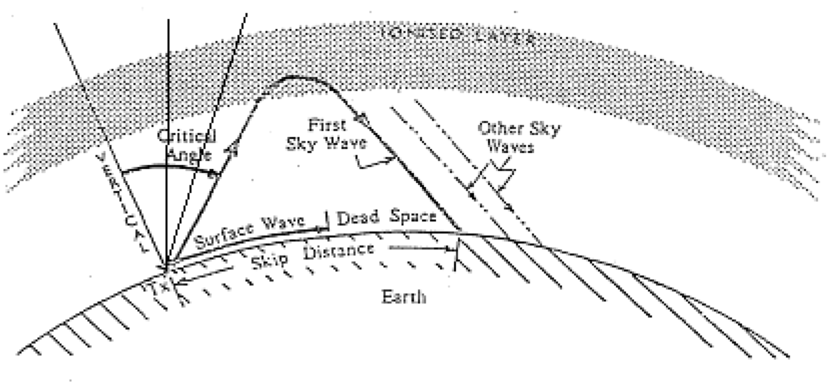

Figure 5 – Dead space (HF band)

1.8.3 Critical angle depends largely on the frequency, the higher the frequency the greater the critical angle, therefore, if skip distance is to be reduced, a lower frequency has to be used. This is most significant when choosing the optimum frequencies for HF communications and ensuring that the skip distance is less than the range of the distant receiver.

1.8.4 For good long-range HF R/T reception a frequency must be chosen which will not suffer too much attenuation. If a relatively high frequency is used, for example 29 MHz, most of the energy will pass through the E layer and be reflected from the more intensely ionised F layer. The higher the frequency, the greater degree of ionisation is required to give reflection. As frequency is reduced and attenuation of the E layer reflections increases, a limit is reached called the "Lowest Usable Frequency (LUF)", and bellow this frequency the attenuation is too great for the signal to be usable.

1.8.5 Thus for least attenuation, and so the highest received signal strength for a given transmitter power, a frequency is chosen which is as high as possible without exceeding the MUF (Maximum Usable Frequency) for the path between the transmitter and distant receiver. The MUF is that frequency, for the prevailing conditions, which produces a skip zone extending just short of the distant receiver. Any higher frequency would give a higher critical angle and a greater skip distance exceeding beyond the receiver, which would then loose that sky wave contact with the transmitter.

1.8.6 MUF at night is much less than by day, because the intensity of ionisation in the layer is less so than lower frequencies have to be used to produce the same amount of refractive bending and give the same critical angle and skip distance as by day. However, the signal attenuation in the ionosphere in the ionosphere is also much less at night so the lower frequency needed is still usable. Hence the night frequency for a given path is about half of the day frequency, and shorter distances can be worked at night than by day while still using a single reflection from the F layer.

1.8.7 The MUF not only varies with path length and between day and night, but also with season, meteor trails, sunspot state, and sudden ionospheric disturbances produced by eruptions on the sun. Because of the variations of MUF, HF transmitting stations have to use frequencies varying widely between about 2 and 20 MHz.

1.9 The theoretical range for HF frequencies varies, depending on the propagation path used, ground or sky waves. Ground waves usually can reach up to 100 nm and sky waves longer distances, however, sky waves will not be received within the skip distance (probably several hundred miles from the transmitter). The theoretical maximum range obtained by means of a single reflection from the E layer is about 1 300 nm, and from the F layer about 2 500 nm. This theoretical maximum range is achieved with the transmitted signal leaving the earth's surface tangentially. Ranges of 8 000 nm or more may be achieved by means of multiple reflections, mainly from the F layer, being the signal alternately refracted down from the layer and reflected up again from the earth's surface until it becomes too weak to use.

Appendix B-1 - BODO Radio Station Information

Station Name:	Bodo Radio

Country: Norway	**State:** Nordland
City: Bodo	**Geographic Location:** 67°16´09N014°21´55E
Transmitter site(s) location(s): Bodo 67°16´N 014°21´E Andoya 69°10´N 015°50´E Berlevaag 70°50´N 029°E	**Receiver site(s) location(s):** Bodo 67°16´N 014°21´E Andoya 69°10´N 015°50´E North Cape 71N 025.30E

Frequencies

Family	Frequency bands								
	3 MHz	3.5 MHz	4.7 MHz	5.6 MHz	6.6 MHz	9 MHz	11.3 MHz	13.3 MHz	18 MHz
D	2971		4675			8891	11279		
1C	2983		4666		6544	8840			
SAR		3023		5680					

Contacts

AFTN Address: ENBOYSYX	**Aircraft in Flight Address:** ENBOZZZX
SATCOM short code number: 425702	
Station Manager	**Supervisor**
Name: **Post Address:** AVINOR N-8041 BODO **Phone:** + 47 67033751 **Fax:** + 47 75520733 **Email:** **AFTN/SITA Address:** ENBOYFYX	**Post Address:** AVINOR N-8041 BODO **Phone:** + 47 75521283 **Fax:** + 47 75542943 **Email:** **AFTN/SITA Address:** ENBOYFYX

Remarks:
Bodo HF radio is collocated and is a department within Bodo ATCC.

Appendix B-2 - GANDER Radio Station Information

Station Name:	Gander Radio
Country: Canada	**State:** Newfoundland
City: Gander	**Geographic Location:** 48°57´58.5N054°35´50.7W
Transmitter site(s) location(s): 48°58´95N054°40´28W	**Receiver site(s) location(s):** 48°57´54N054°33´42W

Frequencies

Family	Frequency bands								
	3 MHz	3.5 MHz	4.7 MHz	5.6 MHz	6.6 MHz	9 MHz	11.3 MHz	13.3 MHz	18 MHz
A	3016			5598		8906		13306	
B	2899			5616		8864		13291	
C	2872			5649		8879	11336	13306	
D	2971		4675			8891	11279		
F		3476			6622	8831		13291	
VOLMET		3485			6604		10051	13270	

Contacts

AFTN Address: CYQXYSYX	**Aircraft in Flight Address:** CYQXZZZX
SATCOM short code number: 431613	
Station Manager	**On Duty Supervisor**
Name: **Post Address:** NAV CANADA P.O Box 328 Gander, NL Canada, A1V 2R3 **Phone:** + 1 709 651 5213 **Fax:** + 1 709 651 5344 **Email:** **AFTN/SITA Address:** CYQXYSYX	**Post Address:** NAV CANADA P.O Box 328 Gander, NL Canada A1V 2R3 **Phone:** + 1 709 651 5222 **Fax:** **Email: burtb@navcanada.ca** **AFTN/SITA Address:** CYQXYSYX

Remarks:
Gander Radio is collocated within Gander OACC.

Appendix B-3 - ICELAND Radio Station Information

Station Name: Iceland Radio

Country: Iceland	**State:**
City: Reykjavik	**Geographic Location:** 64°08´53N 021°47´39W
Transmitter site(s) location(s): 64°05´06N 021°50´43W	**Receiver site(s) location(s):** 64°34´32N 022°08´46W

Frequencies

Family	Frequency bands								
	3 MHz	3.5 MHz	4.7 MHz	5.6 MHz	6.6 MHz	9 MHz	11.3 MHz	13.3 MHz	18 MHz
B	2899			5616		8864		13291	
C	2872			5649		8879		13306	17946
D	2971		4675			8891	11279		

Contacts

AFTN Address: BICCYSYX	**Aircraft in Flight Address:** BICCZZZX
SATCOM short code number: 425105	
Station Manager	**On Duty Supervisor**
Name: **Post Address:** ISAVIA Iceland Radio Smárarimi 6 IS-112 Reykjavík Iceland **Phone:** + 354 424 4500 **Fax:** + 354 424 4552 **Email:** **AFTN/SITA Address:** BICCYFYX	**Post Address:** ISAVIA Iceland Radio Smárarimi 6 IS-112 Reykjavík Iceland **Phone:** + 354 424 4100 **Fax:** + 354 424 4101 **Email:** supervisor.iceland.radio@isavia.is **AFTN/SITA Address:** BICCYFYX

Remarks:

Appendix B-4 - NEW YORK Radio Station Information

Station Name:	**New York Radio**
Country: United States of America	**State:** New York
City: Bohemia, Long Island	**Geographic Location:** 40.46.79N073.05.72W
Transmitter site(s) location(s): Riverhead (40.52.52N072.38.52W)	**Receiver site(s) location(s):** Southampton (40.55.15N072.23.41W)

Frequencies

Family	Frequency bands								
	3 MHz	3.5 MHz	5.6 MHz	6.6 MHz	9 MHz	11.3 MHz	13.3 MHz	18 MHz	22 MHz
A	3016		5598		8906		13306	17946	
E	2962			6628	8825	11309	13354	17952	
CAR A	2887		5550	6577	8846	11396	13297		
CAR B		3455	5520	6586	8918	11330		17907	
LDOCF		3494		6640	8933	11342	13348	17925	21964

Contacts

AFTN Address: KNYCXAAG	**Aircraft in Flight Address:** KNYCZZZX
SATCOM short code number: 436623	
Station Manager	**On Duty Supervisor**
Name: **Post Address:** New York Communications Center 613 Johnson Ave Bohemia, Long Island, NY 11716-2696 **Phone:** + 1 631 244 2480 **Fax:** + 1 631 563 2412 **Email: AFTN/SITA Address:** KNYCXAAG	**Post Address:** New York Communications Center 613 Johnson Ave Bohemia, Long Island, NY 11716-2696 **Phone:** + 1 631 244 2480 **Fax:** + 1 631 563 2412 **Email:** nycmgr@arinc.com **AFTN/SITA Address:** KNYCXAAG

Remarks: The communications control point is located at Bohemia, New York. The primary and backup transmitters are located at Riverhead, New York, on the east end of Long Island. The receivers are located at South Hampton**,** New York, also located on the east end of Long Island. New York radio is located less than 1 mile from New York ACC.

Appendix B-5 - SANTA MARIA Radio Station Information

Station Name:	Santa Maria Radio
Country: Portugal	**State:** Santa Maria - Azores
City: Vila do Porto	**Geographic Location:** 36°58´21N025°09´54W
Transmitter site(s) location(s): Cabrestantes (36°59´44N025°10´14W)	**Receiver site(s) location(s):** Faneca (36°59´44N025°07´48W)

Frequencies

Family	Frequency bands								
	3 MHz	3.5 MHz	4.7 MHz	5.6 MHz	6.6 MHz	9 MHz	11.3 MHz	13.3 MHz	18 MHz
A	3016			5598		8906		13306	17946
E	2962				6628	8825	11309	13354	
H		3491			6667				

Contacts

AFTN Address: LPAZYSYX	**Aircraft in Flight Address:** LPAZZZZX
SATCOM short code number: 426305	
Station Manager	**On Duty Supervisor**
Post Address: **Name:** NAV PORTUGAL APARTADO 47 AEROPORTO SANTA MARIA 9580-909 VILA DO PORTO **Phone:** + 351 296 820 509 **Fax:** **Email:** **AFTN/SITA Address:** LPAZYFYA	**Post Address:** NAV PORTUGAL APARTADO 47 AEROPORTO SANTA MARIA 9580-909 VILA DO PORTO **Phone:** + 351 296 820 401 **Fax:** + 351 296 886 045 **Email:** smaradio@nav.pt **AFTN/SITA Address:** LPAZYSYX

Remarks:
Santa Maria radio is collocated and is a department within Santa Maria OACC. Backup receiver site is also located in the vicinity of Santa Maria OACC.

Appendix B-6 - SHANWICK Radio Station Information

Station Name: Shanwick Radio

Country: Republic of Ireland

State: County Clare

City: Shannon

Geographic Location: 52°47´N 008°55´W

Transmitter site(s) location(s):

Urlanmore (52°45´N 008°56´W)

Receiver site(s) location(s):

Ballygirreen (52°47´N 008°55´W)

Frequencies

Family	Frequency bands								
	3 MHz	3.5 MHz	4.7 MHz	5.6 MHz	6.6 MHz	9 MHz	11.3 MHz	13.3 MHz	18 MHz
A	3016			5598		8906		13306	
B	2899			5616		8864		13291	
C	2872			5649		8879	11336	13306	17946
D	2971		4675			8891		13291	
F	3476				6622	8831		13291	
SAR	2182	3023		5680					
VOLMET		3413		5505		8957		13264	

Contacts

AFTN Address:
EIAAYSYX

Aircraft in Flight Address:
EIAAZZZX

SATCOM short code number: 425002

Station Manager

Name:
Post Address:
Irish Aviation Authority
Shannon Aeradio, Ballygirreen
Newmarket on Fergus, Co. Clare
IRELAND.

Phone: + 353 (0)61 703806
Fax: + 353 (0)61 472528
Email:
AFTN/SITA Address: EIAAYTYX

On Duty Supervisor

Post Address:
Irish Aviation Authority,
Shannon Aeradio, Ballygirreen
Newmarket on Fergus, Co. Clare
IRELAND.

Phone: + 353 (0)61 471199
Fax: + 353 (0)61 472528
Email: NAC_Operations@iaa.ie
AFTN/SITA Address: EIAAYFYX

Remarks:
By international agreement Shanwick Radio provides communications services for the Shanwick OCA. The associated OACC is located at Prestwick, Scotland, U.K.

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