APPENDIX C
CHARACTERIZATION OF FEDERAL GOVERNMENT SPECTRUM USAGE AND OPERATIONS, REPRESENTATIVE SYSTEMS AND TYPICAL PARAMETERS

C.1 INTRODUCTION

As summarized in Section 4, the 1.7-80 MHz frequency range hosts a number of radio services and supports well over one-hundred-thousand Federal Government RF systems. Frequencies in this range are intensively used on the bases of time-and geographic-sharing by several radio systems. This appendix provides a more detailed discussion on federal spectrum usage and operations under each radio service. In addition, this appendix provides a general characterization of Federal Government RF systems that includes presentation of representative federal systems and typical system parameters.

The main data sources used in the description of the Federal Government RF systems, spectrum usage and, in some cases, the radio services are the Government Master File (GMF), federal agencies' inputs, and an earlier NTIA study.[1] Section C.2 discusses the nature of relevant radio services and their allocations in the 1.7-80 MHz band. Special systems are described in Section C.3, and special operating considerations are summarized in Section C.4.

C.2 SERVICES AND EXAMPLE SYSTEMS

C.2.1 Fixed Service (1.7-29.7 MHz)

The use of radio frequencies below 30 MHz for domestic fixed service by the Federal Government is delineated in Section 8.2.11 of the NTIA Manual. An excerpt from the NTIA Manual regarding the use of fixed service below 30 MHz by the Federal Government is presented in Section C.4. The frequency bands allocated to the fixed service in the 1.7-30 MHz band are shown in Table C-1.

In general, the Federal Government fixed service applications include voice and data transmissions over intermediate and long-range distances (25 km to over 2,000 km). Many fixed stations are located in the vicinity of power lines which could eventually be used by BPL systems (*e.g.*, *see* Figure C-1). The DOD, for example, uses HF radios on military installations, both for ground and skywave modes of operations, on or near major urban environments. The DOJ and DHS employ fixed systems throughout the United States, including urban and suburban areas, in support of law enforcement activities.

[1] Grant, W.B., et al., *Spectrum Resource Assessment of Government Use of the HF (3-30 MHz) Band*, NTIA Technical Memorandum 89-141, June 1989. Relevant information from this study is included in this Appendix.

Table C-1: Frequency Bands Allocated to the Fixed Service in the 1.7-30 MHz Band

Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)
1705-1800	95	5730-5900	170	13410-13570	160	19029-19680	651
2000-2065	65	5900-5950	50	13570-13600	30	19800-19990	190
2107-2170	63	6765-7000	235	13800-13870	70	20010-21000	990
2194-2495	301	7300-7350	50	13870-14000	130	21850-21924	74
2505-2850	345	7350-8100	750	14350-14990	640	22855-23000	145
3155-3230	75	9040-9500	460	15600-15800	200	23000-23200	200
3230-3400	170	9900-9995	95	15800-16360	560	23350-24890	1540
4438-4650	212	10150-11175	1025	17410-17480	70	25330-25550	220
4750-4850	100	11400-11600	200	17480-17550	70	26480-26950	470
4850-4995	145	11600-11650	50	18030-18068	38	27540-28000	460
5005-5060	55	12050-12100	50	18168-18780	612	---	
5060-5450	390	12100-12230	130	18900-19020	120	---	
Total Bandwidth = 12,030 kHz							

Both the DOJ and DHS HF systems that support law enforcement activities in many cases use encryption in both ground and skywave modes of operations.[2] Some of these systems support crisis response teams, including the Federal Government's SHARES network program that is described below. The vast majority of fixed systems in this portion of the spectrum operate in the simplex mode. Table C-2 shows the representative technical characteristics of fixed systems in the 1.7-30 MHz band.

Many foreign governments operate HF fixed stations at their embassy and mission facilities that typically are located in major cities throughout the United States. While many of these operations may backup or supplement other means of communications, these HF systems become critical sole means of communications in certain times of crises.

SHARES. The mission of the shared resources (SHARES) network is to provide backup or supplemental communications for exchange of critical information among federal entities during certain crisis situations. Normally, frequency assignments that support the SHARES network are nationwide or assigned under the United States and Possessions (US&P) category. The HF portion of the spectrum is most suitable for the operation of the SHARES network because it offers a medium in which a reliable, geographically expansive network can be established, without satellites, using easy to implement equipment operating over a range of frequencies (Federal Government satellite facilities are used for other purposes in certain times of crises). A summary of the emergency use of Federal Government HF frequencies for the SHARES program is provided in Section C.4.2.

[2] Interference to encrypted radio channels can be particularly harmful insofar as considerable time is needed to reestablish communications in an encrypted mode of operation.

Figure C-1: An Example of a Federal Government Radio Antenna near Power Lines.

Table C-2: Typical Technical Characteristics of Fixed Systems (1.7-30 MHz Band)

System	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (ft)	Ant. Type/ Polarization	Modulations
Typical Fx	2.8	0-2	30-140	Dipole/ V& H	Analog, single channel, suppressed carrier, telephony

C.2.2 Fixed Service (29.7-80 MHz)

There are twelve fixed service bands, as shown in Table C-3, allocated to the Federal Government to support federal fixed service requirements in the 29.7-80 MHz band. The fixed systems operated by the federal non-military agencies in this frequency range normally compliment the mobile or land mobile service. They provide relay connectivity (repeater stations) to hand held and vehicular mobile phones used by the federal agencies for: management, protection, and preservation of the natural resources; search and rescue operations; and law enforcement activities. These fixed systems are also used for: exchange of

meteorological data; detection of unauthorized vehicular traffic, such as on or near shuttle landing areas; and for fire alarm supervisory systems at various facilities.

Table C-3: Frequency Bands Allocated to the Federal Government for Fixed Service in the 29.7-80 MHz Band

Frequency (MHz)	BW (MHz)	Frequency (MHz)	BW (MHz)	Frequency (MHz)	BW (MHz)	Frequency (MHz)	BW (MHz)
29.89-29.91	0.02	34-35	1.0	38.25-39	0.75	49.6-50	0.4
30-30.56	0.56	36-37	1.0	40-42	2.0	74.6-74.8	0.2
32-33	1.0	38-38.25	0.25	46.6-47	0.4	75.2-75.4	0.2
Total Bandwidth = 7.78 MHz							

The DOD also employs their fixed systems as repeaters for: land and air networks; tactical and training purposes; and support of military bases operations. These include tactical communications exercises for base defense missions; command and control; law enforcement; remote control of multiple cameras on test ranges; airfield lighting; and acoustic range traffic lights. In addition, these fixed systems support research, development, test and evaluation of DOD systems.

Federal Agencies' Repeaters (Relay Stations). The vast majority of fixed systems used by the federal agencies in the 29.7-80 MHz band compliments or provides relay connectivity for land mobile systems. The majority of the federal fixed assignments that support relay operations are under the US&P category. Some of these assignments are required for short term intermittent use at unspecified locations and used for notification of planned regular operations. Typical technical characteristics of these systems are provided in Table C-4.

Table C-4: Typical Technical Characteristics of Fixed System (29.7-80 MHz Band)

Fixed Systems	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (Ft)	Ant. Type/ Polarization	Modulations
Non-DoD	16	0-3	16-250	Whip, yagi, collinear & dipole/V&H	Analog and digital, frequency modulated, single channel, data and telephony.
DoD	16-40	0-2	10-400	Whip, dipole, collinear, & coaxial/V&H	Analog and digital, frequency modulated, single channel, data and telephony.

C.2.3 Mobile Service

A total of 42 bands are allocated to the Federal Government for mobile service in the 1.7-80 MHz band. Of these, 13 bands provide secondary allocation to the mobile service and 17 bands exclude the use of aeronautical mobile service as indicated in Table C-5. Typical systems parameters are described below.

Table C-5: Frequency Bands Allocated to the Mobile Service in the 1.7-80 MHz Band

Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)
1705-1800	95	5060-5450 *	390 **	14350-14990 *	640 **	34000-35000	1000
2000-2065	65	5730-5900	170 **	18168-18780 *	612	36000-37000	1000
2107-2170	63	5900-5950	50 **	20010-21000 *	990	38000-38250	250
2173.5-2190.5	17	6765-7000 *	235	23000-23200 *	200 **	38250-39000	750
2194-2495	301	7300-7350 *	50	23350-24890	1540 **	40000-42000	2000
2505-2850	345	7350-8100 *	750	25330-25550	220 **	46600-47000	400
3155-3230	75 **	10150-11175 *	1025 **	26480-26950	470 **	49600-50000	400
3230-3400	170 **	13410-13570 *	160 **	27540-28000	460	74600-74800	200
4438-4650	212 **	13570-13600 *	30 **	29890-29910	20	75200-75400	200
4750-4850	100 **	13800-13870 *	70 **	30000-30560	560	—	--
4850-4995	145	13870-14000 *	130 **	32000-33000	1000	---	--

* Mobile service is secondary in this band

** The use of aeronautical mobile is prohibited in this band.

Total Bandwidth = 17,560 kHz

For the most part, federal mobile service requirements in this portion of the spectrum include voice and data, which also encompass intermediate and long-range operations. The military, for example, uses HF mobile radios in ground wave modes (*e.g.*, hundreds of kilometers) and skywave modes (thousands of kilometers) the same way they use the their fixed systems. The vast majority of military mobile radios operations are for tactical training, including tactical communications to ground units, ships and aircraft, base operations, and as back-ups or supplements to satellite communications. Normal training occurs in military bases which may be in the vicinity of power lines. Example systems used by the DOD for training and tactical communications are described below (AN/VRC-100 and SINCGARS).

The Coast Guard uses the HF and MF portions of the spectrum extensively for sea and air operations that include monitoring distress calls, both international and domestic digital selective calling including for distress calls, and search and rescue operations along the coastal areas of the United States. A total of about 160 base stations sites, including command and control sites, in the United States are used for these purposes. In addition, there are approximately 100 HF/MF-equipped buoy tenders and other vessels that operate on inland waters, up rivers and inshore along the coasts. These vessels/boats are frequently near power lines.

The DOJ and the DHS substantially use mobile radios in the HF band. The vast majority of these radios are dedicated for law enforcement or used in support of emergency and crises responses; as such, these systems are authorized to operate anywhere in the United States. Mobile radios employed by both agencies use encryption technology and some use ALE. An example system is the U.S. Customs Over the Horizon Enforcement Network (COTHEN). A brief description of the COTHEN system is presented below.

Single-Channel Ground and Airborne Radio System (SINCGARS). The SINCGARS is a family of VHF-FM combat net radios which provide the primary means of command and control for infantry, armor, and artillery units in the Army. It is capable of short range or long range operation for voice or digital data communications. The system's configurations include man-pack, vehicular, and airborne units. These units can be used for single channel operation or in a jam-resistant, frequency hopping mode which can be changed as needed. When configured for use of low VHF frequencies, the system operates on any of the 2320 channels between 30-88 MHz in 25 kHz increments and is designed to survive a nuclear environment. The SINCGARS Program is continuously evolving to provide the latest in improvements and capabilities to the soldier and to meet the Army's objectives for widespread digitization.

The SINCGARS system, which was once a conventional voice-only radio used for communications up and down the chain of command, has evolved into a software-defined, open architecture system with extensive networking capabilities. It offers clear or secure voice and data communications capabilities that provide situational awareness and transmit command and control information across entire theaters of battle or control.[3] A handheld unit, an airborne unit (AN/ARC-210D), a man-pack (AN/PRC-119F(V)), and various vehicular components (AN/VRC-90F(V), AN/VRC-87F(V), AN/VRC-87F(V), AN/VRC-89F(V), AN/VRC-91F(V) and VRC-92F(V)) are under production.[4] The SINCGARS program office has fielded more than 136,000 radios to training base and Army units worldwide.[5]

COTHEN. This network became widely operational in 1985. Previously, only Custom's marine vessels were equipped with the COTHEN radios; however, because of the success of this initial deployment, the network now provides communications support for more than 235 aircraft, numerous maritime interdiction vessels, several command offices, and numerous allied agencies including the Coast Guard, Drug Enforcement Administration, Border Patrol, Army, Navy, and Joint Interagency Task Forces.

The network integrates radio, computer, and a tactical voice privacy unit in a extremely reliable, state-of-the-art communications network that meets the demanding requirements of Customs' tactical interdiction aircraft and boats in their fight against smuggling activities. High powered fixed station transmitters located across the United States are connected to Customs' air, marine, and Special Agent In Charge (SAIC) locations via dedicated telephone lines. Tactical interdiction platforms equipped with COTHEN radio can place a call to any other platform or

[3] http:/www.acd.itt.com/sincgars.htm.

[4] *Id.*

[5] http:/www.globalsecurity.org/military/systems/ground/sincgars.htm.

office in the network thousands of miles away typically using an ALE protocol. Units on the COTHEN network use encryption for most of the voice communications. The COTHEN network uses frequencies throughout the HF band in order to obtain both the needed capacity and frequency diversity (*see* Section C.4.1).

AN/VRC-100 (V). The Army's AN/VRC-100 (V) system works in conjunction with the AN/ARC-220 (V) to provide air-to-ground, ground-to-air, ground-to-ground, and air-to-air non-line of sight communications with aircraft at low altitude (30 meters to ground level in the HF band). These radios will support normal voice and encrypted voice communications, as well as message data. The AN/VRC-100 (V) uses multiple modulations and coding techniques and it uses an ALE tone (8-ary frequency shift keying). Table C-6 shows typical technical characteristics of mobile systems.

C.2.4 Land Mobile Service

For so many decades, the federal agencies land mobile requirements have been fulfilled in the mobile bands listed in Table C-5. The vast majority of federal agencies usage of the land mobile service are for: national defense (DOD); law enforcement (*e.g.*, DHS and DOJ); management and preservation of national resources; search and rescue; and emergency and safety communications operations in national seashores, lakes, forests, water resources, and wildlife refuge, including Tribal Lands and reservations (*e.g.*, DOI and DOA). Frequency assignments that support land mobile radios for law enforcement are under the US&P category. The areas of operation for these radios include the urban, suburban, and rural areas, both off-shore and in-land. Operation of these land mobile radios typically occurs near power lines that may be used for BPL systems.

Table C-6: Typical Technical Characteristics of Mobile Service in the 1.7-80 MHz Band

Mobile Systems	Freq. Range (MHz)	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (Ft))	Ant. Type/ Polarization	Modulations
Fx Station	1.7-30	2.8	0	30-100	Whip/V& H	Analog, single channel. Suppressed carrier, telephony
Mobile unit	1.7-30	2.8-3.0	0-2	6-32	Whip/V & H	Analog, single channel. Suppressed carrier, telephony
Fx Station	29.7-80	16	0-3	30-400	Whip, Dipole/V&H	Analog or digital, single channel, Frequency modulated, telephony and data.
Mobile unit	29.7-80	16	0	6-32	Whip/V	Analog or digital, single or multiple channels. Frequency Modulated, telephony and data

In some cases, especially in areas lacking adequate commercial telephone facilities, alternative communications that involve the use of non-government stations (*e.g.*, citizens radio service (CB)) are provided by the federal agencies. Such uses are in accordance with Part 95 of

the FCC Rules and Regulations. In a practical sense, these systems typically may not be in areas where power lines are deployed.

The DOE's most prominent use of the HF spectrum is for secure communications. The DOE's HF system provides a nationwide communications capability to facilitate shipments in support of national defense. The system supplements existing physical security measures by providing normal and emergency communications between vehicles and the DOE's operations office control center.[6] The DOE also relies upon HF to provide essential communications during periods of critical emergencies around various DOE facilities throughout the United States. Typical technical characteristics of land mobile systems in the 1.7-80 MHz band are shown in Table C-7.

Table C-7: Typical Technical Characteristics of Land Mobile Services in the 1.7-80 MHz Band

Land Mobile Systems	Freq. Range (MHz)	Bandwidth (kHz)	Antenna Gain (dBi)	Antenna Height (Ft))	Antenna Type/ Polarization	Modulations
Base Station	1.7-30	2.8	0	30-100	Collinear, whip, dipole/V&H	Analog or digital, single channel., suppressed carrier, telephony and telegraphy
Mobile Unit	1.7-30	2.8-3.0	0-2	6-32	Whip/V&H	Analog or digital, single channel, suppressed carrier, telephony and telegraphy
Base Station	29.7-80	16-25	0-3	30-400	Collinear, whip, dipole/V&H	Analog or digital, single channel, suppressed carrier, telephony and telegraphy
Mobile Unit	29.7-80	16-25	0	6-32	Whip/V	Analog or digital, single channel, suppressed carrier, telephony and telegraphy

C.2.5 Maritime Mobile Service[7]

The maritime mobile bands in the 1.7-80 MHz frequency range allocated to the Federal Government are shown in Table C-8. The Federal Government's main users of the maritime mobile bands are the Coast Guard, Navy, DOI, and the Department of Commerce (DOC).

The Coast Guard operates HF systems for communications between shore stations and ships, and from ship-to-ship. These systems support command and control communications with cutters, aircraft, and shore facilities for various purposes including: off shore search and rescue; drug interdiction; enforcement of laws and treaties; and Arctic and Antarctic operations. Because of the Coast Guard's important role in the drug interdiction, a significant increase in the use of HF systems for air/ground and ship-to-shore communications has taken place over the last

[6] *Supra* note 1 at 66.

[7] *Id.* at 69.

few decades. The Coast Guard also relies on the HF band for services such as distress and safety communications, broadcast of maritime safety information, emergency medical assistance communications, broadcast of weather observation reports, and receipt of vessel position reports for safety purposes.

Table C-8: Frequency Bands Allocated to the Federal Government for Maritime Mobile Service in the 1.7-80 MHz Band

Frequency Band (kHz)	BW (kHz)	Frequency Band (kHz)	BW (kHz)	Frequency Band (kHz)	BW (kHz)
2065-2107	42	6200-6525	325	18780-18900	120
2170-2173.5	3.5	8100-8195	95	19680-19800	120
2190.5-2194	3.5	8195-8815	620	22000-22855	855
4000-4063	63	12230-13200	970	25070-25210	140
4063-4438	375	16360-17410	1050	26100-26175	75
Total Bandwidth (BW) = 4,857 kHz					

In addition, the Coast Guard has an HF network that ties its major bases together, including bases in Alaska, throughout CONUS, Hawaii, Puerto Rico, the U.S. Virgin Islands, and the trust territories of the Pacific Ocean. The Coast Guard also has communication networks in the HF band to support the Long Range Aid to Navigation-C (LORAN-C). Although, the LORAN-C was earmarked for replacement by the Global Positioning System (GPS), the existing LORAN-C chains will be maintained and upgraded, at least till the year 2008, in the transition period to satellite-based navigation.[8]

The Coast Guard carefully monitors several protected HF channels 24 hours a day from several locations in the U.S. and its possessions for distress and maritime safety information communications. Some of these frequencies are used by the Global Maritime Distress and Safety System (GMDSS). Table C-9 shows the specific frequencies monitored by the Coast Guard for distress calling. Consistently over the last few decades, the Coast Guard annually responded to about 2000 search and rescue cases from boats and ships in trouble, where alerting is via frequencies listed in Table C-9.

The Navy also has communication systems between shore stations and ships, as well as ship-to-ship in the HF maritime mobile bands. Navy uses include: communications support to hydrographic surveys; tanker operations; weapon system testing; secure voice communications, and the naval telecommunications system that provides command, control, and communications for the Navy and Marine Corps operating forces. For the Navy, the HF band provides major back-up and supplemental capabilities for long distance emergency and war time communications and will continue to be very important asset to the Navy for fleet-wide communication needs.

[8] http://webhome.idirect.com/~jproc/hyperbolic/loran_c_future.html.

Table C-9: Frequencies Monitored by Coast Guard for Distress and Safety Communications in the HF Band[9]

Freq. (kHz)	Usage	Freq. (kHz)	Usage	Freq. (kHz)	Usage
2174.5 *	NBDP-COM	6215 *	RTP-COM	12577 *	DSC
2182 *	RTP-COM	6268 *	NBDP-COM	12579 *	MSI
2187.5 *	DSC	6312 *	DSC	16420 *	RTP-COM
3023	Aero-SAR	6314	MSI	16695 *	NBDP-COM
4125 *	RTP-COM	8291 *	RTP-COM	16804.5 *	DSC
4177.5 *	NBDP-COM	8376.5 *	NBDP-COM	16806.5	MSI
4207.5 *	DSC	8414.5 *	DSC	19680.5	MSI
4209.5	MSI	8416.5	MSI	22376	MSI
4210	MSI	12290 *	RTP-COM	26100.5	MSI
5680	Aero-SAR	12520 *	NBDP-COM	—	--

* Except provided in the ITU Radio Regulations, any emission capable of causing harmful interference to distress, alarm, urgency or safety communications on these frequencies is prohibited.

Legend:
NBDP = Narrow band direct printing
COM = Communication
RTP= Radio Telephony
DSC = Digital Selective Calling
Aero-SAR = Aeronautical Search and Rescue
MSI = Marine Safety Information

The DOI uses the HF maritime mobile bands for its U.S. Geological Survey organization (USGS) in support of marine geology exploration and mapping tasks. The DOI also has systems in the HF maritime mobile bands to support communications for the Pacific trust territories of the United States. This includes communications between the islands and ships, the outer island dispensary communications system in the marshal Islands, between islands in the Marianas group, and between islands in the American-Samoan group.

The DOC uses HF maritime mobile systems to support ships and boats used by the National Marine Fisheries Service and for communication links between major fishery centers and research vessels of the National Oceanic and Atmospheric Administration (NOAA) Corps Fleet. The National Ocean Service has radio communication facilities in the HF band to support ships and mobile field teams engaged in oceanographic and marine, and geodetic survey activities.

[9] *Frequencies for Distress and Safety Communications for the Global Maritime Distress and Safety System*, ITU Radio Regulations, Appendix S15, Geneva 1998.

GMDSS. The GMDSS is a distress alerting and safety communications system that relies on satellite and terrestrial communications links, and has changed international communications networking from being primarily ship-to-ship to ship-to-shore (Rescue Coordination Center). In addition, the system provides for location determination in cases where a radio operator does not have time to send a complete SOS or MAYDAY call. Ships are required to receive broadcast of maritime safety information via the GMDSS. In 1988, the International Maritime Organization (IMO) amended the Safety of Life at Sea (SOLAS) Convention, requiring most ships to be retrofitted with GMDSS equipment. In the absence of interference, the GMDSS is able to reliably perform the following functions: alerting, including position determination of the unit in distress; search and rescue coordination; locating (homing); maritime information broadcasts; general communications; and bridge-to-bridge communications.

Section 5.4 of the NTIA Manual states that, "stations in the maritime and other radio services employing frequencies and techniques used in the GMDSS shall comply with the relevant ITU-R recommendations with respect to the technical characteristics of, among others, digital selective calling (DSC) distress call formats and . . . other broadcasts of maritime safety information using narrow band direct-printing (NBDP) in the bands 4-27.5 MHz." Additionally, such stations when using DSC shall conform to the calling, acknowledgment, and operating procedures for DSC contained in the ITU Radio Regulations (Article 32) and the relevant ITU-R recommendations. Table C-10 provides typical technical characteristics of maritime mobile systems in the HF band.

Table C-10: Typical Technical Characteristics of Maritime Mobile Systems (1.7-30 MHz Band)

System	Freq. Band (MHz)	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (Ft)	Ant. Type/ Polarization	Modulations
Distress/ SAR *	2-30	2.8	0-2	unknown	Whip, Cone/V	Single sideband-suppressed carrier, single channel, analog, telephony

* SAR = Search and Rescue.

C.2.6 Broadcasting Service

In the Federal Government, HF broadcasting from the U.S. is conducted by the Broadcasting Board of Governors (BBG). The BBG has the mission to promote understanding abroad of the United States, its policies, its people, and its culture. HF radio is a very practical means of communicating directly with the people of other nations because of the extensive availability of inexpensive broadcast receivers. The BBG's global radio network, the Voice of America (VOA), consists primarily of two powerful HF transmitter sites (located in California and Virginia).

The power levels for equipment at VOA installation can be as high as 500 kW. The modulation designator typically is 10K00A3E. This accommodates a 10 kHz bandwidth signal, amplitude modulation, and audio communication. A multi-band, curtain-array antenna is a representative type of antenna for VOA broadcast installation.

While the intended receivers of the VOA's transmissions generally are abroad there are numerous broadcasting receivers owned and operated by foreign citizens and government personnel in the United States that could be susceptible to BPL interference because of proximity to power lines. Protecting other administrations' broadcasting is critical because of reciprocity. The current ITU-R B-03, Seasonal Broadcasting Schedule, shows multiple administrations broadcasting to the United States for every timeframe within a 24- hour period.[10]

The 18 bands allocated to the Federal Government for broadcasting service in the HF portion of the spectrum are listed in Table C-11. Because of frequency reuse capabilities inherent in HF broadcasting, one should expect that broadcast receivers located in the United States are tuned within these bands.

Table C-11: Frequency Bands Allocated to the Federal Government for Broadcasting Service in the 1.7-80 MHz Band

Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)	Frequency (kHz)	BW (kHz)
5900-5950	50	11650-12050	400	15600-15800	200
5950-6200	250	12050-12100	50	17480-17550	70
7300-7350	50	13570-13600	30	17550-17900	350
9400-9500	100	13600-13800	200	18900-19020	120
9500-9900	400	13800-13870	70	21450-21850	400
11600-11650	50	15100-15600	500	25670-26100	430
Total Bandwidth (BW) = 3,720 kHz					

C.2.7 Aeronautical Mobile Service

The aeronautical mobile service is subdivided into two distinct radio services; namely, aeronautical mobile route (R) and aeronautical mobile off-route (OR) services. By definition, the aeronautical mobile (R) service is reserved for communications relating to safety and regularity of flight, primarily along national or international civil air routes; while, the aeronautical mobile (OR) service is intended for other communications, including those relating to flight coordination, primarily outside national or international civil air routes.[11] In the 1.7-80 MHz band, a total of 21 bands are allocated to these services with a total of 2176 kHz of spectrum. Out of the 2176 kHz of spectrum, 1331 kHz is dedicated for the aeronautical mobile (R) service and 845 kHz is assigned to aeronautical mobile (OR) service. In general, the Federal Government frequency assignments in the bands allocated to the aeronautical mobile service in this portion of the spectrum are used for controlling aircraft traffic. Other uses in the United

[10] Broadcasting Board of Governors Response to NTIA Memo, *Questionnaire Regarding Equipment and Operations in the 1.7-80 MHz Frequency Range*, November 7, 2003.

[11] NTIA, *Manual of Regulations and Procedures for Federal Radio Frequency Managers,* U.S. Department of Commerce, National Telecommunications and Information Administration, Washington, D.C., January 2004 Revision.

States may include Airline Operational Control (AOC) communications of foreign air carriers, including for scheduled traffic.

C.2.7.1 Aeronautical Mobile (R) Service

Frequency assignments to stations in the aeronautical mobile (R) service, in the HF band, must be assigned in conformity with the provisions and the allotment plan of Appendix 27 of the ITU Radio Regulation (RR). Such assignments conform to the plan for the allotment of frequencies to: (a) Major World Air Route Areas (MWARAs); (b) Regional and Domestic Air Route Areas (RDARAs); (c) VOLMET Allotment Areas; and (d) Worldwide Allotment Areas contained in Appendix 27 (RR) or, to meet operational requirements not otherwise met by the Allotment Plan, must comply with the provisions of Appendix 27 for the adaptation of allotment procedures. Assignments in support of International Air Routes (MWARA and VOLMET allotments) are also within the purview of applicable International Civil Aviation Organization (ICAO) frequency assignment plans that have been agreed internationally and are recognized in the ITU RR.

As a matter of general policy, HF is not normally used for aeronautical mobile (R) communications in the domestic services within the conterminous United States, the need for such frequencies having been generally eliminated through successful use of the VHF communications.[12] However, Appendix 27 (RR) Part II, Section I, Article 2 provides for the allotment of frequencies to the RDARAs, which include the conterminous United States, and also Alaska, Hawaii, Puerto Rico, and the Virgin Islands. This then enables special aeronautical communication requirements, not conforming fully to the definition of the aeronautical mobile (R) service, to be satisfied by use of frequencies from these allotments within the limitations of the national criteria established jointly with the FCC.[13] Section C.4.4 provides these national criteria.

Certain frequencies in the HF band are available to all government agencies for operational control and safety of civil government aircraft in certain specified areas. These frequencies, as listed in Table C-12, are intended for support of operations not exclusively en route in nature. These frequencies were chosen so as to avoid those channels in which operation might result in harmful interference to aeronautical stations dedicated to the safety and regularity of flight.

[12] *Id.* at 8-13.

[13] *Id.*

Table C-12: Frequencies Designated for Operational Control of Civil Government Aircraft

Assigned Freq. (kHz)	Carrier Freq. (kHz)	Areas of Operation		Assigned Freq. (kHz)	Carrier Freq. (kHz)	Areas of Operation
2897.4	2896	AK, HI, CONUS		10055.4	10054	HI
2948.4	2947	AK, HI, CONUS		11307.4	11306	CONUS
3002.4	3001	AK, HI, CONUS		17950.4	7949	AK, HI, CONUS
6539.4	6538	CONUS		21926.4	21925	AK, HI, CONUS
8886.4	8885	CONUS		21929.4	21928	AK, HI, CONUS
8910.4	8909	AK, HI, CONUS		21935.4	21934	AK, HI, CONUS

The Federal Government aeronautical stations that operate in the aeronautical mobile (R) service within the US&P are normally authorized only for the Federal Aviation Administration (FAA), mainly for its HF system called the National Radio Communications System (NRCS). As such, Federal Government spectrum use of the aeronautical mobile (R) service in the HF band is limited to few federal agencies. For example, the DOI use of the aeronautical mobile (R) service is mainly outside of the contiguous United States. Specifically, their use is mostly in Alaska, Hawaii, and the trust territories of the Mariana and Marshall Islands in the Pacific Ocean. Operations in the trust territories include inter-island communications. In Alaska, Hawaii, and CONUS, the DOI assignments are required for en route communications and flight following of aircraft in support of national resource programs.

Frequency assignments belonging to the Department of Treasury are used for aircraft in support of law enforcement responsibilities. Table C-13 specifies the particular bands used for aeronautical mobile (R) and respective bandwidths.

Table C-13: Frequency Bands Allocated to the Aeronautical Mobile Service (R) (1.7-30 MHz Band)

Frequency (kHz)	Bandwidth (kHz)		Frequency (kHz)/Service	Bandwidth (kHz)
2850-3025	175		10005-10100	95
3400-3500	100		11275-11400	125
4650-4700	50		13260-13360	100
5450-5680	230		17900-17970	70
6525-6685	160		21924-22000	76
8815-8965	150		—	---
Total Bandwidth = 1331 kHz				

Table C-14 shows typical technical characteristics of Federal Government systems in the aeronautical mobile (R) service.

Table C-14: Typical Technical Characteristics of Aeronautical Mobile (R) Systems (1.7-30 MHz Band)

System	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (Ft)	Ant. Type/ Polarization	Modulations
Airborne	2.8	0	18000-40000	Conformal/V	Analog, single channel, suppressed carrier, telephony.
Ground	2.8	0-3	unknown	Various /V	Analog, single channel, suppressed carrier, telephony.

C.2.7.2 Aeronautical Mobile (OR) Service

Frequencies in bands allocated exclusively to the (OR) service are internationally alloted to countries by Appendix 26 of the ITU RR, which also establishes frequency sharing criteria, protection ratios, and other technical and operational principles. These principles recognize the possible necessity for the adaptation of the allotment plan to meet valid requirements of the various administrations, provided these adaptations do not decrease the protection to frequencies assigned in strict adherence to the plan.[14]

Frequencies in the bands allocated exclusively to the (OR) service are nationally used primarily for the satisfaction of military aeronautical requirements. Assignments of frequencies in these bands are subject to coordination with the Military Departments through the Interdepartment Radio Advisory Committee (IRAC) mechanism.

Nationally, the use of the aeronautical mobile (OR) service bands is mainly for military operations that include controlling traffic routes and special military needs. The Navy and Air Force are the major users of the aeronautical mobile (OR) bands. The vast majority of their assignments are dedicated for air-ground-air communications provided by the AN/ARC family of radios. The AN/ARC-190 is a typical radio used by the Air Force in the HF band and is described below. Other uses of the aeronautical mobile (OR) service bands by the Air force are: global command and control stations required for air and ground communications; flight testing; ground tactical communications; communications for the Strategic Air Command (SAC) forces; data coordination; and de-orbiting satellite recovery operations.

Table C-15 shows the frequency bands allocated to the aeronautical mobile service (OR) in the 1.7-30 MHz band and Table C-16 shows a typical technical characteristics of aeronautical mobile service (OR) system in the HF band.

[14] *Id.* at 8-14.

Table C-15: Frequency Bands Allocated to the Aeronautical Mobile (OR) Service (1.7-30 MHz Band)

Frequency (kHz)	Bandwidth (kHz)	Frequency (kHz)	Bandwidth (kHz)
3025-3155	130	11175-11275	100
4700-4750	50	13200-13260	60
5680-5730	50	15010-15100	90
6685-6765	80	17970-18030	60
8965-9040	75	23200-23350	150
Total Bandwidth = 845 kHz			

AN/ARC-190. The AN/ARC-190 works in conjunction with the AN/TRC-181 to provide short-, medium-, and long-range voice and data communications employing an automatic communications processor for auto link and anti-jam capabilities. These systems employ multiple modulations and coding techniques, including sideband suppressed carrier, single sideband reduced or variable level carrier, continuous wave employing frequency hopping and pseudo random pre-selection technique.

Table C-16: Typical Technical Characteristics of Aeronautical Mobile (OR) Systems (1.7-30 MHz Band)

System	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (ft)	Ant. Type/ Polarization	Modulations
AN/ARC (airborne)	3.5	0.0	30,000	Blade/V	Analog and digital, single channel, reduced or suppressed carrier, telephony and data.
AN/TRC (ground)	3.5	0.0	6-32	Whip/V	Analog and digital, single channel, reduced or suppressed carrier, telephony and data.

C.2.8 Standard Frequency and Time Signal[15]

The Federal Government, via the National Institute of Standards and Technology (NIST), has provided standard time and frequency services since 1923 in the HF band. These services are important to a community of technical users in support of basic activities such as navigation, power generations, and communications. However, many of these HF capabilities are being supplemented by the GPS. The services provided include: time announcements; standard time intervals; standard frequencies; geophysical alerts; marine storm warnings; Omega Navigation System status report; Coordinated Universal Time (UTC) corrections; and digital time code.

NIST provides time and frequency services at 2.5 MHz, 5 MHz, 10 MHz, 15 MHz, and 20 MHz. The services are broadcast from stations WWV, in Fort Collins, CO, and from WWVH, in Kauai, HI. Table C-17 shows the radiated power for the transmissions at each location. The antennas at WWV are omnidirectional, half-wave dipoles. At WWVH, the

[15] *Supra* note 1 at 72.

antennas are phased vertical half-wave dipole arrays with maximum gain in a westerly direction. Double sideband amplitude modulation is employed at both stations. Four modulation levels (25, 50, 75, and 100 percent) are used depending on the particular information transmitted.

Table C-17: Radiated Power for Transmissions at Stations WWV and WWVH

Frequency (MHz) [a]	Radiated Power at WWV (kW)	Radiated Power at WWVH (kW)
2.5	10	10
10	10	10
15	10	10
20	2.5	--

[a] The 25 MHz is currently not in use.

As the GPS and other communications systems become more widely assimilated, HF time broadcasts service may become obsolete. Currently, the main users of the HF standard frequency and time signal services are hobbyists, amateurs, and signal propagation researchers.

In the 1.7- 30 MHz frequency range, 13 bands are allocated to the standard frequency and time signal radio service on a primary basis. Table C-18 shows these bands and their respective bandwidths.

Table C-18: Frequency Bands Allocated to the Standard Frequency and Time Signal Service in the 1.7-30 MHz Band

Frequency (kHz)	Bandwidth (kHz)	Frequency (kHz)	Bandwidth (kHz)
2495-2505	10	14990-15010	20
4995-5005	10	19990-20010	20
9995-10005	10	24990-25010	20
Total Bandwidth = 90 kHz			

C.2.9 Aeronautical Radionavigation

In the 1.7-80 MHz frequency range, the 74.8-75.2 MHz band is allocated to the aeronautical radionavigation service. The federal agencies that operate on this band are the Air Force, Army and the FAA. Basically, use of this band is for marker beacons that provide navigational aids, including the Instrumentation Landing System (ILS). Marker beacons provide the pilot a reliable altitude indicator as it approaches the runway (barometric altimeters are not accurate at low altitudes). Most ILS and localizer landing approaches incorporate at least one marker and as many as three. The first marker (Outer Marker) is anywhere from four to 10 miles from the end of a runway and, normally, supports navigation for the initial approach. The marker beacon transmit in the ground-to-air direction at 75 MHz and is modulated with a 400 Hz intermit tone. The second marker (Middle Marker) is normally used about 3,000 feet off the end of the landing runway. The Middle Marker is normally used about 200 feet above ground level. This marker is transmitted at 75 MHz with a 1,300 Hz tone modulation. The third marker (Inner

Marker) is normally installed around 1,000 feet from the end of the runway. Again, the transmit frequency is 75 MHz but the tone is at 3,000 Hz.[16]

ITU RR No. 5.180 states that,

> "The frequency 75 MHz is assigned to marker beacons. Administrations shall refrain from assigning frequencies close to the limits of the guardband to stations of other services which, because of their power or geographical position, might cause harmful interference or otherwise place a constraint on marker beacons. Every effort should be made to improve further the characteristics of airborne receivers and to limit the power of transmitting stations close to the limits 74.8-75.2 MHz."

About 98 percent of the federal assignments that support marker beacons operation belong to the FAA. Because many major airports are within the vicinity of metropolitan or urban areas, BPL operations generally should not be considered in the 74.8-75.2 MHz band. Typical technical characteristics of aeronautical radionavigation systems operating in the 7.4-75.2 MHz band are shown in Table C-19.

Table C-19: Typical Technical Characteristics of Radionavigation Systems in the 74.8-75.2 MHz Band

System	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (Ft)	Ant. Type/ Polarization	Modulations
Marker Beacon	0.8-6	-2.5-2.0	0-3000	Blade/H	Amplitude modulation, double sideband, single channel, digital and telegraphy

C.2.10 Radiolocation Service

The radiolocation service is a radiodetermination service used for detection and positional location of distant objects (targets).[17] There are three bands allocated to the radiolocation service in the 1.7-80 MHz range, as shown in Table C-20.

Table C-20: Frequency Bands Allocated to the Radiolocation Service (1.7-80 MHz Band)

Frequency Band (kHz)	Bandwidth (kHz)	Allocation
1705-1800	95	Primary
1900-2000	100	Primary
3230-3400	170	Secondary

In these bands, three federal entities (Navy, Army, and Tennessee Valley Authority (TVA)) are currently employing radiolocation systems. The Navy uses these bands in support of fleet operations and for surveillance. Specifically, the Navy's radiolocation systems provide position fixing in support of mine countermeasure operations and long range surveillance. For

[16] http:/www.avionicswest.com/marker beacon receiver.htm.

[17] *Id.* at 6-11.

surveillance, the Navy employs a long range, re-locatable over the horizon radar system (AN/TPS-71). This system is described further in Section C.4. The Army has multiple radiolocation requirements in these bands, namely, for test range and off-shore operations, including such as; target scoring; hydrographic surveys; and for determining location of missile payloads during recovery operations. The TVA has two radiolocation assignments for establishing boat positions while conducting water quality surveys in the vicinity of thermal-electric generation plants in TVA service areas. Typical technical characteristics of a radiolocation system in the 1.7-80 MHz band are presented in Table C-21.

Table C-21: Representative Technical Characteristics of Radiolocation Systems in the 1.7-80 MHz Band

System Station	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (ft)	Ant. Type/ Polarization	Modulations
Land & Ship	0.001-0.600	0-3	unknown	unknown/V	Amplitude modulation, double sideband, single channel, digital and telegraphy

C.2.11 Amateur and Amateur-Satellite Services

The amateur service is a radiocommunication service for the purpose of self-training, inter-communication and technical investigation that is used by duly authorized persons interested in radio techniques solely with a personal aim and without pecuniary interest.[18] Amateur radio operators' licenses are granted by the FCC and uses must adhere to technical standards as given in the FCC Rules and Regulations, Part 97 — Amateur Radio Service. The Amateur-satellite service is a radiocommunication service using space stations on earth satellites for the same purposes as those of the amateur service.[19]

Amateur radio operators extensively assist the law enforcement community and other public service organizations during all kinds of emergencies including: hurricanes, earthquakes, tornadoes and floods, motorist accidents, fires and chemical spills, and search and rescue operations.[20]

There are 13 bands allocated to the amateur and amateur-satellite services (1.7-80 MHz band). The majority of these bands is in the lower portion of the HF band and is presented in Table C-22.

[18] 47 C.F.R. §2.1(c).

[19] *Id.*

[20] http://www.arrl.org/hamradio.html.

Table C-22: Frequency Bands Allocated to the Amateur and Amateur-Satellite Services in the 1.7-80 MHz Band

Frequency Band (kHz)	Radio Service	Bandwidth (kHz)	Total Bandwidth (kHz)
1800-1900	Amateur	100	Amateur = 7650 Amateur-Satellite = 2700
3500-4000	Amateur	500	
7000-7100	Amateur/Amateur-Satellite	100	
7100-7300	Amateur	200	
10100-10150	Amateur	50	
14000-14250	Amateur/Amateur-Satellite	250	
14250-14350	Amateur	100	
18068-18168	Amateur/Amateur-Satellite	100	
21000-21450	Amateur/Amateur-Satellite	450	
24890-24990	Amateur/Amateur-Satellite	100	
28000-29700	Amateur/Amateur-Satellite	1700	
50000-54000	Amateur	4000	

The DOD administers the Military Affiliate Radio System (MARS). The MARS is managed and operated by the Army, Navy and the Air Force. The MARS program consists of civilian and military licensed amateur radio operators who are interested in supporting military communications. The MARS volunteer force includes more than 5,000 dedicated and skilled amateur radio operators.[21] They contribute to the MARS mission providing auxiliary or emergency communications on a local, national, and international basis as an adjunct to normal communications.[22] The radios used in the MARS program are the same or equivalent systems used by the amateur radio operators.

The MARS system continues to play an important role in the military for: (1) helping to maintain morale through assistance in the maintenance of contacts with spouses or friends even when the distance separation is great, and (2) when needed, it can augment emergency communication services within the military. The morale of servicemen and women is always an important area of concern for military commanders, particularly for personnel stationed in remote areas away from family and friends. Another area of concern for the military is to maintain an independent system that can be used in time of war, emergencies or other national disasters in ready-to-use condition. The MARS HF network is constantly being tested by calls made by the military personnel. Another benefit of this active system is as a training tool for reservists and active duty servicemen on a system they may be called upon to operate in an emergency situation.[23] Typical technical characteristics of a MARS radio are presented in Table C-23. Note, however, that the antennas used vary widely.

[21] http:/www.asc.army.mil/mars/mars/.

[22] http:/www.//afmars.tripod.com/mars1.html.

[23] *Supra* note 1 at 83-84.

Table C-23: Representative Technical Characteristics of MARS System (1.7-30 MHz Band)

System	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (Ft)	Ant. Type/ Polarization	Modulations
MARS	2.7	0-10	0-80	Dipole, yagi, log periodic/ H & V	Amplitude modulated, Analog and digital, single or multiple channels, suppressed carrier, telephony and telegraphy.

C.3 FEDERAL GOVERNMENT SPECIAL OPERATIONS

C.3.1 Automatic Link Establishment (ALE) Systems

The Federal Government employs ALE subsystems in the medium to high frequency (MF-HF) range of the radio spectrum to eliminate the need for extensive training needed for manual establishment of HF and MF radio channels that use ionospheric (skywave) signal propagation. An ALE system is characterized by periodic polling of several frequencies (typically seven or more) that are assigned to a station to determine if ionospheric circuits are available at these frequencies. An ALE equipped radio automatically selects the best channel for communications by maintaining in real time a data base of link performance (*e.g.*, received signal-to-noise power ratio) versus frequency for each addressee in the users net and using that data to choose frequencies on which to initiate a link. A network of stations is assigned a number of frequencies over which to communicate, and each station is assigned a unique address (*e.g.,* alpha-numeric).

For example, station A, attempting to establish a link with station B will repetitively broadcast the address code for station B over one of the assigned network frequencies. This transmission will last long enough for station B to automatically scan its assigned frequencies. If station B receives and recognized its address code, it stops on that frequency. The equipment at both ends of the link will then automatically handshake and alert the operators that the link has been or can be established, and the desired traffic can be transmitted (*e.g.*, voice, secure voice, and data). If communications fail, the ALE equipment tries another frequency in the preset list until a link is established or the operator is informed of communications failure. Failures will occur, for example, if interference prevents communications on frequency assignments that an ALE system would otherwise determine to be the best available channels, in which the user will not realize that interference is the cause.

C.3.2 Sounders

In general, sounders are used to gain an in-depth real-time knowledge of the ionosphere conditions important to communication applications. In a stable ionospheric condition, sounder data need only to be taken every 15 minutes, and a complete record can be obtained in a fraction of a minute. Sounders data typically are used in support of non-ALE applications.

There are three main types of sounding systems; namely, backscatter, oblique and vertical incidence sounders. Backscatter sounders typically receive weak signals originating from a signal transmitted to the ionosphere, scattered back to the Earth's surface, back to the ionosphere, and scattered back to the original transmitter site and its associated receiver system. This technique is well suited for obtaining the propagation conditions as they relate to range, azimuth bearing, and frequency of operation. Oblique sounding uses an intermittent beacon located at a known distance from the receiver site. Since the range variable is removed, the resulting signal will be due to the ray-path distance associated with the various layers in the ionosphere. With good synchronization between the beacon and the receiver system, detailed information can be readily obtained. With this method, it is possible to determine the ionospheric virtual height. However, for this method to be applicable, the beacon must be placed in the area under the portion of the ionosphere that is of interest. Vertical incidence sounding provide information regarding the portion of the ionosphere that is directly overhead. The advantage of this type of sounding is that the transmitter and the receiver are co-located and this greatly simplifies the synchronization problem between the transmitter and the receiver. Operationally, however, the vertical incidence sounders are the least desirable type of sounder for determining appropriate communication system parameters. Table C-24 provides a summary of the Federal Government agencies sounding systems and relevant technical characteristics.

C.3.3 Over the Horizon (OTH) Radars[24]

Over the horizon radar systems are employed by the DOD. The OTH radars use skywave propagation to detect targets at long ranges from the radar transmitter site. The target return is a result of the backscatter signal traversing the path to the ionosphere and back to the original transmitter site (primary radar) or an alternative site (secondary site). OTH radar systems generally utilize more bandwidth than is typically used for communications. These systems place increased demands on the amount of spectrum used and performance is greatly affected by the characteristics of the ionospheric channel. OTH-HF radars are capable of detecting targets at distances beyond the horizon and therefore, targets located well beyond the range of the conventional microwave radar. This increased range is possible due to the ability of the HF signals to propagate well beyond the line-of-sight either by ground wave diffraction around the curvature of the Earth or by skywave. An example OTH radar system operating in the HF portion of the spectrum is the AN/TPS-71. A brief description of this system is provided below.

[24] *Supra* note 1 at 74.

Table C-24: Federal Government Sounding Systems and Technical Characteristics

Federal Agency	Receiver Type	No. of Assignments[25]	Operating Frequency (kHz)	Emission Bandwidth	Antenna Type	Gain/ Polarization	Function(s)
AF	DIGISONDE 128	2	415-20012.5	20KM0N	--	15/T	-Provides ionosphere data to AF Global Weather Center
	DPS-4	2	1000-40000	30KV7D	--	10/T	-Ionospheric research. -Propagation research
	DIGITAL IONOSONDE	1	2220.5-2465	60KM1N	---	1	-Regional ionospheric forecast and specification
	AN/FMQ-12	20	1012.5-30000	2H5N0N 75KM0N 75KP0N 600HF9W	Broad-band dipole	0-16/ T/H	-Weather forecasting. -Ionospheric research -Provides ionospheric data to AF Global Weather Center
AR	AN/TRQ-35	2	2000-30000	2H5N0N	Double Delta		-Support Army's fixed communications
N	R-2368/URR AN/TPS-71 AN/ARC-191	15	2000-30000	2H5N0N 100HN0N 600HF1B 4K2F3N 4K2Q1N 100KQ1N 100KF3N	Phased array/ Whip/ Log periodic	0-36/ V&H	-Wide area surveillance. -Detection, location, tracking of aircraft and ships. -Air Defense warning.
C	---	1	1000-20000	40KP0N	--		-Propagation research studies
DOE	STQIONOSONDE	5	2505-14990	100HNON	Inverted-V	2	-Doppler shift measurement to support DOE earthquake monitoring system.

[25] In the Government Master File, an assignment may represent multiple radio equipments.

AN/TPS-71. The Navy's AN/TPS-71 is transportable OTH radar, with an operating frequency range of 5-28 MHz that can provide wide area active surveillance in support of tactical forces. Uses include detection, location, and tracking of aircraft and ship targets at a range of up to 1600 nautical miles in high interest marine areas. Transportable, in this sense, refers to having the capability to redeploy the system to another location over a period of time, as opposed to tactical mobility. This provides the Navy flexibility to be responsive to changing threat patterns and capabilities. This is a frequency agile system. There are a few OTH radar sites in the United States (AK, TX, and, two in VA), and few more overseas. The basic technical characteristics of the AN/TPS-71 receiver are shown in Table C-25.

Table C-25: Technical Characteristics of the AN/TPS-71 System (1.7-30 MHz Band)

System	Bandwidth (kHz)	Ant. Gain (dBi)	Ant. Height (Ft)	Ant. Type/ Polarization	Modulations
AN/TPS-71	4.2-100	9-36 *	Not available	Phased Array/ Vertical	FM/CW or Angle-modulated, single channel, with analog or digital signals.

* The 9 dBi and 36 dBi antenna gains are measured at the 5 MHz to 28 MHz, respectively.

C.4 SPECIAL OPERATIONAL CONSIDERATIONS

C.4.1 Operational Requirements for Access to Several Frequency Assignments within an Allocation

Ionospheric (skywave) signal propagation is frequency selective and frequencies usable for communications between any two points changes over time throughout the day. This is why several different segments of the 1.7-30 MHz frequency range are allocated to each radio service (*i.e.*, so that the service has full-time access to frequencies that are usable throughout the day). This is an important factor in assessing the operational impact of broadband interfering signals that typically overlap an entire HF allocation for one or more services. In the event local harmful interference occurs across an HF allocation, the associated service will not be able to operate in that locale for several hours during the day.

Even if only a portion of a given allocation is subjected to local harmful interference, the local communications reliability is greatly diminished for services that utilize multiple frequency assignments within a band. This is because the choice among multiple assignments allows the local radio operator (or ALE system) to avoid channels that are laden with relatively high local noise power levels or are in use by other radio systems.

C.4.2 Federal Government use of Radio Frequencies Below 30 MHz for Domestic Fixed Service

Section 8.2.11 of the NTIA Manual provides restrictions on fixed service use of frequencies below 30 MHz. To insure that, insofar as practicable, sufficient high frequencies will be available for the operation of radio circuits essential to the national security and defense and to conserve frequencies below 30 MHz for services which cannot operate adequately without them, only in following circumstances shall departments and agencies of the Executive Branch of the Government use frequencies below 30 MHz for domestic fixed service within the conterminous United States:

a) When it is indispensable to do so, and on the condition that the characteristics of the stations continue to conform to those in the GMF, a land station may communicate, on a secondary basis, with fixed stations or other land stations in same category, using its assigned frequencies;

b) Where technical and operational requirements dictate, fixed stations may transmit to other fixed stations for the domestic haul or overseas traffic in transit, or destined for the United Sates. Such domestic radio haul shall be a segment of the overall overseas radio system;

c) When there is a need to provide instantaneous transmission of vital emergency, operational command and alerting traffic of such importance as to affect the immediate survival and defense of the nation;

d) When required for use in an emergency jeopardizing life, public safety, or important property under conditions calling for immediate communication where other means of communication do not exist or are temporarily disrupted or inadequate;

e) When there is a need to provide for a communications system manned by fully qualified operators who are military reservists or affiliates (e.g., MARS). Except in emergencies, frequency assignments in this category shall not be used as a means for passing traffic that in the absence of such assignments would require delivery by other means;

f) When other telecommunication facilities do not exists, are inadequate, or are impracticable of installation, and when the use of frequencies above 30 MHz is not practicable; and

g) In an emergency where it has not been feasible to make prior arrangements for alternate means of communications, it is permissible to operate temporarily on regularly assigned frequencies in a manner other than that specified in the terms of an existing assignment or on other appropriate frequencies under special circumstances such as an emergency must actually exist or imminently threaten emergency operations shall be discontinued as soon as substantially normal communications facilities are restored.

Also, Section 8.2.11 (2) and (3) of the Manual supplements or clarifies the above mentioned restrictions with respect to the requests for the authorization of frequencies below 30 MHz for new systems or in circumstances where congestion in the radio spectrum would be increased materially, and establishing adequate radio backup of wireline facilities in advance for use during an emergency.

C.4.3 Summary of the Emergency use of Federal Government HF Frequencies for the SHARES Program

The National Communications System (NCS) SHARES HF Radio Program is a key element in the national telecommunications infrastructure using presently authorized HF radio networks and cooperating federal agencies. SHARES is a collection of existing federal agency controlled HF stations that will interoperate to exchange national security emergency preparedness (NSEP) traffic for any federal entity during a crisis or emergency. Participating agencies agree to accept SHARES actual or simulated emergency traffic, assuming responsibilities for delivery or relay to the extent it does not interfere with their own agency mission. The SHARES HF Program supports Executive Order 12472, 12656, and NSDD-97.

Agencies providing frequencies for the NCS SHARES program must have a US&P assignment in the GMF. Operations under these assignments are limited to SHARES operation and tests. Participating agencies in the NCS SHARES HF Radio Program are authorized to test the operating system periodically provided the respective agency Frequency Assignment Subcommittee Representatives are notified at least 30 days in advance.

C.4.4 National Criteria Established Jointly by NTIA and FCC on the use of Frequencies from Appendix 27 Allotment Plan

In the HF band, there are special and certain related aeronautical mobile requirements not fully conforming to the definition of the aeronautical mobile (R) service that have to be satisfied by the frequencies from ITU RR Appendix 27 allotment plan. However, the use of these frequencies will abide within the limitations of the following national criteria established jointly by the NTIA and FCC:

1) Communications related to safety and regularity of flight between an aircraft and those aeronautical stations primarily concerned with flight along national or international civil air routes shall have absolute priority over all other uses;

2) Use of (R) band high frequencies shall be limited to single sideband air/ground and incidental air/air communications beyond the range of VHF/UHF facilities;

3) Users shall share frequencies to the maximum extent possible;

4) Requirements shall be handled on a case-by-case basis;

5) A showing must be made that the accommodation of the requirements in the bands other than aeronautical mobile (R), *e.g.*, fixed bands, is not satisfactory for technical, operational, or economic reasons;

6) Only those requirements will be considered where the primary need for communications is for the safety of the aircraft and its passengers or for operational control communications, *i.e.*, "communications required or exercising authority over initiation, continuation, diversion, or termination of a flight in accordance with the provisions of Annex 6" (ICAO);

7) Use of aeronautical mobile (R) high frequencies in accordance with the foregoing normally shall be limited to non-military; and

8) If the aforementioned criteria are met, the stipulation that (R) bands are to be used only for flights along national and international civil air routes need not be met.