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CHAPTER 5

Federal Communications Commission  
Office of the Secretary

06-123

**Spectrum Standards**

**5.1 GENERAL**

**5.1.1 Introduction**

This chapter contains Radio Frequency Spectrum Standards applicable to Federal radio stations and systems.

A radio frequency spectrum standard is a principle, rule, or criterion that bounds the spectrum-related parameters, and characteristics, of a radio station or system for the purpose of managing the Radio Frequency Spectrum. Application of spectrum standards include:

1. assisting consideration of telecommunications systems for the National spectrum review process (Chapter 10),
2. systems planning, design, and procurement,
3. consideration of protection devices for the transmission of classified, and/or sensitive but unclassified information, and their spectrum needs.

The standards contained herein are those associated with the potential impact of any system or station on the normal operation of other systems or stations.

If spectrum standards are not specified in this chapter, the appropriate provisions of the ITU Radio Regulations normally shall apply. If spectrum standards are not specified in this chapter or in the ITU Radio Regulations, the appropriate criteria contained in current Recommendations of the ITU-R shall be used as guidelines.

Compliance with standards contained in this chapter may not preclude the occurrence of interference. Therefore, compliance with the standards does not obviate the need for cooperation in resolving and implementing engineering solutions to harmful interference problems (see Section 2.3.7).

**5.1.2 Consequences of Nonconformance with the Provisions of this Chapter**

In any instance of harmful interference caused by nonconformance with the provisions of this chapter, the responsibility for eliminating the harmful interference normally shall rest with the agency operating in nonconformance.

**5.1.3 Agency Procurement Specifications**

Procurement specifications shall, as a minimum, assure compliance with the appropriate requirements of this chapter. Agencies may promulgate more stringent criteria for their own use.

**5.1.4 Measurement Methods**

Spectrum standards for this chapter are referenced to measurement methods in Annex M. Measurement methods referenced in the annex are provided only for clarification and uniform interpretation of the standards. In cases of harmful interference, the agencies involved are expected to utilize these or equivalent, mutually agreed upon, methods of measurement for resolution of any disagreement concerning compliance with the standards. Agencies may, at their discretion, use these measurement methods as minimum qualification test procedures, e.g., as part of factory test procedures.

**5.1.5 Terminology**

Definitions of Special Terms, Services, and Stations are contained in Chapter 6.

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## Desired Relationship of Occupied Bandwidth to Necessary Bandwidth

The emission designator(s) associated in the authorization for any particular frequency assignment specifies the value of the necessary bandwidth of emission for the particular type(s) of transmission permitted. The values of necessary bandwidth are generally idealized. All reasonable effort shall be made in equipment design and operation by Government agencies to maintain the occupied bandwidth of the emission of any authorized transmission as close to the necessary bandwidth as is reasonably practicable. (See Annex J for additional information concerning the method of calculating necessary bandwidth.)

### Authorized Bandwidth

For purposes of this Manual, the term “authorized bandwidth” is defined as the necessary bandwidth (bandwidth required for the transmission and reception of intelligence) and does not include allowance for transmitter drift or doppler shift. See, in addition, Chapter 6 for the definitions of special terms including authorized bandwidth and mean power.

### Resolution Bandwidth

Resolution bandwidth is the 3 dB bandwidth of the measurement system used, e.g., in power spectral density measurements. The appropriate resolution bandwidth of the measurement system varies depending on the modulation type and frequency band but should not be greater than the necessary bandwidth of the transmitter being measured.

### Power (RR)

Power is designated as:

peak envelope power (PX or pX)

mean power (PY or pY)

carrier power (PZ or pZ)

p denotes power expressed in watts

P denotes power in dB relative to a reference level

### Logarithm

In this chapter,  $\text{Log} = \text{Log}_{10}$

## 5.2 FREQUENCY TOLERANCES AND UNWANTED EMISSIONS

### 5.2.1 Table of Frequency Tolerances

Frequency tolerance standards applicable to Federal stations are specified in Table 5.2.1. The table specifies standards for station types arranged within frequency bands.

Transmitter frequency tolerance is the maximum permissible departure from the assigned frequency by the center frequency of the frequency band occupied by an emission.

Receiver frequency tolerance is the maximum permissible departure of the center frequency of the IF passband from the desired center frequency of the IF passband.

In Table 5.2.1 the units for frequency tolerance are expressed in ( $\pm$ ) parts per million (ppm) unless otherwise stated. For the purpose of this Manual, the " $\pm$ " symbol will always be implied. For example,  $\pm 10$  ppm will appear as 10 ppm.

The power shown for the various categories of stations is the peak envelope power for single sideband transmitters and the mean power for all other transmitters, unless otherwise indicated. (RR)

**Table 5.2.1 Table of Frequency Tolerances**

Frequency Band 9 kHz to 535 kHz	Frequency Tolerance
<b>I. Fixed Stations</b>	
A. 9 - 50 kHz	100
B. 50 - 535 kHz	50
<b>II. Mobile Stations</b>	
<b>A. Aeronautical Stations</b>	
1. Aeronautical	50
2. Aircraft	50
3. Survival craft	500
<b>B. Land Mobile Stations</b>	
1. Base (TIS) (530 kHz)	100 Hz
2. Land Mobile	20
3. Direct Printing telegraph and data.	10 Hz
<b>C. Maritime Mobile Stations</b>	
1. Coast	100
2. Ship	
a. Direct printing telegraph and data.	10 Hz
b. Other than above	200
3. Ship Emergency Transmitters	500 (a)
4. Survival Craft	500
<b>III. Radiodetermination Stations</b>	100

Frequency Band 535 kHz to 1605 kHz	Frequency Tolerance
<b>I. Broadcasting Stations</b>	10 Hz (b)

Frequency Band 1605 kHz to 4000 kHz	Frequency Tolerance
<b>I. Fixed Stations</b>	
A. All, except SSB	10
B. SSB radiotelephone	20 Hz
<b>II. Mobile (Aeronautical, Land, Maritime) Stations</b>	
<b>A. Aeronautical Mobile Stations</b>	
1. Aeronautical	
a. $pY \leq 200W$	20
b. $pY > 200W$	10
c. SSB radiotelephone	10 Hz (c)
2. Aircraft	
a. All except SSB	20
b. SSB radiotelephone	20 Hz (d)
<b>B. Land Mobile Stations</b>	
1. Base	
a. $pY \leq 200W$ , except SSB	20 (e)
b. $pY > 200W$ , except SSB	10
c. SSB radiotelephone	20 Hz
2. Land Mobile	
a. All except SSB	50
b. SSB radiotelephone	20 Hz
<b>C. Maritime Mobile Stations</b>	
1. Coast	
a. $pY \leq 200W$ , except c and d below	100
b. $pY > 200W$ , except c and d below	50
c. SSB Radiotelephone	20 Hz
d. Direct printing telegraph and data	10 Hz
2. Ship	
a. All except below	40 (f)
b. SSB radiotelephone	40 Hz
c. Direct printing telephony and data	40 Hz
3. Survival Craft	
a. EPIRB	100
<b>D. Radiodetermination Stations</b>	
1. Radionavigation	
a. $pY \leq 200W$	20
b. $pY > 200W$	10
2. Radiolocation	
	10
<b>E. Broadcasting Stations</b>	
	10 Hz

Frequency Band 4 to 29.7 MHz	Frequency Tolerance
I. Fixed Stations	
A. $pY \leq 500W$ , except C and D below	20
B. $pY > 500W$ , except C and D below	10
C. SSB/ISB Radiotelephone	20 Hz
D. Class F1B emissions	10 Hz
II. Mobile (Aeronautical, Land, Maritime) Stations	
A. Aeronautical mobile stations	
1. Aeronautical	
a. $pY \leq 500W$ , except SSB	30
b. $pY > 500W$ , except SSB	10
c. SSB Radiotelephone	10 Hz (c)
2. Aircraft	
a. All except SSB	30
b. SSB Radiotelephone	20 Hz
B. Land mobile stations	
1. Base	
a. $pY \leq 500W$ , except SSB	20
b. $pY > 500W$ , except SSB	10
c. SSB Radiotelephone	20 Hz
2. Land Mobile	
a. All except SSB	30
b. SSB Radiotelephone	20 Hz
C. Maritime mobile stations	
1. Coast	
a. SSB radiotelegraph	20 Hz
b. Direct printing telegraph and data	10 Hz
c. Other than above	20 Hz (g)
2. Ship	
a. Class A1A emission	10
b. Other than A1A emissions	
(1) SSB Radiotelephone	50 Hz
(2) Direct printing, telegraphy and data	10 Hz
(3) Other than above	50 Hz (h)
3. Survival craft	50
III. Broadcasting stations	2
IV. Space and earth stations	20

Frequency Band 29.7 to 108 MHz	Frequency Tolerance
I. Fixed stations	
A. 29.7-50 MHz, single-channel analog/digital FM/PM	5 (i)
B. Other than above	
1. $pY \leq 10W$	20
2. $pY > 10W$	5
II. Mobile (Aeronautical, Land, Maritime) Stations	
A. 29.7- 50 MHz, analog and digital FM/PM	
1. Land and mobile	5 (i)
2. Portables	20 (i)
B. Other than above	
1. $pY \leq 10W$	20 (j)
2. $pY > 10W$	5
III. Aeronautical Radionavigation stations (Marker beacons on 75 MHz)	50
IV. Broadcasting stations	
A. TV sound and vision	500 Hz (k)(l)
B. Other than TV	
1. $pY \leq 10 W$	3000 Hz
2. $pY > 10 W$	2000 Hz
V. Space and earth stations	20

Frequency Band 108 to 470 MHz	Frequency Tolerance
I. Fixed stations.	
A. 108 - 406.1 MHz, all except below.	5
B. 138 - 150.8 and 162 - 174 MHz, narrowband analog /digital FM/PM except C below	1.5
C. 162 - 174 MHz, low power and splinter channels	
1. $pY \leq 10W$	5
2. $pY > 10W$	2
D. 406-470 MHz	
1. 406.1-420 MHz	
a. Multi-Channel	2.5 (m)(n)
b. Analog/Digital FM/PM	
(1) Wideband	2.5 (i)
(2) Narrowband	1.0 (i)

Frequency Band 108 to 470 MHz	Frequency Tolerance
2. Other than above a. $pY \leq 10$ W b. $pY > 10$ W	5 2.5
II. Mobile (Aeronautical, Land, Maritime) Stations	
A. Aeronautical mobile stations	
1. Aeronautical	
a. Analog/digital FM/PM (1) 162-174 MHz (a) Wideband (b) Narrowband (2) 406.1-420 MHz (a) Wideband (b) Narrowband b. Other than above	5(i) 1.5(o) 2.5 (i) 1.0 (o) 20
2. Aircraft	
a. 156-174 and 406.1-420 MHz (1) 162-174 MHz analog/digital FM/PM (a) Wideband (b) Narrowband (2) 406.1-420 MHz analog/digital FM/PM (a) Wideband (b) Narrowband b. Other than above	5 5(i) 2.5 (o) 5(i) 2.5(o) 20
B. Land mobile stations	
1. Base	
a. 108 - 406.1 MHz, all except below	5
b. 138-150.8 and 162 - 174 MHz analog/digital FM/PM (1) Wideband (2) Narrowband	5(i) 1.5(o)(v)
c. 162 - 174 MHz, splinter channel (1) $pY \leq 10$ W (2) $pY > 10$ W	5 2
d. 220 - 222 MHz, single-channel, narrowband	0.1
e. 406.1 - 470 MHz  (1) 406.1 - 420 MHz analog/digital FM/PM (a) Wideband (b) Narrowband	2.5 (i) 1.0 (o)

Frequency Band 108 to 470 MHz	Frequency Tolerance
(2) Other than above (a) $pY \leq 10$ W (b) $pY > 10$ W	5 2.5
2. Land Mobile	
a. 138-150.8 and 162-174 MHz, all except below	5 (j)
b. 138-150.8 and 162-174 MHz, analog/digital FM/PM (1) Wideband (2) Narrowband	5 (i) 2.5 (o)
c. 162 - 174 MHz (splinter channels) (1) $pY \leq 10$ W (2) $pY > 10$ W	5 2
d. 220 - 222 MHz (single channel, narrowband)	1.5 (p)
e. 406.1- 420 MHz analog/digital FM/PM (1) Wideband (2) Narrowband (a) portable ( $pY = 5$ watts) (b) all others	5 (i) 2.5 (o)(w) 2 (o)
f. Other than above	15
C. Maritime mobile stations	
1. Coast	
a. 150.8 - 162.0125 MHz (1) FM (a) $pY < 3$ W (b) $3$ W $\leq pY \leq 50$ W  (2) Other than above (a) $pY < 3$ W (b) $3$ W $\leq pY < 100$ W (c) $pY \geq 100$ W	100 (q) 50 (q) 10 5 2.5
b. Outside of 150.8 - 162.0125 MHz (1) 162 - 174 MHz, analog/digital FM/PM (a) Wideband (b) Narrowband  (2) 406.1 - 420 MHz, analog/digital FM/PM (a) Wideband (b) Narrowband  (3) Other than above	5 (i) 1.5 (o) 2.5 (i) 1.0 (o) 10

Frequency Band 108 to 470 MHz	Frequency Tolerance
2. Ship	
a. 150.8 - 162.0125 MHz (FM, pY < 25 W)	100 (q)(r)
b. 156 - 162 MHz	10
c. 162 - 174 MHz, analog/digital FM/PM	
(1) Wideband	5 (i)
(2) Narrowband	2.5 (o)
d. 406.1 - 420 MHz, analog/digital FM/PM	
(1) Wideband	5 (i)
(2) Narrowband	2 (o)
(3) Other than above	5
e. 450 - 470 MHz	5
f. Outside above bands	20 (r)
3. Survival craft	
a. 156 - 174 MHz	10 (r)
b. Other than above	20 (s)
III. Radiodetermination Stations	
A. Radionavigation stations	
1. Radar	50
2. Other than radar	20
B. Radiolocation stations	
1. Radar	50 (t)
2. Other than radar	50
IV. Broadcasting Stations	
A. TV sound and vision	500 Hz (k)(o)
B. Other than TV	2000 Hz
V. Space and Earth Stations	20

Frequency Band 470 to 960 MHz	Frequency Tolerance
I. Fixed Stations	
A. Point-to-Multipoint (932 - 932.5, 941 - 941.5 MHz)	1.5 (n)
B. Point-to-Point (932.5 - 935, 941.5 - 944 MHz)	2.5 (n)
C. Other than above	5
II. Mobile (Aeronautical, Land, Maritime) Stations	
A. Land (Aeronautical, Base, Coast)	5
B. Mobile (Aircraft, Land Mobile, Ship)	
1. pY ≤ 3 W	20

Frequency Band 470 to 960 MHz	Frequency Tolerance
2. pY > 3 W	5
III. Radiolocation Stations	400
IV. Broadcasting Stations	
A. TV Broadcasting	500 Hz (k)(i)
B. TV Broadcasting Translators	200
V. Space and Earth Stations	20

Frequency Band 960 to 1215 MHz	Frequency Tolerance
I. Aeronautical Radionavigation Stations	
A. Aeronautical and Ship Stations	10
B. Aircraft	50
II. IFF/ATCRBS of similar type station	
A. Interrogators 1030 MHz	200 kHz
B. Transponders 1090 MHz	3 MHz

Frequency Band 1215 to 10500 MHz	Frequency Tolerance
I. Fixed Stations	
A. pY ≤ 100 W	
1. 1215 to 4000 MHz	30 (n)
2. 4 to 10500 MHz	50 (n)
B. pY > 100 W	10 (n)
II. Mobile (Aeronautical, Land, Maritime) Stations	
A. 1215 to 2450 MHz	20
B. 2450 to 4000 MHz	30
C. 4000 to 10500 MHz	50
III. Radiodetermination Stations	
A. 1215 to 2450 MHz	500
B. 2450 to 4000 MHz	800
C. 4000 to 10500 MHz	1250
IV. Space and Earth Stations	20

Frequency Band 10.5 to 30 GHz	Frequency Tolerance
I. Fixed Stations	
A. 21.2 - 23.6 GHz	300
B. 21.8 - 22 GHz and 23 - 23.2 GHz	500 (u)
C. Other than above	50 (n)
II. Mobile (Aeronautical, Land, Maritime) Stations	100

Frequency Band 10.5 to 30 GHz	Frequency Tolerance
III. Radiodetermination Stations	2500
IV. Space and Earth Stations	50

Frequency Band Greater than 30 GHz	Frequency Tolerance
I. Fixed Stations	75
II. Mobile (Aeronautical, Land, Maritime) Stations	150
III. Radiodetermination Stations	5000
IV. Space and Earth Stations	75

### Notes For Frequency Tolerances

(a) If the emergency transmitter is used as the reserve transmitter for the main transmitter, the tolerance for ship station transmitters applies.

(b) In the area covered by the North American Regional Broadcasting Agreement (NARBA), the tolerance of 20 Hz may continue to be applied.

(c) 20 Hz is applicable to other than Aeronautical Mobile (R) frequencies.

(d) The tolerance for aeronautical stations in the Aeronautical Mobile (R) service is 10 Hz.

(e) Travelers Information Stations (TIS) on 1630 kHz have a tolerance of 100 Hz.

(f) For A1A emissions the tolerance is 50 ppm.

(g) For A1A emissions the tolerance is 10 ppm.

(h) For ship station transmitters in the band 26.175-27.5 MHz, on board small craft, with a carrier power not exceeding 5 W operating in or near coastal waters and utilizing A3E or F3E and G3E emissions, the frequency tolerance is 40 ppm.

(i) This tolerance is based on emissions with an analog input and a necessary bandwidth of 16 kHz. Stations with digital inputs may require a different necessary bandwidth, but still must meet all other standards. It does not apply to military equipment used for tactical and/or training operations, FM wireless microphone systems whose  $pY < 0.1$  watts, equipment on splinter channels, and fixed stations with multichannel emissions. Also, in the band 162-174 MHz, it does not apply

to equipment operating on channels designated for low power systems as set forth in Sections 4.3.8 and 5.3.6, or NOAA Weather Radio Transmitters. The measurement method for the receiver frequency tolerance is contained in paragraph 2.1.2.E.1 of Annex M.

(j) 50 ppm applies to wildlife telemetry with mean power output less than 0.5 W.

(k) In the case of television stations of:

(1) 50 W (vision peak envelope power) or less in the band 29.7-100 MHz;

(2) 100 W (vision peak envelope power) or less in the band 100-965 MHz and which receive their input from other television stations or which serve small isolated communities. It may not, for operational reasons, be possible to maintain this tolerance. For such stations, this tolerance is 1000 Hz.

(l) For transmitters for system M(NTSC) the tolerance is 1000 Hz. However, for low power transmitters using this system note (m) applies.

(m) The receiver frequency tolerance shall be maintained within 10 ppm.

(n) See Annex M, paragraph 2.1.2.C.1.(a), for the measurement method of (1) multichannel equipment in the 406.1-420 MHz band, (2) point-to-point and point-to-multipoint equipment in the bands 932-935/941-944 MHz, or (3) point-to-point and transportable type equipment operating between 1710 MHz and 15.35 GHz (except for systems designed to use scatter techniques).

(o) This tolerance is for stations with emissions having a necessary bandwidth of 11 kHz or less. It does not apply to military equipment used for tactical and/or training operations, FM wireless microphone systems whose mean output power does not exceed 0.1 watt, equipment operating on channels designated for low power systems as set forth in Sections 4.3.8 and 5.3.6, and NOAA Weather Radio Transmitter.

(p) This standard is for narrowband operations with a necessary bandwidth of 4 kHz or less.

(q) The frequency tolerance standard is for maritime mobile stations using FM emissions in the band 150.8-162.0125 MHz with a necessary bandwidth of less than or equal to 16 kHz. See Annex M, paragraph 2.1.2.B, for the measurement method.

(r) Outside band 156-174 MHz, for transmitters used by on-board communications stations, a tolerance of 5 ppm shall apply.

(s) For transmitters used by on-board communications stations, a tolerance of 5 ppm applies.

(t) A frequency tolerance of 10 ppm applies to wind profiler radars operating on the frequency 449 MHz.

(u) Applies to frequency pairs 21.825 GHz, 23.025 GHz; 21.875, 23.075 GHz; 21.925, 23.125 GHz; and, 21.975 GHz, 23.175 GHz only.

(v) This tolerance is for new narrowband stations which will become effective on 1 January 2006. Stations already operational, procured prior to 1 January 2006 or have been approved by NTIA/SPS shall conform to a 2.5ppm tolerance standard.

(w) This tolerance is for new narrowband stations which will become effective on 1 January 2006.

## **5.2.2 Location of Standards for Levels of Unwanted Emissions**

### **5.2.2.1 Location of Specific Standards**

The location of levels of unwanted emission standards are provided in Table 5.2.2.1 below. The table specifies the section number for each standard by station type.

Table 5.2.2.1

<b>Station Type: FIXED STATIONS</b>	<b>Location of Standards</b>
Single Sideband and Independent Sideband Equipment (2-29.7 MHz)	§5.3.1
Multichannel (406.1-420 MHz) Point-to-point and point-to-multipoint (932-935/941-944 MHz) Point-to-point and transportable, except for systems using scatter techniques (1.71-15.35 GHz)	§5.3.3
Analog or Digital FM/PM Wideband Operations (29.7-50, 162-174, and 406.1-420 MHz)	§5.3.5.1
Analog or Digital FM/PM Narrowband Operations (138-150.8, 162-174, and 406.1-420 MHz)	§5.3.5.2
Low Power Channels and Splinter Channels (162-174 MHz and 406.1-420 MHz)	§5.3.6
Telemetry, Terrestrial (1435-1525, 2200-2290, 2310-2320 and 2345-2390 MHz)	§5.3.7
Analog Transmissions and Low Power Transmit (21.2-23.6 GHz)	§5.3.9
Other than above	§5.2.2.2

<b>Station Type: LAND and MOBILE STATIONS</b>	<b>Location of Standards</b>
Single Sideband and Independent Sideband Equipment (2-29.7 MHz)	§5.3.1
Maritime Mobile Stations using FM (150.8-162.0125 MHz)	§5.3.2
Land Mobile, Single Channel Narrowband Operations (220-222 MHz)	§5.3.4
Analog or Digital FM/PM Wideband Operations (29.7-50, 162-174, and 406.1-420 MHz)	§5.3.5.1
Analog or Digital FM/PM Narrowband Operations (138-150.8, 162-174 MHz and 406.1-420. MHz)	§5.3.5.2
Low Power Channels and Splinter Channels (162-174 MHz and 406.1-420 MHz)	§5.3.6
Telemetry, Terrestrial (1435-1525, 2200-2290, 2310-2320 and 2345-2390 MHz)	§5.3.7
Other than above	§5.2.2.2

<b>Station Type: RADIODETERMINATION STATIONS</b>	<b>Location of Standards</b>
Primary radars including spacebased radars on a case-by-case bases (100 MHz to 40 GHz)	Part 5.5
Other than above	§5.2.2.2

<b>Station Type: BROADCASTING STATIONS</b>	<b>Location of Standards</b>
All bands	§5.2.2.2

<b>Station Type: EARTH and SPACE STATIONS (excluding spacebased radars)</b>	<b>Location of Standards</b>
Below 470 MHz	§5.2.2.2
470 MHz and above	Part 5.6

**5.2.2.2 General Standards**

**Below 29.7 MHz, the following standard applies when no other standard applies:**

The mean power of any unwanted emissions supplied to the antenna transmission line, as compared with the mean power of the fundamental, shall be in accordance with the following:

1. On any frequency removed from the assigned frequency by more than 100 percent, up to and including 150 percent of the authorized bandwidth, at least 25 decibels attenuation;

2. On any frequency removed from the assigned frequency by more than 150 percent, up to and including 300 percent of the authorized bandwidth, at least 35 decibels attenuation; and

3. On any frequency removed from the assigned frequency by more than 300 percent of the authorized bandwidth, for transmitters with mean power of 5 kilowatts or greater, at least 80 decibels attenuation; and for transmitters with mean power less than 5 kilowatts, at least  $43 + 10 \log(pY)$  decibels attenuation (i.e., 50 microwatts absolute level), except that:

a. For transmitters of mean power of 50 kilowatts or greater and which operate over a frequency range approaching an octave or more, a minimum attenuation of 60 decibels shall be provided and every effort should be made to attain at least 80 decibels attenuation.

b. For hand-portable equipment of mean power less than 5 watts, the attenuation shall be at least 30 decibels, but every effort should be made to attain  $43 + 10 \log(pY)$  decibels attenuation (i.e., 50 microwatts absolute level).

c. For mobile transmitters, any unwanted emissions shall be at least 40 decibels below the fundamental without exceeding the value of 200 milliwatts, but every effort should be made to attain  $43 + 10 \log(pY)$  decibels attenuation (i.e., 50 microwatts absolute level).

d. When A1A, F1B, or similar types of narrowband emissions are generated in an SSB transmitter, the suppressed carrier may fall more than 300 percent of the authorized bandwidth from the assigned frequency. Under these conditions, the suppressed carrier shall be reduced as much as practicable and shall be at least 50 decibels below the power of the fundamental emission.

29.7 MHz and above, the following standard applies when no other standard applies:

The mean power of any emission supplied to the antenna transmission line, as compared with the mean power of the fundamental, shall be in accordance with the following (above 40 GHz these are design objectives pending further experience at these orders of frequency):

1. On any frequency removed from the assigned frequency by more than 75 percent, up to and including 150 percent, of the authorized bandwidth, at least 25 decibels attenuation;

2. On any frequency removed from the assigned frequency by more than 150 percent, up to and including 300 percent, of the authorized bandwidth, at least 35 decibels attenuation; and

3. On any frequency removed from the assigned frequency by more than 300 percent of the authorized bandwidth:

a. For transmitters with mean power of 5 kilowatts or greater, attenuation shall be at least 80 decibels.

b. For transmitters with mean power less than 5 kilowatts, spurious output shall not exceed 50 microwatts (i.e.,  $43 + 10 \log(pY)$ ) decibels attenuation except for frequency modulated maritime mobile radiotelephone equipment above 30 MHz as follows:

(1) The mean power of modulation products falling in any other international maritime mobile channel shall not exceed 10 microwatts for mean transmitter power 20 watts or less.

(2) The mean power of any other unwanted emission on any discrete frequency within the international maritime mobile band shall not exceed 2.5 microwatts for transmitters with mean power of 20 watts or less.

(3) For maritime mobile transmitters of mean power above 20 watts, these 2.5 and 10 microwatt limits may be increased in proportion to the increase of the mean power of the transmitters

above this 20 watts.

### 5.3 FIXED AND MOBILE STATIONS

#### 5.3.1 HF Single Sideband and Independent Sideband Equipment (2-29.7 MHz)

This standard specifies that spectrum standards for single sideband equipment for single channel voice, direct printing telegraphy and data, in the Fixed and Mobile services between 2 and 29.7 MHz (Except in the bands allocated exclusively to the Aeronautical Mobile (R) service.) In using the spectrum standards indicated below, it should be recognized that they do not prohibit an agency from making improvements thereon.

##### A. Transmitter Standards

1. For unwanted emissions for fixed and mobile services (except the land mobile service), the peak power of any emission on any frequency removed from the center of the authorized bandwidth<sup>1</sup> (BW) by a displacement frequency ( $f_d$  in kHz) shall be attenuated below the peak envelope power (pX) of the transmitter in accordance with the following schedule:

$f_d$ in kHz	Attenuation in dB
$50\%BW < f_d \leq 150\%BW$	26
$150\%BW < f_d \leq 250\%BW$	35
$f_d > 250\%BW$	$40 + 10 \log(pX)$ or 80 whichever is the lesser attenuation.

Figure 5.3.1 below provides an example of HF SSB emission plotted using the measurement method described in Annex M. The figure also shows the standard superimposed on the plot to show conformance.

For the land mobile service, the peak power of any emission on any frequency removed from the center of the authorized bandwidth<sup>1</sup> (BW) by a displacement frequency ( $f_d$  in kHz) shall be attenuated below the peak envelope power (pX) of the transmitter in accordance with the following schedule:

$f_d$ in kHz	Attenuation in dB
1.75 kHz $f_d < 5.25$ kHz	28
5.25 kHz $f_d < 8.75$ kHz	38
$f_d > 8.75$ kHz	$43 + 10 \log(pX)$

2. Where suppressed carrier operation is employed, transmitters shall be capable of operation with the emitted carrier power attenuated at least 40 dB below peak envelope power.

3. Where interoperability with conventional double sideband AM receivers is required, single sideband transmitters shall have the capability to transmit the carrier at a level within 6 dB of the peak envelope power.

4. The upper sideband mode shall be employed where there is need for working among international services.

##### B. Receiver Standards

1. Selectivity. The passband<sup>2</sup> shall be no greater than the authorized bandwidth of emission

1. In other than exceptional cases the practice is to authorize 3 kHz as the necessary bandwidth for normal voice intelligibility. This is specified by the emission designator. In the practical case, to meet the minimum performance requirements of this paragraph the roll-off of the emission curve will begin at a value somewhat less than 1.5 kHz from the assigned frequency.

2. Passband--The passband is the band of frequencies limited by the two frequencies for which the voltage is attenuated to one-half of the voltage of the most favored frequency.

and the slope of the selectivity characteristic outside the passband shall be 100 dB/kHz.

2. Tunability. The equipment shall be capable of operation on any frequency within its tuning range. However, where a synthesizer is employed as the frequency controlling element, the receiver shall be capable of operation on any frequency which is an integral multiple of 0.1 kHz.

### C. Antenna Standards<sup>3</sup>

#### Fixed Station

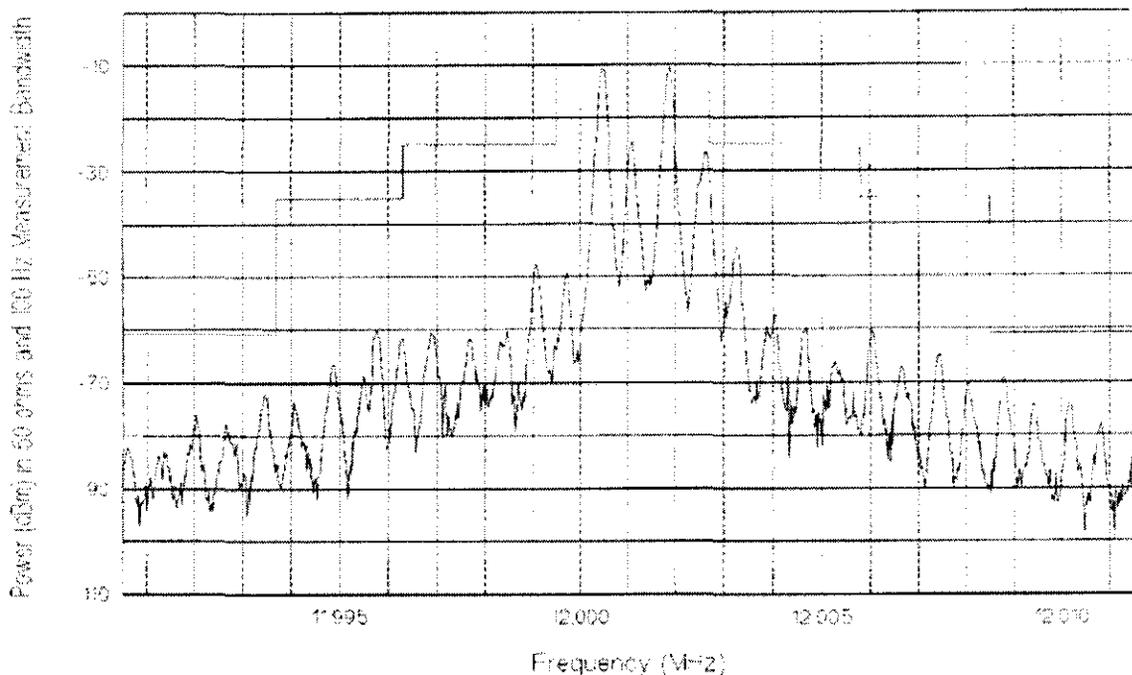
1. Directive antennas are not required below 4 MHz. Directive antennas shall be employed above 4 MHz unless in specific cases they are shown to be impracticable.

2. Minimum forward power gain over an isotropic radiator located at the same height over the same earth as directive antenna shall be 10 dB in the range 4 to 10 MHz and 15 dB in the range 10 to 30 MHz.<sup>4</sup> The gain of any reference antenna used in an actual measurement must be specified relative to an isotropic antenna.

3. The antenna gain in the desired direction over that of a lobe in any other direction shall be greater than 6 dB.

#### Mobile Station

To the extent practicable, land stations shall use antennas designed so as to reduce their radiation and/or their susceptibility to interference in those directions where service is not required.



**Figure 5.3.1 RSL (dBm) vs. Frequency (MHz)**

Example of measured Emission for HF SSB Transmitter Fundamental with NTIA Standard in Section 5.3.1.  
Modulation Tones = 400 Hz and 1800 Hz, Resolution. BW = 100 Hz, Span = 21.1 kHz.

- 
3. Applies to both transmitting and receiving antennas, but to the latter only when protection from harmful interference is required.
  4. These gain figures would be approximately 6 dB greater if the gain were to be expressed relative to an isotropic antenna in free space, in order to account for ground reflection.

### 5.3.2 Maritime Mobile Stations using FM (150.8-162.0125 MHz)

This standard is for maritime mobile stations using FM emissions in the band 150.8-162.0125 MHz with a necessary bandwidth of less than or equal to 16 kHz.

After January 21, 1997, ship station transmitters, except portable ship station transmitter, must be capable of automatically reducing power to 1 watt or less when tuned to the frequency 156.375 MHz or 156.650 MHz. A manual override will permit full carrier power operation on these channels.

### 5.3.3 Fixed Services (406.1-420 MHz Band, the 932-935/941-944 MHz Bands, and the 1710 MHz-15.35 GHz Frequency Range)

The following standard is for Federal Government Fixed Services employing: (a) multichannel equipment in the 406.1-420 MHz band, (b) point-to-point and point-to-multipoint equipment in the bands 932-935/941-944 MHz, or (c) point-to-point and transportable type equipment operating between 1710 MHz and 15.35 GHz (except for systems designed to use scatter techniques).

This standard became effective on August 28, 1990, for fixed operations (point-to-point and point-to-multipoint) in the bands 932-935/941-944 MHz. These bands are partially allocated for Government and non-Government fixed service use on a co-primary basis. Standards for receivers operating in the bands 932-935/941-944 MHz, are not mandatory and are presented herein to provide guidelines to promote efficient and effective use of these shared frequencies.

This standard became effective on January 1, 1987, for multichannel equipment operating in the 406.1-420 MHz band. Such equipment placed in operation or contracted for prior to January 1, 1987, may continue to operate without regard to the requirements of this standard.

This standard became effective on January 1, 1979, for fixed equipment operating in the 1710 MHz - 15.35 GHz frequency range. Such equipment placed in operation or contracted for prior to January 1, 1979 may continue to operate without regard to the requirements of this standard until January 1, 1994.

#### A. Transmitter Standards

**Unwanted Emissions.** The mean power of any emission on any frequency removed from the center of the authorized bandwidth (BW) by a displacement frequency ( $f_d$  in kHz) shall be attenuated below the mean output power (pY) of the transmitter in accordance with the following schedule. For cases where a resolution bandwidth is not specified, use 100 kHz for center frequencies less than 1 GHz and 1 MHz for center frequencies greater than or equal to 1 GHz:

(a) For transmission other than those employing digital modulation techniques:

$f_d$ in kHz	Attenuation in dB
$50\%BW < f_d \leq 100\%BW$	25
$100\%BW < f_d \leq 250\%BW$	35
$f_d > 250\%BW$	$43 + 10\log(pY)$ or 80 whichever is the lesser attenuation

(see Figure 5.3.3a for a sample application of this standard)

(b) For transmissions employing digital modulation techniques:<sup>5</sup>

---

5. Relatively narrowband digital radio systems may be unduly restricted by this standard. Work is in progress to define appropriate limitations for such narrowband systems. This standard will be modified in accordance with the findings and experience with such narrowband systems.

In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent, up to and including 250 percent, of the authorized bandwidth as specified by the following equation but at least 50 decibels:

$$A = 35 + 0.8(\% - 50) + 10 \log(BW)$$

where:

A = attenuation (in decibels) below the mean output power level, % = percent of the authorized bandwidth removed from the assigned frequency.

and: BW = authorized bandwidth in MHz.

Attenuation greater than 80 decibels is not required.

In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least  $43 + 10 \log(pY)$  decibels, or 80 decibels, whichever is the lesser attenuation. The Measurement Method is in paragraph 2.1.1.C.1.(b) of Annex M. (see Figure 5.3.3b for a sample application of this standard)

(c) In the bands 932-935 and 941-944 MHz, fixed point-to-multipoint stations using transmissions employing digital modulation techniques with a bandwidth of 12.5 kHz or less, the power of any emission shall be attenuated below the unmodulated carrier power (mean power can be used) of the transmitter (pY) in accordance with the following schedule:

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 2.5 kHz up to and including 6.25 kHz: At least  $53 \log(f_d/2.5)$  decibels;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 6.25 kHz up to and including 9.5 kHz: At least  $103 \log(f_d/3.9)$  decibels;

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 9.5 kHz up to and including 15 kHz: At least  $157 \log(f_d/5.3)$  decibels;

(4) On any frequency removed from the center of the authorized bandwidth by a displacement frequency greater than 15 kHz: At least  $50 + 10 \log(pY)$  or 70 decibels, whichever is the lesser attenuation.

(d) In the bands 932-935 and 941-944 MHz, fixed point-to-multipoint stations using transmissions employing digital modulation techniques with a bandwidth greater than 12.5 kHz, the power of any emission shall be attenuated below the unmodulated carrier power (mean power can be used) (pY) of the transmitter in accordance with the following schedule;

(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 5 kHz up to and including 10 kHz: At least  $83 \log(f_d/5)$  decibels;

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 10 kHz up to and including 250 percent of the authorized bandwidth: At least  $116 \log(f_d/6.1)$  or  $50 + 10 \log(pY)$  or 70 decibels, whichever is the lesser attenuation;

(3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least  $43 + 10 \log(pY)$  decibels or 80 decibels, whichever is the lesser attenuation.

2. The maximum equivalent isotropic radiated power (EIRP) shall not exceed the values specified below. However, the additional constraints of Section 8.2.34 of this manual apply.

Frequency Band (MHz)	Maximum Allowable EIRP (dBm)
406.1-420	80
932-932.5	47
932.5-935	70
941-941.5	60
941.5-944	70
1710-4990	80
7125-15350	85

### B. Receiver Standards

1. The receiver unwanted signals shall be attenuated at least 60 dB relative to the receiver sensitivity at the center of the passband. The Measurement Method is in paragraph 2.1.1.C.2.(b) of Annex M.

2. Selectivity. Receiver selectivity is the degree to which a receiver is able to discriminate against the effects of undesired signals primarily outside the authorized emission bandwidth that arrive at its RF input terminals.

The -3 dB receiver bandwidth should be commensurate with the authorized emission bandwidth plus twice the frequency tolerance of the transmitter specified in Section 5.2.1. The -60 dB receiver bandwidth shall not exceed five times the -3 dB receiver bandwidth.

3. Conducted Undesired Emissions are those undesired signals generated in the receiver and leaving the receiver by way of the receiving transmission line.

Conducted emissions from the receiver on any frequency, as measured at the radio frequency interface point to the antenna system, shall not exceed -85 dBW. For the bands 406.1-420 MHz and 932-935/941-944 MHz, conducted emissions shall not exceed -57 dB.

4. Noise Figure. The noise figure of a receiver is the ratio expressed in dB of (1) the output noise power to (2) the portion of noise power attributable to thermal noise in the input termination at 290 kelvins.

The receiver noise figure including preamplifier should be 9 dB or less for frequencies below 4400 MHz, 12 dB or less for frequencies between 4400 MHz, and 10 GHz, and 14 dB or less for higher frequencies (up to 15.35 GHz).

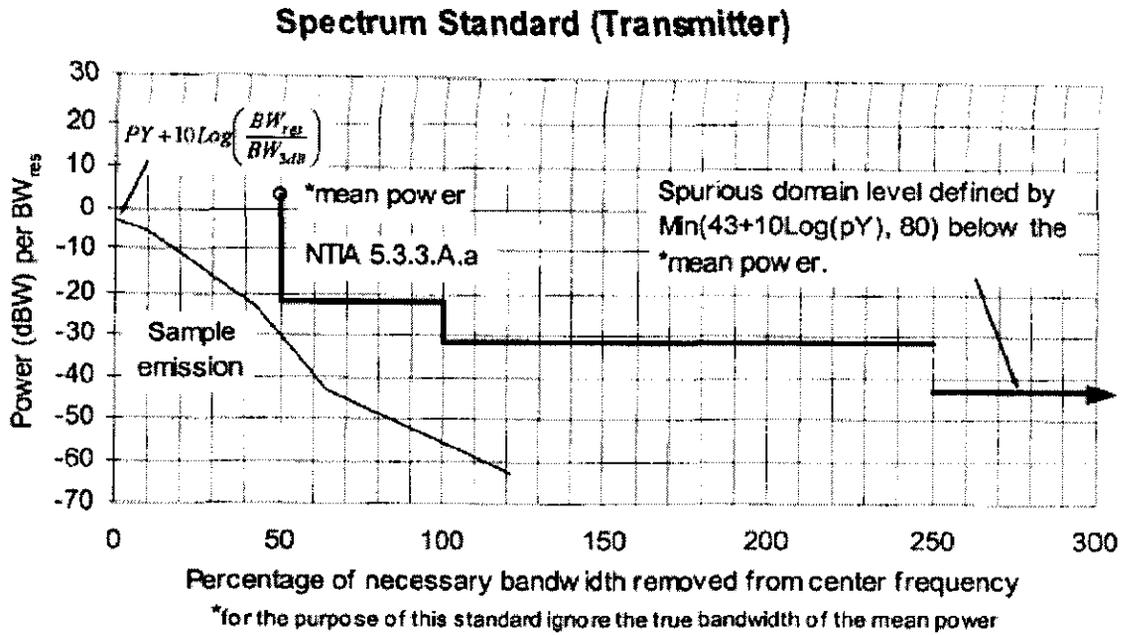
### C. Antenna Standards

The following limitations do not apply to transportable antenna systems when used in tactical and training operations. Additionally, the following limitations do not apply to multipoint distribution systems (point-to-multipoint) operating in the bands 406.1-420, 932-932.5 and 941-941.5 MHz.

1. Each station shall employ directional antennas with the major lobe of radiation directed toward the receiving station with which it communicates, or toward any passive repeater that may be used.

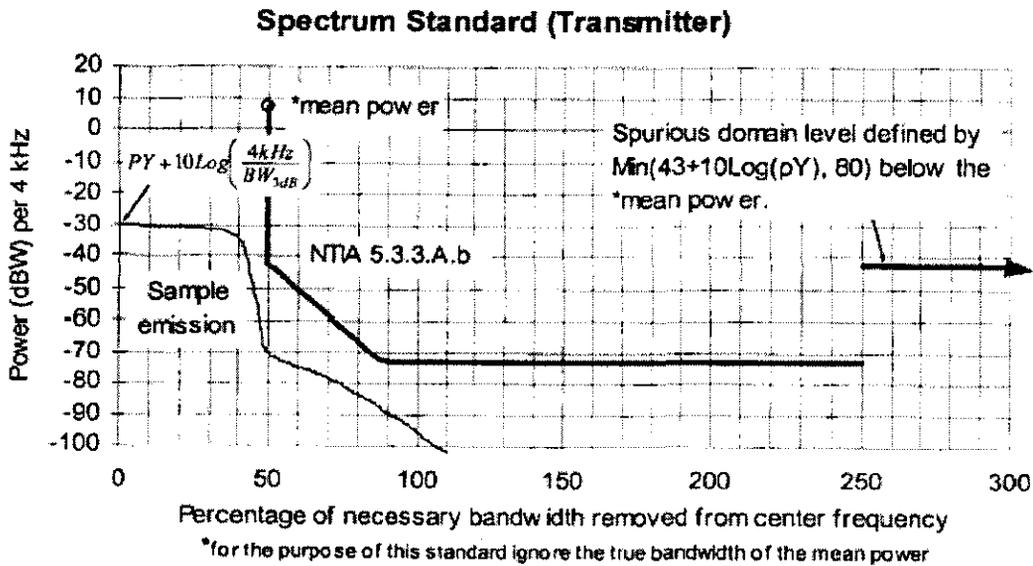
2. Antenna Radiation Pattern. The antenna radiation pattern is the relative power gain as a function of direction for the specified polarization.

Directional antennas shall meet the performance standards indicated in Table 5.3.3. For assignments in bands shared with satellite-space services, determination on additional beamwidth limitations shall be made on a case-by-case basis if mutual interference problems are likely to be involved.



**Figure 5.3.3a**

Figure 5.3.3a shows a sample analog emission whose center frequency is 7.135 GHz, necessary bandwidth is 19.8 MHz, -3 dB bandwidth is 4 MHz, and mean output is 2 watts (3 dBW), plotted against the standard. The emission complies with the standard.



**Figure 5.3.3b**

Figure 5.3.3b shows a sample digital emission whose necessary bandwidth is 30 MHz, -3 dB bandwidth is 22 MHz, and mean output power is 5 watts (7 dBW), plotted against the standard. The emission complies with the standard.

Frequency Band	Maximum beamwidth (3 dB point)	Minimum suppression at angle in degrees from center line of main beam (dB)						
		5-10°	10-15°	15-20°	20-30°	30-100°	100-140°	140-180°
406.1-420 MHz <sup>1</sup>	80°	-	-	-	-	10	10	10
a) 932.5-935 MHz 941.5-944 MHz <sup>2</sup>	14°	-	6	11	14	17	20	24
b) 932.5-935 MHz 941.5-944 MHz <sup>2</sup>	20°	-	-	6	10	13	15	20
1710-1850 MHz <sup>3</sup>	10°	-	14	16	18	23	24	30
1710-1850 MHz <sup>4</sup>	8°	5	18	20	20	25	28	36
2200-2400 MHz	8.5°	4	12	16	16	24	25	30
4.4-4.99 GHz	4°	13	20	23	24	29	31	31
7.125-8.5 GHz	2.5°	19	23	28	30	34	35	43
14.4-15.35 GHz	1.5°	21	26	31	35	37	41	48

1 - Any secondary lobe.

2 - Stations in this service must employ an antenna that meets the performance standard except that, in areas not subject to frequency congestion, subject to frequency coordination along the borders of the U.S., antennas meeting standards for category B may be employed. Note, however, the use of a high performance antenna may be required where interference problems can be resolved by the use of such antennas.

3 - These suppression levels could be met, e.g., by a 1.2 meter (4 foot) diameter parabolic antenna.

4 - This standard is applicable to new stations in the 1710-1850 MHz band placed in service after January 1, 1985, except for those located on the military test ranges specified in Section 7.17.1 and those limitations noted in paragraph 5.3.3.C. These suppression levels could be met, e.g., by a 1.83 meter (6 foot) diameter parabolic antenna.

Note: It is recognized that relatively narrowband systems may be unduly restricted by this standard. Work is in progress to define appropriate limitations for such narrowband systems. This standard will be modified in accordance with findings and experience with such narrowband systems.

#### **5.3.4 Land Mobile, Single Channel Narrowband Operations (220-222 MHz Band)**

The 220-222 MHz band was reallocated on September 6, 1988 to the land mobile service for shared Government and non-Government operations. The operations are limited to single channel, narrowband equipment. The 2 MHz available in this band are allocated in 400 channels each 5 kHz wide and paired to create 200 narrowband channel pairs. See Section 4.3.15 for the channeling plan. This standard became effective on January 1, 1992.

### A. Transmitter Standards

1. Bandwidth Limitations: The maximum authorized bandwidth shall be 4 kHz.

2. Unwanted Emissions: On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz), the power of any emission shall be attenuated below the peak envelope power (pX) watts in accordance with the following schedule:

$f_d$ in kHz		Attenuation in dB
	the	$30 + 20(f_d - 2)$ or
$2 < f_d \leq 3.75$	lesser	$55 + 10\log(pX)$ or
	of	65
$3.75 < f_d$	at least	$55 + 10\log(pX)$

The Measurement Method is in paragraph 2.1.1.D of Annex M.

### B. Geographic Separation of Sub-Band A Base Station Receivers and Sub-Band B Base Station Transmitters

Base station receivers utilizing channels assigned for sub-band A as designated in Chapter 4 will be geographically separated from those base station transmitters utilizing channels removed 200 kHz or less and assigned from sub-band B as follows:

Separation Distances (Kilometers)	Effective Radiated Power (Watts)*
0.0-0.3	**
0.3-0.5	5
0.5-0.6	10
0.6-0.8	20
0.8-2.0	25
2.0-4.0	50
4.0-5.0	100
5.0-6.0	200
over 6.0	500

\* Transmitter peak envelope power shall be used to determine effective radiated power.

\*\* Stations separated by 0.3 km or less shall not be authorized. This table does not apply to the low-power mobile data channels 196-200. (See Section C.)

Except for nationwide assignments, the separation of co-channel base stations shall be 120 kilometers. Shorter separations will be considered on a case-by-case basis upon submission of a technical analysis indicating that at least a 10 dB protection will be provided to an existing station's 39 dB $\mu$  signal level contour.

### C. Limitations on Power and Antenna Height:

1. The permissible effective radiated power (ERP) with respect to antenna heights shall be determined from the following table. These are maximum values and applications are required to justify power levels requested.

**Table. ERP vs. Antenna Height**

Antenna Height above Average Terrain (HAAT) Meters	Effective Radiated Power (ERP) Watts*
Up to 150	500
150 to 225	250
225 to 300	125
300 to 450	60
450 to 600	30

**Table. ERP vs. Antenna Height**

Antenna Height above Average Terrain (HAAT) Meters	Effective Radiated Power (ERP) Watts*
600 to 750	20
750 to 900	15
900 to 1050	10
Above 1050	5

\* Transmitter PEP shall be used to determine ERP.

2. The maximum permissible ERP for mobile units is 50 watts. Portable units are considered as mobile units.

3. Channels 196-200 are limited to 2 watts ERP and a maximum antenna height of 6.1 meters (20 feet) above ground.

### **5.3.5 Standards for Fixed and Mobile Analog or Digital FM/PM Operations (29.7-50, 138-150.8, 162-174, and 406.1-420 MHz Bands)<sup>6</sup>**

#### **5.3.5.1 Standard for Fixed and Mobile Analog or Digital FM/PM Wideband Operations (29.7-50, 162-174, and 406.1-420 MHz Bands)**

Standards in this section related specifically to digital systems became effective on October 1, 1990.

These standards do not apply to:

- Military equipment used for tactical and/or training operations.
- FM wireless microphone systems whose mean output power does not exceed 0.1 watt.
- Equipment operating on splinter channels. (See Section 5.3.6).
- Fixed stations equipment with multichannel emissions (see Section 5.3.3).

The following is for fixed and mobile/land mobile service employing fixed, land, mobile and portable stations using analog or digital FM or PM emissions in the bands 29.7-50, 162-174, and 406.1-420 MHz. These standards are based upon emissions with analog input and a necessary bandwidth of 16 kHz.<sup>7</sup>

Stations with digital input may require a different necessary bandwidth but still must meet all other standards.

#### **A. Transmitter**

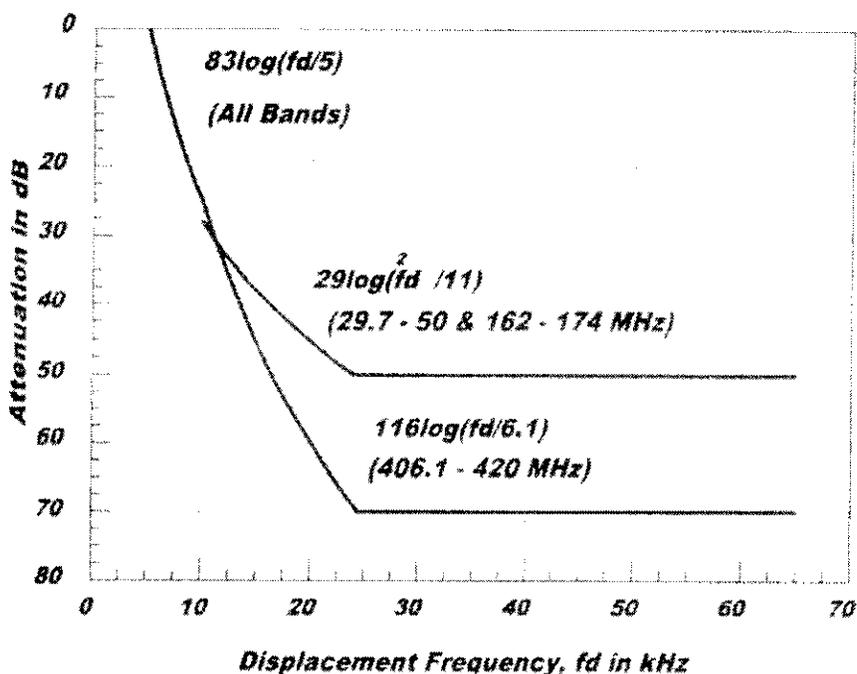
6. In the band 406.1 - 410 MHz, power is limited to a maximum of 7 W/kHz of necessary bandwidth as specified in footnote US117 to the Tables of Frequency Allocations (Chapter 4).

7. The spacing of channels (adjacent channel spacing) is 20 kHz in the 30-50 MHz band and 25 kHz in the 162-174 and 406.1 - 420 MHz bands.

1. Unwanted Emissions: The power of any unwanted emission on any frequency removed from the center of the authorized bandwidth (BW) by a displacement frequency ( $f_d$  in kHz) shall be attenuated below the unmodulated carrier power (pZ) in accordance with the following and Figure 5.3.5.1.

$f_d$ in kHz	Attenuation in dB
$5 \text{ kHz} < f_d \leq 10 \text{ kHz}$	All bands: $83\log(f_d/5)$
$10 \text{ kHz} < f_d \leq 250\% \text{ BW}$	29.7-50 MHz & 162-174 MHz: $29\log(f_d^2/11)$ or 50 whichever is the lesser attenuation

Figure 5.3.5.1



406.1-420 MHz:  $116\log(f_d/6.1)$  or  $50 + 10\log(pZ)$  or 70 whichever is the lesser attenuation.

$f_d > 250\% \text{ BW}$	All bands: $50 + 10\log(pZ)$ (i.e. 10 microwatts absolute) Portable $43 + 10\log(pZ)$ (i.e. 50 microwatts absolute)
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Figure 5.3.5.1 shows the mask for a fixed or mobile station operating in the bands 29.7-50, 162-174 and 406.1- 420 MHz with an authorized bandwidth of 25 kHz and a mean power of 100 watts.

Figure 5.3.5.1 Levels of Unwanted Emissions

2. Frequency Deviation for all station classes and frequency bands shall not exceed  $\pm 5$  kHz. The Measurement Method is in paragraph 2.1.1.E.1 of Annex M.

**B. Receiver****1. Spurious Response Attenuation:**

Station Class	Band (MHz)		
	29.7-50	162-174	406.1-420
Land, Fixed, Mobile	85 dB	85 dB	85 dB
Portable	60 dB	60 dB	50 dB

**2. Adjacent Channel Selectivity:**

ANALOG			
Station Class	Band (MHz)		
	29.7-50	162-174	406.1-420
Land, Fixed, Mobile	80 dB	80 dB	80 dB
Portable	50 dB	70 dB	60 dB

DIGITAL			
Station Class	Band (MHz)		
	29.7-50	162-174	406.1-420
Land, Fixed, Mobile	50 dB	55 dB	55 dB
Portable	50 dB	50 dB	50 dB

**3. Intermodulation Attenuation:**

Station Class	Band (MHz)		
	29.7-50	162-174	406.1-420
Land, Fixed, Mobile	60 dB	70 dB	70 dB
Portable	50 dB	50 dB	50 dB

4. Conducted Spurious Emissions: All station classes and all bands -57 dB.

5. The Measurement Method is in paragraph 2.1.1.E.1 of Annex M.

**5.3.5.2 Standards for Fixed and Mobile Analog or Digital FM/PM Narrowband Operations in the 138-150.8, 162-174 and 406.1-420 MHz Bands**

The standards outlined in this section apply to narrowband systems in the 138-150.8, 162-174 and 406.1-420 MHz bands. These standards do not apply to:

- Military equipment used for tactical and/or training operations in the 138-150.8 MHz band.
- FM wireless microphone systems whose mean output power does not exceed 0.1 watt.
- Equipment operating on channels designated for low-power systems as set forth in Sections 4.3.8, 4.3.8a, 4.3.10, 4.3.10a and 5.3.6.
- NOAA Weather Radio Transmitters.

### Standards

The following standards apply to fixed and mobile/land mobile services employing fixed, land, mobile, and portable stations using analog or digital emissions in the 138-150.8, 162-174 and 406.1-420 MHz bands with a necessary bandwidth of 11 kHz or less. These standards are based upon either TIA/EIA 603-B for narrowband analog or TIA TSB 102.CAAB-A for narrowband digital transmitters and receivers. Additionally, the receiver standards listed below are based upon Class A receiver limits as specified in the appropriate TIA publication.

### Effective Dates

These standards for new narrowband stations operating within the subject frequency bands shall become effective on 1 January 2006. Stations already operational, procured prior to 1 January 2006 or have been approved by NTIA/SPS will be allowed to operate in accordance with existing standards and without modification until the end of the life cycle of the equipment.

### Waivers

Waivers of the requirements herein may be requested when supported by reasonable justification. Waiver requests should be accompanied by technical data in support of the waiver and an explanation of the non-conforming parameters. Waivers granted will be subject to the provisions of Section 5.1.2.

### A. Transmitter

1. Unwanted Emissions: The power of any unwanted emission on any frequency removed from the center of the authorized bandwidth (BW) by a displacement frequency ( $f_d$ ) shall be attenuated below the unmodulated carrier power (pZ) in accordance with the following and the emission mask in Figure 5.3.5.2.

Displacement Freq ( $f_d$ )	Attenuation (dB)
$0 < f_d \leq 2.5$ kHz	0
$2.5$ kHz $< f_d \leq 12.5$ kHz	$7(f_d - 2.5)$
$12.5$ kHz $< f_d$	$50 + 10\log(pZ)$ or 70 whichever is the smaller

2. Frequency Deviation for all FM or PM station classes shall not exceed 2.5 kHz for analog emissions, and 3.11 kHz for digital emissions

3. The Measurement Method is in paragraph 2.1.1.E.2 of Annex M.

### B. Receiver

1. Spurious Response Attenuation (all bands):

a. Stations already operational, procured prior to 1 January 2006 or approved by NTIA/SPS.

Station Class	Digital	Analog
Land, Fixed	70 dB	70 dB
Mobile	70 dB	70 dB
Portable	60 dB	60 dB

b. All new stations after 1 January 2006, except as noted in (a) above

Station Class	Digital	Analog
Land, Fixed	90 dB	75 dB
Mobile	80 dB	75 dB
Portable	70 dB	70 dB

2. Adjacent Channel Selectivity (all bands):

a. Stations already operational, procured prior to 1 January 2006 or approved by NTIA/SPS.

Station Class	Digital	Analog
Land, Fixed	60 dB	70 dB
Mobile	60 dB	70 dB
Portable	50 dB	60 dB

b. All new stations after 1 January 2006, except as noted in (a) above

Station Class	Digital	Analog
Land, Fixed	60 dB	45 dB
Mobile	60 dB	45 dB
Portable	60 dB	45 dB

3. Intermodulation Rejection (all bands):

a. Stations already operational, procured prior to 1 January 2006 or approved by NTIA/SPS.

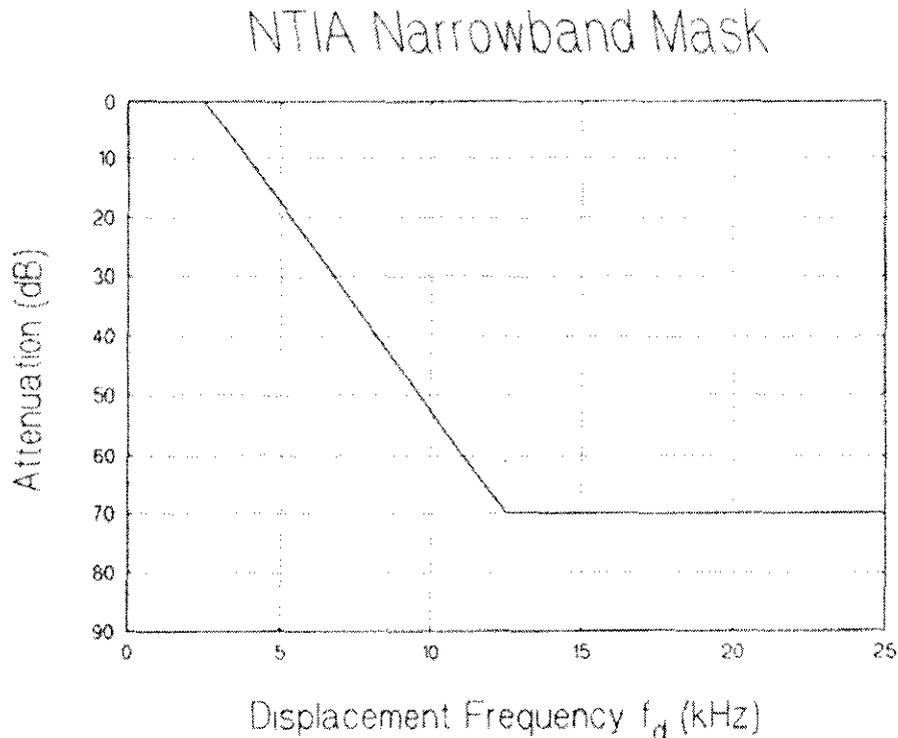
Station Class	Digital	Analog
Land, Fixed	70 dB	70 dB
Mobile	70 dB	70 dB
Portable	50 dB	50 dB

b. All new stations after 1 January 2006, except as noted in (a) above.

Station Class	Digital	Analog
Land, Fixed	80 dB	75 dB
Mobile	75 dB	75 dB
Portable	70 dB	70 dB

4. Conducted Spurious Emissions for all station classes and all bands: -57 dBm.

5. The Measurement Method is in paragraph 2.1.1.E.2 of Annex M.



**Figure 5.3.5.2 LEVELS OF UNWANTED EMISSIONS**

Note: This emission mask represents the Telecommunications Industry Association (TIA) emission mask developed for narrowband FM and Digital systems designed to operate in 12.5 kHz channels in the 138-150.8 MHz, 162-174 MHz, and 406.1-420 MHz bands. (The mask assumes  $p_Z=100$  watts.)

### 5.3.6 Low Power Channels and Splinter Channels (162-174 MHz Band)

1. The following transmitter standards are for the use of fixed and mobile low power channels identified in Section 4.3.8 and splinter channels identified in Section 4.3.10.

2. Emission--For FM or PM emission the maximum frequency deviation plus the highest audio tone shall not exceed 0.5 times the authorized bandwidth (authorized bandwidth is equal to  $2D + 2M$ ).

3. Unwanted emission levels at the equipment antenna terminals on any frequency removed from the center of the authorized bandwidth (BW) by a displacement frequency ( $f_d$  in kHz) shall be attenuated below the mean power (pY) of the unmodulated carrier output as specified by the following:

$f_d$ in kHz	Attenuation in dB
$50\%BW < f_d \leq 100\%BW$	25
$100\%BW < f_d \leq 250\%BW$	35
$f_d > 250\%BW$	$43 \text{ dB} + 10 \log(pY)$

4. Power output--The maximum mean power of the unmodulated carrier output for operations on splinter channels in the 406-420 MHz band shall be limited to 30 watts.

### 5.3.7 Telemetry, Terrestrial (1435-1525, 2200-2290, 2310-2320 and 2345-2390 MHz Bands)

This standard is applicable to terrestrial telemetering stations, authorized for operation in the bands 1435-1525, 2200-2290, 2310-2320 and 2345-2390 MHz. The details of this standard can be found in Chapter 2 of the Range Commanders Council Telemetry IRIG Standard TG 106-## Part 1. This document can be found at <http://www.ntia.doc.gov/osmhome/106.pdf> or <http://www.ntia.doc.gov/osmhome/106.doc>. Subsequent revisions of this document will be reviewed by the Technical Subcommittee prior to adoption.

### 5.3.8 Low Power Transmit (21.8-22.0 and 23.0-23.2 GHz Band Segments)<sup>8</sup>

These standards apply to the following four frequency pairs within the above two band segments:

21.825 GHz	23.025 GHz
21.875 GHz	23.075 GHz
21.925 GHz	23.125 GHz
21.975 GHz	23.175 GHz

#### 1. Unwanted Emissions.

When using transmissions other than those employing digital modulation techniques: the mean power of any emission supplied to the antenna transmission line, as compared with the mean power of the fundamental, shall be in accordance with the following (above 40 GHz these are design objectives pending further experience at these orders of frequency):

- a. On any frequency removed from the assigned frequency by more than 50 percent, up to and including 100 percent of the authorized bandwidth, at least 25 decibels attenuation;
  - b. On any frequency removed from the assigned frequency by more than 100 percent, up to and including 250 percent of the authorized bandwidth, at least 35 decibels attenuation; and
  - c. On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth, at least  $43 + 10 \log(pY)$  decibels or 80 decibels, whichever is the lesser attenuation.
2. Maximum effective radiated power (ERP) shall be 55 dBm.
  3. The rated transmitter output power shall not exceed 0.100 watts.
  4. Upon showing need, a maximum bandwidth of 50 MHz may be authorized per frequency assigned.
  5. These radio systems shall have no more than five hops in tandem, except upon showing of need, but in any event the maximum tandem length shall not exceed 40 km (25 miles).
  6. Interfering signals at the antenna terminals of stations authorized shall not exceed -90 dBm and -70 dBm, respectively, for co-channel and adjacent channel interfering signals.
  7. Antennas employing circular polarization may be used with these systems.
  8. Maximum beamwidth shall not exceed  $4^\circ$  with a minimum front-to-back ratio of 38 dB.

## 5.4 DISTRESS AND SAFETY COMMUNICATIONS

### 1. Global Maritime Distress and Safety System (GMDSS):

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:

- a. Digital selective calling (DSC) distress call formats (RR 32.9.3 and 34.2);
- b. DSC on VHF channel 70 (156.525 MHz):
  - (1) Capability of sensing the presence of a signal on channel 70, and

<sup>8</sup> These frequency pairs are shared between Government and non-Government users. Power constraints placed on the frequency pairs facilitate coordination due to the decreased interference potential.