420-450 MHz

1. Band Introduction

The band 420-450 MHz is used by the military and other Federal agencies for a number of important radar applications, multi-function position-location communications systems, space operations and space research, and test range telecommand and flight termination systems making the band essential to national security.

The band 420-450 MHz is used extensively by the military agencies for land-based, shipborne, and airborne radar systems to perform important national security functions. The physics of radio propagation make the band excellent for long-range radar search and surveillance operations, and the associated target tracking. The band is used for long-range search and surveillance radars to detect and track ballistic missiles and aircraft, and to catalog objects in space.

The military agencies use the band 420-450 MHz for the multi-function Position Location Reporting System (PLRS) and the modernized Enhanced Position Location Reporting System (EPLRS). EPLRS is a data communications network that enables the rapid determination of the locations of all units in the network. EPLRS also has communications and navigational capabilities in addition to the position location feature. The EPLRS and its airborne version, the AEPLRS, are critical to the operations and safety of our military forces.

The band 448-450 MHz is used for important weather observations using wind-profiler radars to detect wind speeds and crosswinds to aid in weather forecasting and to provide flight planning and operational information to aircraft.

The band 420-450 MHz is used for command control and flight termination functions at numerous missile and rocket launch and test ranges.

The band 420-450 MHz is extensively used for atmospheric research by incoherent scatter radars (ISRs). The National Science Foundation (NSF) funded the development and construction of the Advanced Modular Incoherent Scatter Radar (AMISR), a solid state, phased-array radar operating in the band. AMISR employs a modular design that enables the radar to be easily disassembled and relocated to provide observing capabilities at different locations depending on scientific needs.

2. Allocations

2a. Allocation Table

The frequency allocation table shown below is extracted from the Manual of Regulations & Procedures for Federal Radio Frequency Management, Chapter 4 – Allocations, Allotments and Plans.

Table of Frequency Allocations

United States Table

Federal Table	Non-Federal Table	FCC Rule Part(s)
420-450 RADIOLOCATION US217 G2 G129 5.286 US7 US87 US230 US397 G8	420-450 Amateur US7 NG135 5.282 5.286 US87 US217 US230 US397	Private Land Mobile (90) Amateur (97)

2b. Additional Allocation Table Information

5.282 In the bands 435-438 MHz, 1 260-1 270 MHz, 2 400-2 450 MHz, 3 400-3 410 MHz (in Regions 2 and 3 only) and 5650-5670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. 5.43). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. 25.11. The use of the bands 1 260-1 270 MHz and 5 650-5 670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.

5.286 The band 449.75-450.25 MHz may be used for the space operation service (Earth-to-space) and the space research service (Earth-to-space), subject to agreement obtained under No. 9.21.

G2 In the bands 216-217 MHz, 220-225 MHz, 420-450 MHz (except as provided by US217 and G129), 890-902 MHz, 928-942 MHz, 1300-1390 MHz, 2310-2390 MHz, 2417-2450 MHz, 2700-2900 MHz, 3300-3500 MHz (except as provided by footnote US108), 5650-5925 MHz, and 9000-9200 MHz, the Federal radiolocation service is limited to the military services.

G8 Low power Federal radio control operations are permitted in the band 420-450 MHz.

G129 Federal wind profilers are authorized to operate on a primary basis in the radiolocation service in the frequency band 448-450 MHz with an authorized bandwidth of no more than 2 MHz centered on 449 MHz, subject to the following conditions: 1) wind profiler locations must be pre-coordinated with the military services to protect fixed military radars; and 2) wind profiler operations shall not cause harmful interference to, nor claim protection from, military mobile radiolocation stations that are engaged in critical national defense operations.

NG135 In the 420-430 MHz band the amateur service is not allocated north of line A (def. § 2.1).

US7 In the band 420-450 MHz and within the following areas, the peak envelope power output of a transmitter employed in the amateur service shall not exceed 50 watts, unless expressly authorized by the FCC after mutual agreement, on a case-by-case basis, between the District Director of the applicable field office and the military area frequency coordinator at the applicable military base. For areas (e) through (g), the appropriate military coordinator is located at Peterson AFB, CO.

(a) Arizona, Florida, and New Mexico.

(b) Within those portions of California and Nevada that are south of latitude 37° 10' N.

(c) Within that portion of Texas that is west of longitude 104° W.

(d) Within 322 km (200 miles) of Eglin AFB, FL (30° 30' N, 86° 30' W); Patrick AFB, FL (28° 21' N, 80° 43' W); and the Pacific Missile Test Center, Point Mugu, CA (34° 09' N, 119° 11' W).

(e) Within 240 km (150 miles) of Beale AFB, CA (39° 08' N, 121° 26' W).

(f) Within 200 km (124 miles) of Goodfellow AFB, TX (31° 25' N, 100° 24' W) and Warner Robins AFB, GA (32° 38' N, 83° 35' W).

(g) Within 160 km (100 miles) of Clear, AK (64° 17' N, 149° 10' W); Concrete, ND (48° 43' N, 97° 54' W); and Otis AFB, MA (41° 45' N, 70° 32' W).

US87 The band 449.75-450.25 MHz may be used by Federal and non-Federal stations for space telecommand (Earth-to-space) at specific locations, subject to such conditions as may be applied on a case-by-case basis. Operators shall take all practical steps to keep the carrier frequency close to 450 MHz.

US217 In the band 420-450 MHz, pulse-ranging radiolocation systems may be authorized for use along the shoreline of the conterminous United States and Alaska. In the sub-band 420-435 MHz, spread spectrum radiolocation systems may be authorized within the conterminous United States and Alaska. All stations operating in accordance with this provision shall be secondary to stations operating in accordance with the Table of Frequency Allocations. Authorizations shall be granted on a case-by-case basis; however, operations proposed to be located within the following geographic areas should not expect to be accommodated:
(a) Arizona, Florida, and New Mexico.
(b) Those portions of California and Nevada that are south of latitude 37° 10' N.
(c) That portion of Texas that is west of longitude 104° W.
(d) Within 322 km (200 miles) of Eglin AFB, FL (30° 30' N, 86° 30' W); Patrick AFB, FL (28° 21' N, 80° 43' W); and the Pacific Missile Test Center, Point Mugu, CA (34° 09' N, 119° 11' W).
(e) Within 240 km (150 miles) of Beale AFB, CA (39° 08' N, 121° 26' W).
(f) Within 200 km (124 miles) of Goodfellow AFB, TX (31° 25' N, 100° 24' W) and Warner Robins AFB, GA (32° 38' N, 83° 35' W).
(g) Within 160 km (100 miles) of Clear, AK (64° 17' N, 149° 10' W); Concrete, ND (48° 43' N, 97° 54' W); and Otis AFB, MA (41° 45' N, 70° 32' W).

US230 The bands 422.1875-425.4875 MHz and 427.1875-429.9875 MHz are allocated to the land mobile service on a primary basis for non-Federal use within 80.5 kilometers (50 miles) of Cleveland, OH (41° 29' 51.2" N, 81° 41' 49.5" W) and Detroit, MI (42° 19' 48.1" N, 83° 02' 56.7" W). The bands 423.8125-425.4875 MHz and 428.8125-429.9875 MHz are allocated to the land mobile service on a primary basis for non-Federal use within 80.5 kilometers of Buffalo, NY (42° 52' 52.2" N, 78° 52' 20.1" W).

US397 In the band 432-438 MHz, the Earth exploration-satellite service (active) is allocated on a secondary basis for Federal use. Stations in the Earth exploration-satellite service (active) shall not be operated within line-of-sight of the United States except for the purpose of short duration pre-operational testing. Operations under this allocation shall not cause harmful interference to, nor claim protection from, any other services allocated in the band 432-438 MHz in the United States, including secondary services and the amateur-satellite service.

3. Federal Agency Use

3a. Federal Agency Frequency Assignments Table

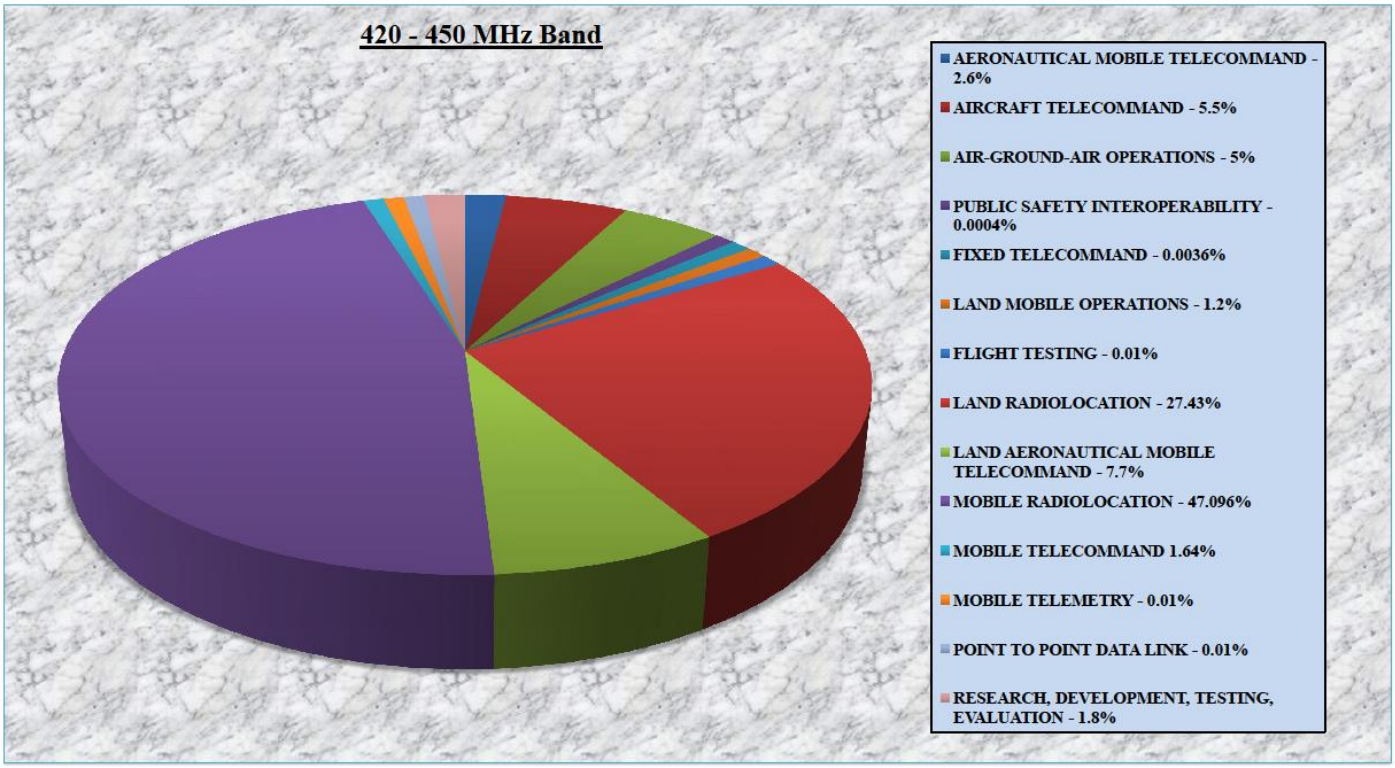
The following table identifies the frequency band, type(s) of allocations(s), types of application, and the number of frequency assignments by agency.

Federal Frequency Assignment Table

420-450 MHz Band																			
SHARED BAND																			
	RADIOLOCATION AMATEUR																		
	TYPE OF APPLICATION																		
AGENCY	AERONAUTICAL MOBILE TELECOMMAND	AIRCRAFT TELECOMMAND	AIR GROUND AIR OPERATIONS	PUBLIC SAFETY INTEROPERABILITY	FIXED TELECOMMAND	FLIGHT TESTING	LAND AERONAUTICAL MOBILE TELECOMMAND	LAND MOBILE OPERATIONS	LAND RADIOLOCATION	MOBILE RADIOLOCATION	MOBILE TELECOMMAND	MOBILE TELEMETRY	POINT TO POINT DATA LINK	SHIP-SHORE-SHIP OPERATIONS	SPACE OPERATIONS	SPACE RESEARCH	RESEARCH DEVELOPMENT TESTING EVALUATION	TOTAL
AF	229	20			8	1	7	9	401	425	3		5	1	4		5	1118
AR					4		31	3	196	162	3		5				5	409
CG										3				3			1	7
DHS								1										1
DOC									3								3	6
DOE		4			3		5			1	2						6	21
DOJ				1				1										2
MC									9	27	2							38
N		33	39				7		37	54	26	1		2			19	218
NASA							12	4		1		10				3	10	40
NSF		1															4	5
TOTAL	229	58	39	1	15	1	62	18	646	673	36	11	10	6	4	3	53	1865

The number of actual systems, or number of equipments, may exceed and sometimes far exceed, the number of frequency assignments in a band. Also, a frequency assignment may represent, a local, state, regional or nationwide authorization. Therefore, care must be taken in evaluating bands strictly on the basis of assignment counts or percentages of assignments.

3b. Percentage of Frequency Assignments Chart



4. Frequency Band Analysis by Application

4a. Fixed-Site Land-Based Radars

The Air Force operates large fixed-site land-based radars in the band 420-450 MHz for the continual ground-based missile warning coverage to defend the United States and Canada. The radars are used for search and surveillance to provide early warning. The radars and associated data processing systems enable the cataloging of objects in space.

Very high transmitter powers and large antennas are required to provide the long-range radar search and tracking of small objects at long distances. The large size of the antennas associated with these radar systems generally limit operations to large land-based installations, although shipborne and airborne radar systems have been deployed with excellent performance. To fulfill their operational missions, the land-based radars are very high powered, with peak powers in the megawatt range with large antennas.

4b. Airborne Radars

The band 420-450 MHz is used by the military for airborne radar surveillance systems. Long-range object detection, acquisition, and tracking are essential functions of these radar systems. Ground-based radars are extremely limited by the radio horizon, and the employment of long-range radars on airborne platforms is an excellent way to extend the capability of individual radar systems. Furthermore, airborne radars can be used at or near the military theaters of operation.

The characteristics of airborne radars in the band 420-450 MHz have been published in Annex 1 of ITU-R Recommendation ITU-R M.1462.[1]

The Department of Homeland Security, Immigration and Customs Enforcement, operates search and surveillance radars in the band 420-450 MHz on aircraft for early warning in their border patrol activities.

4c. Shipborne Radars

Military shipborne surveillance and tracking radars are also operated in the band 420-450 MHz. These radar systems typically operate at sea, although operations in littoral waters for training and in naval ports for testing and maintenance can occur. The characteristics of shipborne radars in the band 420-450 MHz have been published in Annex 1 of ITU-R Recommendation ITU-R M.1462.[2]

4d. Wind Profiler Radar

The National Oceanographic and Atmospheric Administration (NOAA) uses wind profiler radar systems operating in the band 448-450 MHz for weather forecasting and detection by providing real-time wind speed and direction data at various altitudes. The primary role of a wind profiler radar is in weather forecasting and identification of severe wind conditions. The wind profiler radar is a ground-based vertically-directed Doppler radar that measures the wind speed of crosswinds as a function of altitude in the clear atmosphere, where overlying wind streams have substantially different velocities. The wind profiler radar detects scattering from the turbulent media in the clear-air. Clear-air echoes are very weak, so a radar using a high powered transmitter and a large-aperture antenna is required to detect low level return signals from the atmosphere. The propagation characteristics of the atmosphere require that the wind profiler radar systems operate somewhere in the 50-1000 MHz range.

[1] Rec.-R M.1462, "Characteristics of an Protection Criteria for Radars Operating in the Radiolocation Service in the Frequency Range 420-450 MHz," Annex 1, "Technical and Operational Characteristics of Radiolocation Systems Operating in the Frequency Range 420-450 MHz," International Telecommunication Union, Geneva, 2000, at 3.
[2] *Id.* at 3.

Wind profiler radars can operate in one of three frequency ranges depending on the desired resolution of the measurements. NTIA researched and analyzed various candidate frequency bands to accommodate wind profilers and selected the frequency 449 MHz. NTIA Report 91-280 recommends the frequency band 440-450 MHz as one of the best options for replacing the 404 MHz wind profiler radars, and subsequently, the frequency 449 MHz was decided.[3]

Although the wind profiler radars are not direct replacements of radiosondes used in weather forecasting, the wind profiler radars will provide regular, real-time wind speed and direction information. Furthermore, the wind profiler radars will also provide long-term cost savings through automated use, not requiring expendable radiosondes. Although the primary role of a wind profiler radar is for weather forecasting; other applications have been identified including severe wind condition warnings, flight planning, launch vehicle support, and pollution studies.

The NOAA Profiler Network (NPN) has been operating since 1992 with five radars operating on 449 MHz. Systems expansions will begin in 2011 to deploy 35 systems, mostly in the Midwestern states and Alaska. The NPN provides hourly vertical wind profile data that is distributed to the National Weather Service (NWS), environmental research groups, and universities.

4e. Military Position-Location Systems

The military agencies developed and deployed the Position Locating Reporting System (PLRS) in the 1970's. The PLRS is a radiolocation system to determine positions, and it is also used for communications and navigation purposes. The system has been modernized with technological advances over the years, and it has experienced tremendous expansion, including airborne usage.

The military operates the Enhanced Position Location Reporting System (EPLRS) multi-function system in the band 420-450 MHz; and the Air Force operates the airborne system (AEPLRS) in the band. The EPLRS/AEPLRS is a computer controlled-communications network that distributes near real-time tactical information, generally integrated into radio sets, and coordinated by a Network Control Station. EPLRS is used for data distribution and position location and reporting. It enhances command and control of tactical units by providing commanders with the location of friendly units. The EPLRS employs Time Division Multiple Access and uses a frequency hopping, spread spectrum waveform.

[3] "Assessment of Bands for Wind Profiler Accommodation (216–225, 400.15–406, and 420–450 MHz Bands), "National Telecommunications and Information Administration, NTIA Report TR-91-280, G. Patrick and M. Richmond, Sept. 1991.

The military has purchased over 10,000 EPLRS radio sets, and the Marine Corps has over 1,000 sets for operations on land.[4] The Navy has purchased over 100 EPLRS sets for ship installations to support Marine Corps amphibious operations; and the Air Force has procured over 700 AEPLRS sets to support their Situational Awareness Data Link (SADL). The EPLRS and the AEPLRS are important to tactical military operations. In the United States, the EPLRS and AEPLRS systems are used for testing and training purposes.

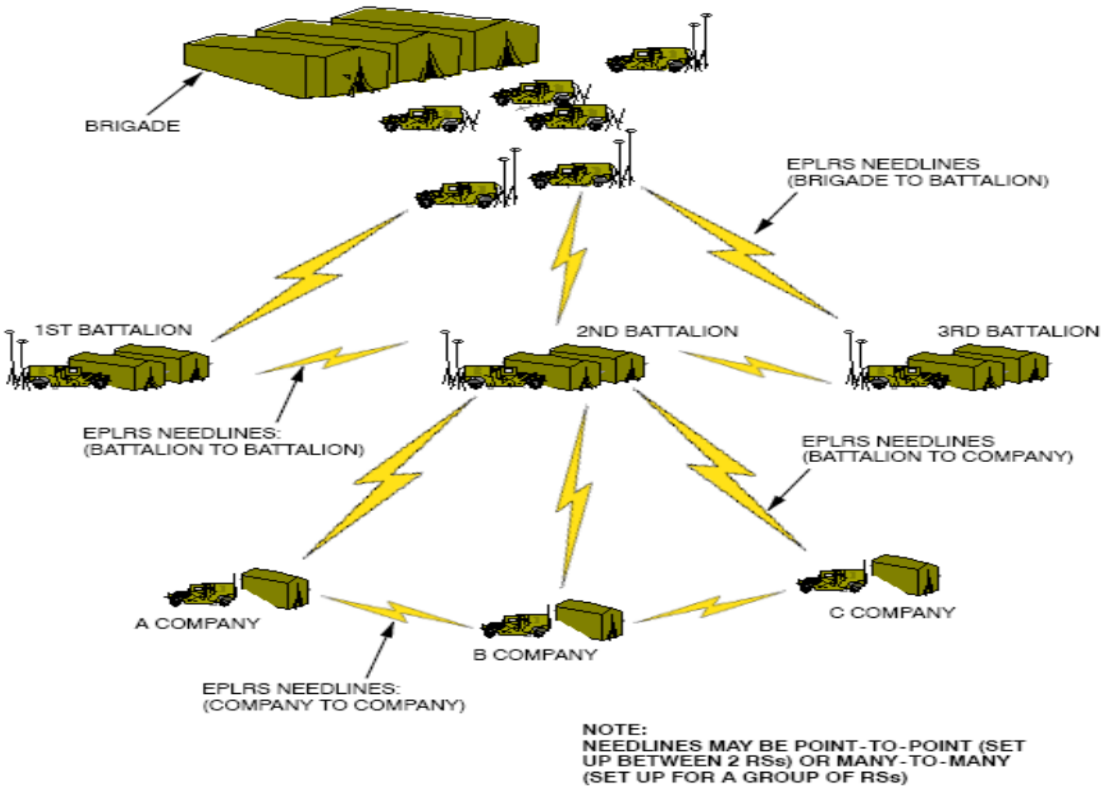


Figure 1. Example of EPLRS Military Tactical Usage in a Battleground or Training Scenario[5]

Figure 1 presents an example of military use of EPLRS by the military in a training scenario. The EPLRS systems provide various forms of multi-hop radio communications between multiple EPLRS Radio Systems (RS), and the devices connected to each RS. The available options include, but are not limited to One-to-One; Many-to-Many; and Few-to-Many types of communications. Simplex and duplex communications are available, and the system can provide short-range and long-range communications.[6]

[4] The data on the numbers of EPLRS and AEPLRS units purchased by the military services is obtained from Project Manager Tactical Reporting Systems, "Enhanced Position Location Reporting System (EPLRS)", Product Manager, Tactical Radios-Current Force, SFAE-C3T-TRC-TR-CF, Fort Monmouth, NJ. See: http://peoc3t.monmouth.army.mil/trcs/pdfs/EPLRS.pdf

[5] *Id.* at 4.

[6] "Enhanced Position Location Reporting System (EPLRS) Model User Guide 7.0," Contract DASW01-03-D-0008, OPNET Technologies, Inc., Bethesda, MD. Jan. 7, 2008, at 1.

4f. Command Control and Flight Termination

The band 420-450 MHz is used for command control and flight-termination functions at missile and rocket launch and test ranges. The band is used for flight control at all rocket and missile launch and test ranges, and at ranges where drones and unmanned aircraft are tested.

4g. Atmospheric Research

NSF supports research of the upper atmosphere through use of incoherent radar facilities. Incoherent scatter radars require a technique that uses high power transmitters. Large antennas allow concentrating the transmitted energy in narrow beams, from which a small fraction is backscattered. Many basic properties of the ionospheric plasma can be determined by combining the measurements with other quantities.

NSF supported development and construction of AMISR, a solid state, phased-array radar operating in the band. The AMISR is currently deployed at Poker Flats, Alaska and a number of foreign locations, but the radar can be easily disassembled and deployed at other locations. Another high power incoherent radar transmitter operates at 430 MHz at Arecibo, Puerto Rico.

4h. Space Operations and Space Research

The Air Force uses the band for controlling satellites and to downlink satellite data. The National Aeronautics and Space Administration uses the band for space research

5. Planned Use

The Federal Government use of land-based, shipborne, and airborne long range search and surveillance radar systems in the band 420-450 MHz will continue for the foreseeable future.

The military use of position location systems operating in the band 420-450 MHz will continue for the foreseeable future.

NOAA is expanding its use of wind profiler radars operating on 449.0 MHz, with an eventual deployment of 35 new radar systems, beginning in 2011.

The command control and flight termination systems operating in this band will continue indefinitely.

The Federal government's use of the 420-450 MHz band for scientific research purposes will continue for the foreseeable future.