

410-420 MHz

1. Band Introduction

This band is used by Federal agencies primarily for conventional and trunked land mobile radio communication systems.¹ Maritime mobile communication systems also operate in this band. Systems used for the collection and transmission of hydrological and meteorological data are permitted to operate in this band on a limited basis. This band is also used for extra-vehicular communications in connection with the manned space program.

2. Allocations

2a. Allocation Table

The frequency allocation table shown below is extracted from the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (NTIA Manual), Chapter 4 – Allocations, Allotments and Plans.²

Table of Frequency Allocations

United States Table

Federal Table	Non-Federal Table	FCC Rule Part(s)
410-420 FIXED US13 MOBILE SPACE RESEARCH (space-to-space) 5.268 G5	410-420 US13	Private Land Mobile (90)

2b. Additional Allocation Table Information

G5 In the bands 162.0125-173.2, 173.4-174, 406.1-410 and 410-420 MHz, use by the military services is limited by the provisions specified in the channeling plans shown in Sections 4.3.7 and 4.3.9 of the NTIA Manual.

US13 The following center frequencies, each with a channel bandwidth not greater than 12.5 kHz, are available for assignment to non-Federal fixed stations for the specific

1. The 410-420 MHz band is part of the 406.1-420 MHz band that is used for Federal land mobile systems.

2. National Telecommunications and Information Administration, *Manual of Regulations and Procedures for Federal Radio Frequency Management*, (NTIA Manual) available at www.ntia.doc.gov/osmhome/redbook/redbook.html,

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purpose of transmitting hydrological and meteorological data in cooperation with Federal agencies, subject to the condition that harmful interference will not be caused to Federal stations:

Hydro Channels (MHz)			
169.425	170.2625	171.100	406.1250
169.4375	170.275	171.1125	406.1750
169.450	170.2875	171.125	412.6625
169.4625	170.300	171.825	412.6750
169.475	170.3125	171.8375	412.6875
169.4875	170.325	171.850	412.7125
169.500	171.025	171.8625	412.7250
169.5125	171.0375	171.875	412.7375
169.525	171.050	171.8875	412.7625
170.225	171.0625	171.900	412.7750
170.2375	171.075	171.9125	415.1250
170.250	171.0875	171.925	415.1750

New assignments on the frequencies 406.125 MHz and 406.175 MHz are to be primarily for paired operations with the frequencies 415.125 MHz and 415.175MHz, respectively.

5.268 Use of the band 410-420 MHz by the space research service is limited to communications within 5 km of an orbiting, manned space vehicle. The power flux-density at the surface of the Earth produced by emissions from extra-vehicular activities shall not exceed $-153 \text{ dB(W/m}^2\text{)}$ for $0^\circ \leq \delta \leq 5^\circ$, $-153 + 0.077(-5) \text{ dB(W/m}^2\text{)}$ for $5^\circ \leq \delta \leq 70^\circ$ and $-148 \text{ dB(W/m}^2\text{)}$ for $70^\circ \leq \delta \leq 90^\circ$, where δ is the angle of arrival of the radio-frequency wave and the reference bandwidth is 4 kHz. No. 4.10 does not apply to extra-vehicular activities. In this frequency band the space research (space-to-space) service shall not claim protection from, nor constrain the use and development of, stations of the fixed and mobile services.

3. Federal Agency Use

3a. Federal Agency Frequency Assignments Table

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

Federal Frequency Assignment Table

410-420 MHz Band								
FEDERAL EXCLUSIVE BAND								
AGENCY	TYPE OF APPLICATION							
	DIFFERENTIAL GLOBAL POSITIONING SYSTEM	LAND MOBILE OPERATIONS	MOBILE SURFACE TELEMETRY	OCEANOGRAPHIC OPERATIONS	SHIP SHORE SHIP OPERATIONS	SPACE RESEARCH	RESEARCH DEVELOPMENT TESTING EVALUATION	TOTAL
	FIXED	MOBILE	SPACERESEARCH					
A		536						536
AF		1266					4	1270
AOTC		8						8
AR		1050						1050
AUSC		1						1
BBG		32						32
CG		892			162			1054
CSB		1						1
CIT		2						2
DHS		539						539
DOC		1149	14	4	2			1169
DOE		733		4				737
DOI		793						793
DOJ		2960						2960
ED		23						23
EEOC		1						1
EPA		22						22
FAA		934						934
FDIC		7						7
FRS		167						167

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GAO		1						1
GPO		5						5
GSA		53						53
HHS		113						113
HR		11						11
HUD		3						3
L		10						10
LC		8						8
NARA		4						4
NASA	1	199			6	2		208
NEA		2						2
NSF		5						5
N		295		8		12		315
MC		64						64
OPM		5						5
SBA		2						2
SEC		13						13
SEN		10						10
SI		2						2
SSA		24						24
S		121						121
T		63						63
TDA		1						1
TVA		386						386
USCP		4						4
USPC		3						3
USPS		1205						1205
USTR		1						1
VA		607						607
TOTAL	1	14336	14	8	172	6	18	14555

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

The following chart displays the percentage of frequency assignments for the applications operating in the frequency band 410-420 MHz. This band contains frequency assignments in the Government Master File (GMF) for the fixed, mobile, and space research services. As shown in the chart, most of the frequency assignments are for communication systems (voice and data) that operate in the land mobile service. The agencies with the largest number of frequency assignments in this band in the GMF include the: Department of Justice, U.S. Postal Service, Department of the Air Force, U.S. Coast Guard, Department of the Army, Department of Commerce, Department of Interior, Federal Aviation Administration, Department of Homeland Security, Department of Energy, and Department of Agriculture.

A few of the frequency assignments are for systems used for maritime mobile (ship-to-shore) communication.

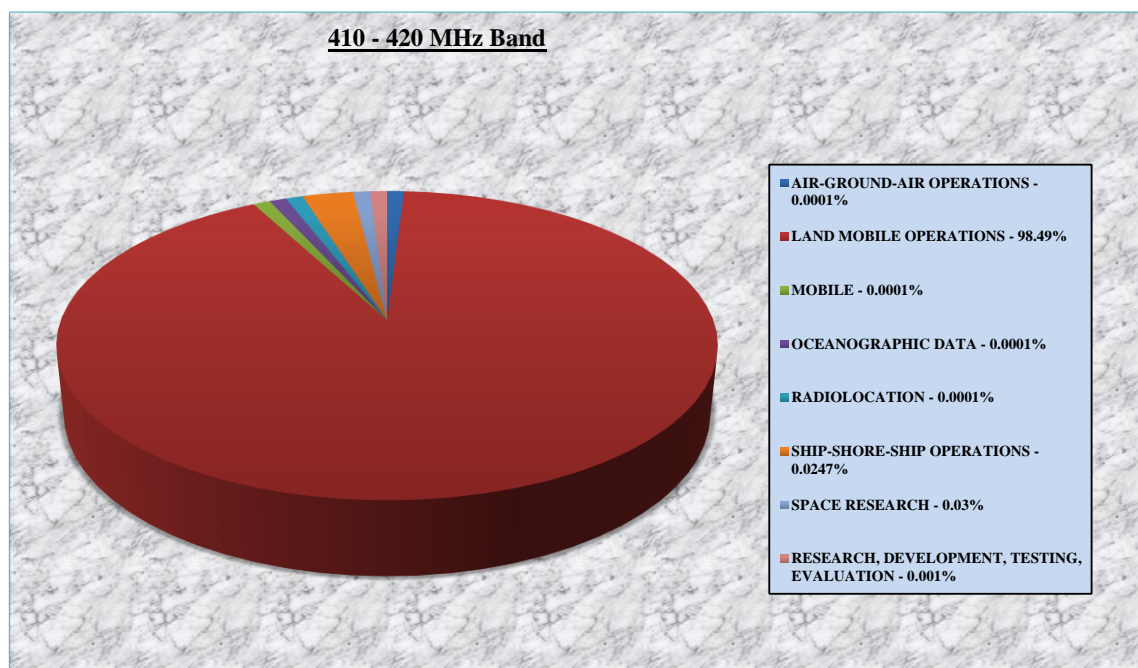


Figure 1. Percentage of Frequency Assignments By Application

4. Frequency Band Analysis By Radio Service

4a. Land Mobile Service

The land mobile service is defined as a mobile service between base stations and land mobile stations, or between land mobile stations. The Federal agencies use this band for conventional and trunked land mobile voice and data communications systems in support of mail delivery, law enforcement, security, public safety, transportation, natural resources, emergency and disaster, and medical and administrative duties. The communication systems operating in this frequency band are used for promoting public safety and efficiency in traveling via air, water, and land; interdicting entry of illegal persons and substances into the United States; establishing communications between disaster areas and relief forces; ensuring the swift search and rescue of human life; protecting the national forests, parks and farmlands; bringing to justice perpetrators of Federal crimes; the delivery of mail, and ensuring the security of energy generation and distribution networks. These systems are used for Federal emergency response and public safety organizations which conduct large-scale exercises to prepare for and respond to a wide variety of emergencies and disasters.

Federal agencies operate wildlife tracking systems and systems used for remote control and remote interrogation.

The Coast Guard operates communication systems in this band are used for the coordination of maritime rescue operations. Rescue 21 is an advanced search and rescue communication system that will be used by the Coast Guard to more effectively locate and assist boaters in distress. Rescue 21 will consist of approximately 300 coastal communication sites nationwide, operating in the 162-174 MHz and 406.1-420 MHz bands, with communication consoles in over 250 Coast Guard facilities, communication equipment on over 650 Coast Guard vessels, and over 3000 portable radios.

The National Aeronautics and Space Administration and the Department of Defense use the frequency of 416.5 MHz for range safety operations (i.e., command destruct, flight termination) at test ranges as specified in Section 8.2.54 of the NTIA Manual.

The Department of Commerce National Weather Service operates systems in this band for gathering and disseminating metrological data. There are frequencies in this band designated under footnote US13 that are shared with local governments and used for transmitting hydrological and meteorological data.

Federal agencies also have mission requirements to operate communication systems on board aircraft on an intermittent basis in the 410-420 MHz band.³ These may involve, for example, situations where Federal law enforcement officials may have to board an aircraft during a pursuit situation.⁴

After January 1, 2008, all land mobile systems in the 406.1-420 MHz band were required to migrate to 12.5 kHz narrowband technology. Section 4.3.9 of the NTIA Manual of Regulations and Procedures for Federal Radio Frequency Management (NTIA Manual) specifies the channel plan where frequencies in the 406.1-410 MHz band are paired with frequencies in the 410-420 MHz band for duplex operation. This plan also provides for single frequency operation using frequencies in the 410 to 420 MHz band. . To date, not all agencies have complied with the migration to 12.5 kHz technology for various reasons. Table 2 provides a distribution of the emission bandwidths for the frequency assignments in the 410-420 MHz band. NTIA has instituted specific processes to accommodate continued use of 25kHz channels to prevent interference to other agencies implementing and operating narrowband systems.⁵

Table. 2 Distribution of Emission Bandwidths in the 410 to 420 MHz Band

Emission Bandwidth	Percentage of Frequency Assignments
Less than 8 kHz	0.4
12.5 kHz	75.4
25 kHz	24.1
Greater than 25 kHz	0.1

Unlike commercial communication systems where licensees are issued based on geographic areas designated by the Federal Communications Commission (e.g., Major Trading Area, Basic Trading Area) Federal agencies are authorized to use a frequency under specified conditions, which place limitations on the transmission characteristics (e.g., power, antenna gain) and the operational area. The operational area for a land mobile system can be specified in terms of the base station location (latitude and longitude) and a radius of operation for the associated mobile and portable stations. For

3. The 410-420 MHz band is allocated for the fixed and mobile services. The mobile service consists of the aeronautical, land, and maritime mobile services.

4. NTIA Manual, 8.2.56.

5. NTIA Manual, 4.3.7.

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agencies with intermittent communication requirements where the location is unknown the operational area can be specified: on a nationwide basis; within a state or multiple states; or within a geographic area. For example, Federal law enforcements agents performing undercover operations or providing protection as the President travels throughout the country must have communications capabilities for a limited duration (e.g., two to three days) typically on short notice (e.g., 24 hours or less). Federal emergency response and public safety organizations must respond to a wide variety of emergencies and disasters, such as hurricanes, wildfires, earthquakes, and industrial accidents, that can occur at anytime throughout the country. In order to address these intermittent radio communications requirements a land mobile system is authorized under an area frequency assignment.

In the 406.1-410 MHz band, a channel plan is employed to distribute channels among the Federal agencies. Subject to agreement, channels identified for one agency may be used by another agency. There are some channels designated for smaller agencies that do not have designated channels in the plan or for use when an agency cannot find an available channel within the channel plan. Sections 4.2.3 and 4.2.4 of the NTIA Manual designate channels in the 410-420 MHz band that are identified for use by all Federal agencies under certain geographic restrictions without a specific frequency assignment, and with no protection from interference. In the Federal spectrum management process, the channel plan provide a structure within which agencies select frequencies providing a certain degree of flexibility that support nationwide operations. This plan does not convey a right to or ownership of the identified channels and agencies must still obtain frequency assignments from NTIA to use their identified channels.

Section 4.3.16 of the NTIA Manual designates frequencies in the 410-420 MHz band that are available for assignment to all Federal agencies to satisfy law enforcement and public safety incident response interoperability communication requirements.⁶ The frequencies are also available to non-Federal entities for interoperability communication to enable joint Federal and non-Federal operations for law enforcement and incident response.

In the early 1990s, NTIA recognized that the use of trunked radio technology could increase the efficiency and utility of spectrum resources within the Federal land mobile bands. The Military Departments individually invested significant funds supporting fixed facility infrastructures requirements at many bases, posts, camps, and stations and continue to rely on this proven technology. In an effort to increase the use of trunking by the Federal agencies, NTIA sponsored the Federal Specialized Mobile Radio (FedSMR) program. The FedSMR program uses frequencies in the 406.1-420 MHz band to offer

6. NTIA Manual 4.3.16.

trunked radio service in five urban areas on the East Coast.⁷ The purpose of FedSMR program was to provide spectrum efficient trunked radio communications to Federal agencies. However, the FedSMR program has seen limited success, and is primarily used by Federal agencies that are not heavy users of the land mobile bands. For example, in Washington, D.C., the main users of FedSMR are the Smithsonian Institution, the National Archives, the National Zoo and the U.S. Holocaust Memorial. The FedSMR program currently supports over 2100 subscribers.⁸

Federal agencies are examining the development of shared trunked radio systems to satisfy their communication requirements. Because of the limited number of users, a dedicated Federal trunked radio system may only be viable in heavily populated metropolitan areas. However if Federal users were able to share trunked systems in the less populated areas with non-Federal users this would maximize spectrum usage. The lack of clear regulatory policy and procedures has limited to some extent the implementation of trunked networks that are shared by Federal and non-Federal users. To begin addressing this problem Section 8.2.47 was added to the NTIA Manual providing guidance for shared Federal and non-Federal land mobile systems.

Along the Mexican and Canadian borders the United States must share the 410-420 MHz band. Within a 90.1 mile (145 kilometers) sharing zone along the United States and Mexican border the 410-420 has been divided into two equal sub-bands. The United States can operate land mobile systems in the Mexican sub-band in the sharing zone if agreed to power flux-density limits are met. Within a 75 mile sharing zone along the United States and Canadian border, the 410-420 MHz band is equally divided into 12.5 kHz band segments. The United States is not permitted to operate land mobile systems in the Canadian band segments, thereby cutting in half the availability of channels in the border area. Additional details regarding the sharing arrangements in the 410-420 MHz band with Mexico and Canada can be found in Chapter 3 of the NTIA Manual. Given the increasing need for communications for Federal law enforcement and security along these two borders, the limitations on the access to the 410-420 MHz band makes identification of assignable channels difficult.

7. The original FedSMR program included systems in the following cities: Boston, MA, New York, City, Baltimore/Washington DC, Philadelphia, PA, and Norfolk, VA. Currently FedSMR only operates in Washington, DC; Baltimore, MD; and Norfolk, VA.

8. A breakdown of the current subscribing agencies in the Washington DC area is provided in the United States Department of Commerce *Strategic Spectrum Plan 2007 Version*, at 24 available at http://www.ntia.doc.gov/osmhome/spectrumreform/Spectrum_Plans_2007/Commerce_%20Strategic_%20Spectrum_%20Plan_Nov2007.pdf.

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Federal agencies use commercial services such as the cellular phone service, personal communications service, and BlackBerry devices for non-critical administrative functions. In many cases, however, due to remote locations or unique mission requirements, the use of commercial services is not possible. Often no other reliable commercial services exist in National Forests or on military reservations or other areas where Federal agencies require service. Where commercial service is available, it may not penetrate buildings or other areas where Federal agencies require indoor coverage. The functions performed by many Federal agencies require rapid push-to-talk connections, security and broadcast capabilities which are not provided by commercial service providers. In addition, during emergencies, commercial services may be inoperable, or overwhelmed by commercial traffic. Commercial services often cannot satisfy the encryption requirements of many Federal agencies. For these reasons, many agencies operate their own land mobile systems to support mission essential communication functions. In order to implement cost efficient land mobile systems (e.g., fewer number of base stations) that provide coverage over large geographic areas and in buildings, these systems must operate below 1 GHz.⁹ The 410-420 MHz band is especially suited for urban environments due to lower background noise and the ability to propagate effectively along urban streets and penetrate buildings for indoor coverage.

Typical transmitters at fixed locations (base and repeater stations) have power levels that are in the range of 50 to 110 watts, with some lower power levels for transmitters providing short range communications. Mobile transmitters have similar or lower power levels. Portable transmitters typically have a transmitter power of 6 watts or less. Figure 2 shows the distribution of transmitter power levels for the frequency assignments in the 410-420 MHz band. Many assignments include provision for base, mobile, and portable transmitters, and thus there can be various transmitter power levels.

9. The radiowave propagation losses are lower at lower frequencies, which mean the coverage area is larger.

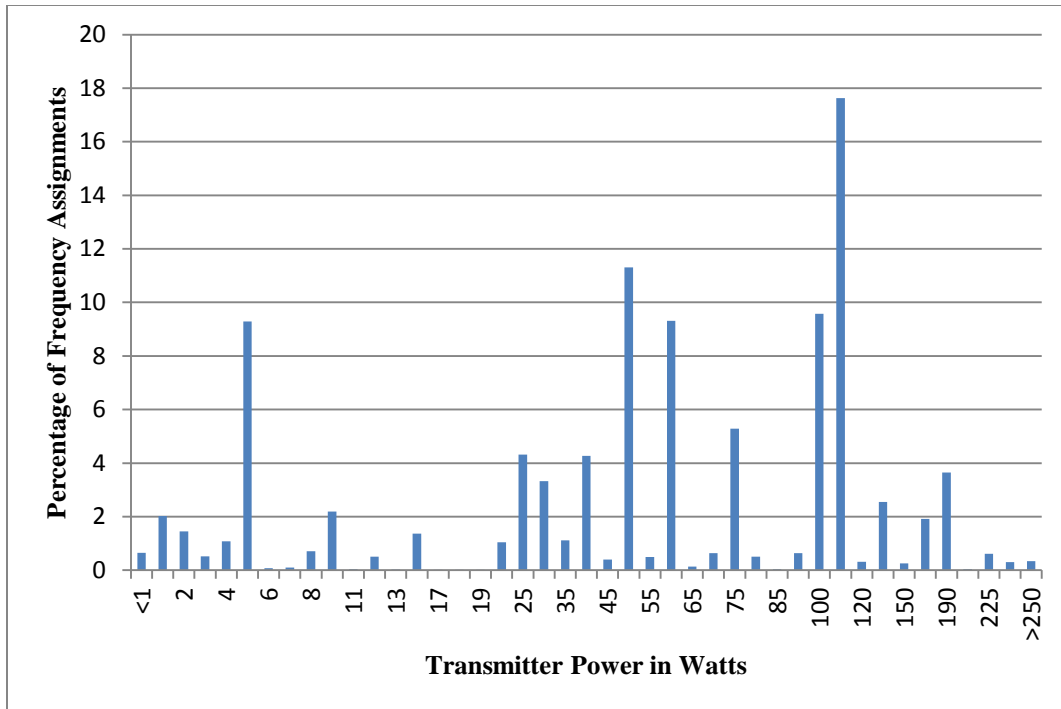


Figure 2. Distribution of Fixed Station Transmitter Power Levels in the 410-420 MHz Band

Figure 3 shows the distribution of antenna heights above ground level for the frequency assignments in the 410-420 MHz band. As shown in Figure 3, over 50 percent of the frequency assignments have an antenna height of 20 meters or less, and 75 percent are less than 40 meters. Typical base station installations would be on buildings or towers. Mobile antenna heights are typically at 1 or 2 meters, and are generally mounted on vehicles. Portable units may be less than 2 meters, but can be considerably higher when used within a building or an aircraft.

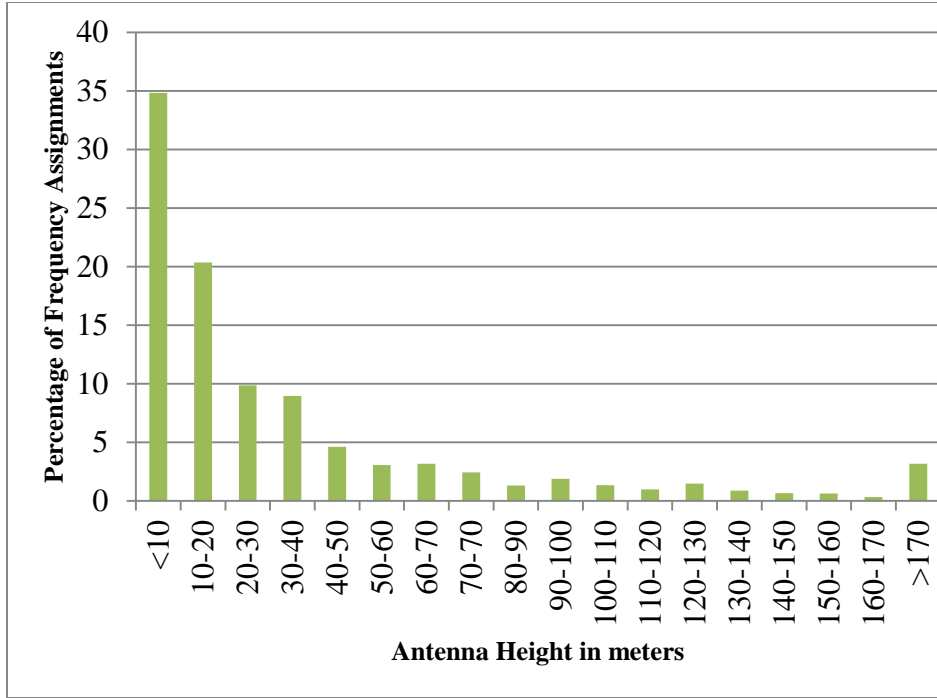


Figure 3. Distribution of Fixed Station Antenna Heights Above Ground Level in the 410 – 420 MHz Band

Figure 4 shows the distribution of antenna gain values for the frequency assignments in the 410-420 MHz band. Most base station antennas have gain values ranging from 3 to 9 dBi, and typically employ collinear and yagi antennas.¹⁰ Mobile antennas typically have an omni-directional gain of 3 dBi. Portable units use omni-directional whip antennas, often with negative gain.

10. Antennas are chosen for the shape of the coverage area to minimize required transmit power and to minimize interference to other systems.

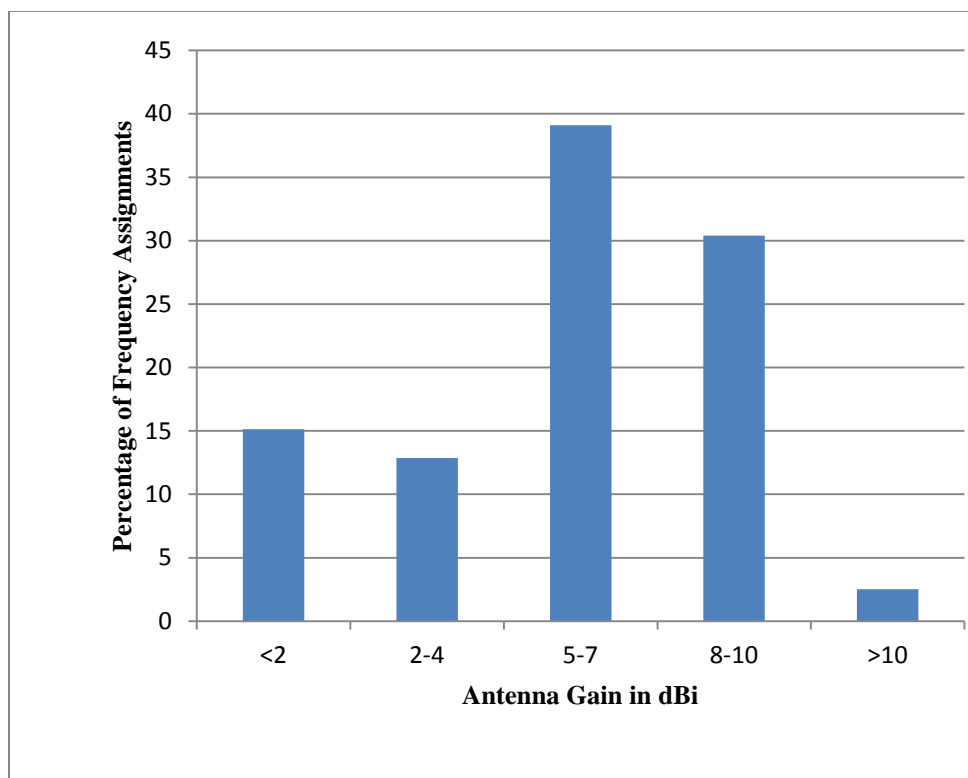


Figure 4. Distribution of Antenna Gains in the 410-420 MHz Band

4b. Fixed Service Systems

The fixed service is defined as a radiocommunication service between specified fixed points. The Federal agencies operate a small number of fixed point-to-point communication systems in the 410-420 MHz band. These systems are used for backhaul traffic to and from repeaters and ship-to-shore communication systems. Fixed service systems operating in this band also include base station to repeater, repeater to repeater, or repeater to base station systems used in conjunction with land mobile systems.

4c. Space Research (Space-to-Space) Service

The space research service is a radiocommunication in which spacecraft or other objects in space are used for scientific or technological research purposes. The National Aeronautics and Space Administration operates systems in support of Extra-Vehicular Activity communications for manned space program and other space related efforts in this band. The systems are used for communications between the crew members and for relaying telemetry data to the main space craft.

5. Planned Use

The Federal use of this band for voice communication systems operating in the land mobile service is expected to remain the same; however, if additional requirements for transmitting data are developed, the demand for spectrum will increase.

Trunked radio systems that are shared by multiple Federal agencies may provide some relief of spectrum crowding in this band.

As commercial systems expand coverage and provide additional capabilities, Federal agencies may be able to use these services to satisfy communication requirements for limited administrative functions; however, there will still be a continuing requirement for the agencies to operate land mobile systems to provide communication in support of their specific missions.

The deployment of land mobile communication systems that are shared between Federal and non-Federal users are expected to increase the demands for spectrum in this band.

The fixed service use in this band is expected to continue indefinitely.

The use of this band for flight termination systems will be discontinued in 2010.

The space research (space-to-space) in this band is expected to continue indefinitely.