

(d) Voice operations above 25 MHz. Stations will normally be authorized F3E or G3E emission. Stations utilizing digital voice modulation, will be authorized F1E, G1E, F2E or G2E emission. Authorization includes the use of non-voice emissions for tone signaling devices whose sole functions are to establish and to maintain communications, to provide automatic station identification and, for operations in the Public Safety Radio Service, to activate emergency warning devices used solely for advising the general public or emergency personnel of an impending emergency.

(e) Non-voice operations. A1A, A1B, A1D, A2B, A2D, A3C, A3D, F1B, F1D, F2B, F2D, F3D, G1B, G1D, G2B, G2D, G3D, and J2B emissions will be authorized.

(f) Other emissions. Requests for emissions other than those listed in paragraphs (c) through (e) of this section will be considered on a case-by-case basis to insure that the new emissions would cause no more interference than other emissions that are currently permitted.

#### § 88.413 Bandwidth limitations.

(a) Each authorization issued to a station licensed under this part will show an emission designator representing the class of emission authorized. The designator will be prefixed by the specified necessary bandwidth. This figure does not necessarily indicate the bandwidth occupied by the emission at any instant. In those cases where Part 2 of this chapter does not provide a formula for the computation of necessary bandwidth, the occupied bandwidth as defined in Part 2 may be used in lieu of the necessary bandwidth. The maximum authorized bandwidth contains those frequencies upon which 99 percent of the radiated power appears, extended to include any discrete frequency upon which the power is at least 0.25 percent of the total radiated power.

(b) The maximum authorized single channel bandwidth of emission corresponding to the type of emission specified in § 88.409 of this part will be as follows:

(1) For A1A or A1B emissions, the maximum authorized bandwidth is 0.25 kHz. The maximum authorized bandwidth for type A3E emission will be 8 kHz.

(2) For operations below 25 MHz utilizing J3E emission, the bandwidth occupied by the emission may not exceed 3000 Hz. The assigned frequency will be specified in the authorization. The authorized carrier frequency will be 1400 Hz lower in frequency than the assigned frequency. Only upper sideband emission may be used. In the case of regularly available double sideband radiotelephone channels, an assigned frequency for J3E emissions is available either 1600 Hz below or 1400 Hz above the double sideband radiotelephone assigned frequency.

(3) Generally, for all other types of emissions, the maximum authorized bandwidth will not be more than that normally authorized for voice operations.

(4) Where a frequency is assigned exclusively to a single licensee, more than a single emission may be utilized within the authorized bandwidth. In such cases, the frequency stability requirements of § 88.425 do not apply, but out-of-band emission limits of § 88.421 must be met.

(5) Contiguous channels (non-standard bandwidths) may be authorized for systems requiring more than the normal single channel bandwidth provided the system meets the spectrum efficiency standard in § 88.433. If necessary, licensees may, with license modification, trade channels among themselves in order to obtain contiguous frequencies.

(6) Unless specified elsewhere, channel spacings and bandwidths that will be authorized in the following frequency bands are given in Table C-1.

Frequency band MHz	Channel spacing (kHz) 2	Authorized bandwidth (kHz)	
		1	2
Below 25	---	---	---
25-50	20	20	20
72-76 Fixed	20	20	20
72-76 Mobile	5	10	4
150-174	5	12	4
216-220	---	---	---
220-222	5	4	4
420-512 <sup>3</sup>	6.25	10	5
806-821	25	20	20
821-824	12.5	20	20
851-866	25	20	20
866-869	12.5	20	20
896-901	12.5	13.6	13.6
929-930	25	20	20
935-940	12.5	13.6	13.6
1427-1435	---	---	---
2450-2483.5	---	---	---
Above 2500	---	---	---

<sup>1</sup> Stations authorized prior to (eff date of rules) must meet this bandwidth requirement by January 1, 1996 and, where applicable, must reduce bandwidth by the appropriate date listed in § 88.433(d) to conform with stations authorized pursuant to Note 2.

<sup>2</sup> For stations authorized after xxxx (eff date of rules).

<sup>3</sup> Bandwidths for radiolocation systems in the 420-450 MHz band will be reviewed and authorized on a case-by-case basis.

**§ 88.417 Modulation requirements.**

Each transmitter must meet the requirements provided in paragraphs (a) or (b) of this section. The requirements of this paragraph do not apply to

mobile stations that are authorized to operate with a maximum power output of 2 watts or less.

(a) Transmitters utilizing analog emissions must be equipped with an audio low-pass filter whose characteristics will enable the transmitter to meet the emission limitations specified in § 88.421 under all conditions of operation..

(b) Transmitters utilizing digital emissions are exempt from the audio low-pass filter requirement provided that such transmitters must be tested for type acceptance using the digital modulating signal or signals specified by the manufacturer. The type acceptance application must contain such information as may be necessary to demonstrate that the transmitter complies with the emission limitations specified in § 88.421.

**§ 88.421 Emission masks.**

Except as indicated elsewhere in this part, transmitters used in the Private Land Mobile Radio Services must comply with the emission masks outlined in this section. The measurements of emission power can be expressed in peak or average values provided they are expressed in the same parameters as the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, the reference to the unmodulated transmitter carrier power refers to the total power.

(a) Below 25 MHz. Transmitters utilizing emissions other than single sideband (J3E) must meet the emission requirements of paragraph (b)(1) of this section. For transmitters utilizing J3E emission, the carrier must be at least 40 dB below the peak envelope power and the power of emissions must be reduced below the output power (P in watts) of the transmitter as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 150 percent of the authorized bandwidth:  
At least 25 decibels (dB);

(2) On any frequency removed from the assigned frequency by more than 150 percent, but not more than 250 percent of the authorized bandwidth:  
At least 35 dB;

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least  $43 + 10 \log P$  dB.

(b) 25-50 MHz, 72-76 MHz, and above 800 MHz.

(1) For transmitters operating in the 25-50 MHz frequency band, on frequencies listed at § 88.1189 for fixed use in the 72-76 MHz band that are equipped with an audio low-pass filter pursuant to § 88.417(a), in the 800 and 900 MHz bands referenced in paragraphs (e)(1) and (f)(1) of this section, and on frequencies above 940 MHz, the power of any emission must be below the unmodulated carrier power (P) as follows:

(i) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth:  
At least 25 dB.

(ii) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

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

(2) For transmitters not equipped with an audio low-pass filter pursuant to § 88.421(b), the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 5 kHz, but not more than 10 kHz: At least  $83 \log (f_d/5)$  dB;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least  $29 \log (f_d^2/11)$  dB or 50 dB, whichever is the lesser attenuation;

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

(c) 72-76 MHz (mobile use), 150-174 MHz, 216-222 MHz. For transmitters operating in the 150-174 MHz or 216-222 MHz frequency bands, or on frequencies listed at § 88.905(d) for low power mobile operation in the 72-76 MHz frequency band, any emission must be reduced below the power of the highest emission contained within the authorized channel bandwidth as follows:

(1) On any frequency within the authorized bandwidth to the edge of the authorized bandwidth ( $f_e$ ): Zero dB.

(2) On any frequency removed from the edge of the authorized bandwidth, ( $f_e$ ), to ( $f_e$ ) + 1.75 kHz:  $30 + 20x(f_e)$  dB, or  $55 + 10 \log (P)$ , or 65 dB, whichever is the lesser attenuation.

(3) On any frequency beyond 1.75 kHz removed from the edge of the authorized bandwidth ( $f_e$ ): At least  $55 + 10 \log (P)$  dB.

(d) 420-512 MHz. For transmitters operating in the 420-512 MHz frequency band, any emission must be attenuated below the power (P) of the highest emission contained within the authorized channel bandwidth as follows:

(1) On any frequency within the authorized bandwidth to the edge of the authorized bandwidth ( $f_e$ ): Zero dB.

(2) On any frequency removed from the edge of the authorized bandwidth, ( $f_e$ ), to ( $f_e$ ) + 2.1 kHz:  $30 + 16.7x(f_e)$  dB, or  $55 + 10 \log (P)$ , or 65 dB, whichever is the lesser attenuation.

(3) On any frequency beyond 2.1 kHz removed from the edge of the authorized bandwidth ( $f_e$ ): At least  $55 + 10 \log (P)$  dB.

(e) 806-821/851-866 MHz, 929-930 MHz.

(1) Transmitters operating in the 806-821/851-866 MHz or 929-930 MHz bands that are **equipped** with an audio low-pass filter pursuant to § 88.417(a) must meet the emission limitations of paragraph (b) (1) of this section.

(2) For transmitters that operate in the 806-821 MHz/851-866 MHz or 929-930 MHz frequency bands and that are **not equipped** with an audio low-pass filter pursuant to § 88.417(b), the power of any emission must be attenuated below the unmodulated carrier power ( $P$ ) as follows:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 5 kHz, but no more than 10 kHz: At least  $83 \log (f_d/5)$  dB;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 10 kHz, but no more than 250 percent of the authorized bandwidth: At least  $116 \log (f_d/6.1)$  dB, or  $50 + 10 \log (P)$  dB, or 70 dB, whichever is the lesser attenuation;

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

(f) 821-824/866-869 MHz.

(1) Transmitters operating in the 821-824/866-869 MHz frequency bands that are **equipped** with an audio low-pass filter pursuant to § 88.417(a) must meet the emission limitations of paragraph (b) (1) of this section.

(2) For transmitters that operate in the 821-824/866-869 MHz frequency bands that are **not equipped** with an audio low-pass filter pursuant to § 88.417(b), the power of any emission must be attenuated below the unmodulated carrier power ( $P$ ) as follows:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of 4 kHz or less: Zero dB.

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 4 kHz, but no more than 8.5 kHz: At least  $107 \log (f_d/4)$  dB;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 8.5 kHz, but no more than 15 kHz: At least  $40.5 \log (f_d/1.16)$  dB;

(iv) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 15 kHz, but no more than 25 kHz: At least  $116 \log (f_d/6.1)$  dB;

(v) On any frequency removed from the center of the authorized bandwidth by more than 25 kHz: At least  $43 + \log (P)$  dB, or 80 dB, whichever is the lesser attenuation.

(g) 896-901 MHz/935-940 MHz.

(1) For transmitters operating in the 896-901 MHz/935-940 MHz frequency bands that are **equipped** with an audio low pass filter pursuant to § 88.417(a), the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) as follows:

(i) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 6.8 kHz, but no more than 9.0 kHz: At least 25 dB;

(ii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 9.0 kHz, but no more than 15 kHz: At least 35 dB;

(iii) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 15 kHz: At least  $43 + 10 \log (P)$  dB, or 70 dB, whichever is the lesser attenuation.

(2) For transmitters that operate in the 896-901 MHz/935-940 MHz frequency bands that are **not equipped** with an audio low-pass filter pursuant to § 88.417(b), the power of any emission must be attenuated below the unmodulated carrier power of the transmitter (P) as follows:

(i) 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, but no more than 6.25 kHz: At least  $53 \log (f_d/2.5)$  dB;

(ii) 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, but no more than 9.5 kHz: At least  $103 \log (f_d/3.9)$  dB;

(iii) 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, but no more than 15 kHz: At least  $157 \log (f_d/5.3)$  dB;

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

(h) Below 1000 MHz, the resolution bandwidth of the instrumentation used to measure the emission power must be 100 Hz for measuring emissions up to and including 250 kHz from the edge of the authorized bandwidth, and 10 kHz for measuring emissions more than 250 kHz from the edge of the authorized bandwidth. Above 1000 MHz, the resolution bandwidth of the instrumentation must be 1 MHz. If a video filter is used, its bandwidth must not be less than the resolution bandwidth. The power level of the highest emission within the channel, to which the attenuation is referenced, must be remeasured for each change in resolution bandwidth.

§ 88.425 Frequency stability.

(a) Unless noted elsewhere in this part, transmitters used in the services governed by this part must be maintained within the limits given in Table C-2. Transmitter frequency stability must enable the equipment to meet the emission mask requirements given in § 88.421.

Table C-2 Frequency Stability parts per million (ppm)				
Frequency range (MHz)	Fixed and base stations		Mobile stations	
	200 W or less output power		Over 2 W output power	2 W or less output power
Below 25	100	1 2 3	100	200
25-50	20		20	50
72-76	5	4	---	50
150-220	0.1	5	1.5	1.5
220-222	0.1		1.5	1.5
420-512	0.1	6 7	1.0	1.0
806-821	1.5	8	2.5	2.5
821-824	10	8	1.5	1.5
851-866	1.5		2.5	2.5
866-869	1		1.5	1.5
896-901	0.1	8	1.5	1.5
929-930	1.5		---	---
935-940	0.1		1.5	1.5
1427-1435	300	9	300	300
Above 2450 10	---		---	---

<sup>1</sup> Fixed and base stations with over 200 watts transmitter power must have a frequency stability of 50 ppm, except in the Public Safety Radio Service where the frequency stability is 100 ppm.

<sup>2</sup> For single sideband operations below 25 MHz, the carrier frequency must be maintained within 50 Hz of the authorized carrier frequency.

<sup>3</sup> Travelers information station transmitters operating from 530-1700 kHz and transmitters exceeding 200 watts peak envelope power used for disaster communications and long distance circuit operations pursuant to §§ 88.1273 and 88.1283 must maintain the carrier frequency to within 20 Hz of the authorized frequency.

<sup>4</sup> Call box stations in the Public Safety Radio Service operating in the 72-76 MHz band may operate with a frequency stability of 50 ppm.

- 5 Stations operating in the 154.45 to 154.49 MHz or the 173.2 to 173.4 MHz bands may operate with a frequency stability of 5 ppm.
- 6 Operational fixed stations controlling mobile relays, through use of the associated mobile frequency, may operate with a frequency stability of 5 ppm.
- 7 Base stations operating on frequencies used for remote control purposes in railroad yard and terminal areas, may operate with a frequency stability of 5 ppm.
- 8 Control stations may operate with the frequency stability specified for associated mobile stations.
- 9 Fixed stations with output powers above 120 watts and necessary bandwidth less than 3 kHz must operate with a frequency stability of 100 ppm. Fixed stations with output powers less than 120 watts and using time-division multiplex, may operate with a frequency stability of 500 ppm.
- 10 Frequency stability to be specified in the station authorization.

(b) For the purpose of determining the frequency stability limits, the power of a transmitter is considered to be the maximum rated output power as specified by the manufacturer.

(c) The frequency stability requirement will apply 20 milliseconds after the initial power transmission from the transmitter that is 20 dB below the final output power.

**§ 88.429 Power and antenna height limits.**

Applications for authorizations must request no more power than the actual power necessary for satisfactory operation. Except where otherwise specifically provided, the maximum power that will be authorized is as follows:

- (a) Below 25 MHz. For single sideband operations (J3E emission), the maximum transmitter peak envelope power is 1000 watts.
- (b) 25-50 MHz. The maximum transmitter output power is 300 watts.
- (c) 72-76 MHz. The maximum effective radiated power for stations operating on fixed frequencies is 300 watts. Stations operating on mobile-only frequencies are limited to one watt transmitter output power.
- (d) 150-216 MHz. The maximum authorized effective radiated power (ERP) with respect to antenna heights will be in accordance with Table C-3.

Table C-3 150-216 MHz ERP/Antenna Height	
Antenna height above average terrain (HAAT) meters (feet)	Effective radiated power (ERP) (watts)
Up to 60 (197)	300
60-75 (197-246)	190
75-90 (246-295)	120
90-120 (295-394)	75
120-180 (394-590)	30
Above 180 (590)	5

(e) **216-220 MHz**. Requested transmitter power will be considered and authorized on a case-by-case basis.

(f) **220-222 MHz**. The permissible ERP with respect to antenna heights will be authorized in accordance with Table C-4. These are maximum values and applicants are required to justify power levels requested. In this band, Channels 196-200 are limited to 2 watts ERP and a maximum antenna height of 6.1 m (20 ft) above ground. The maximum permissible ERP for mobile units is 50 watts. Portable units are considered as mobile units.

Table C-4 220-222 MHz ERP/Antenna Height	
Antenna height above average terrain (HAAT) meters (feet)	Effective radiated power (watts) <sup>1</sup>
Up to 150 (492)	500
150-225 (492-738)	250
225-300 (738-984)	125
300-450 (984-1476)	60
450-600 (1476-1968)	30
600-750 (1968-2460)	20
750-900 (2460-2952)	15
900-1050 (2952-3444)	10
Above 1050 (3444)	5

<sup>1</sup> Transmitter PEP will be used to determine ERP.

(g) **421-430 MHz**. Base station authorizations in the **421-430 MHz** band will be subject to effective radiated power (ERP) and effective antenna height (EAH) limitations as shown in the Table below. ERP is defined as the product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction. EAH is calculated by subtracting the assumed

average terrain elevation (AATE) as listed in Table D-6 of § 88.817, from the antenna height above mean sea level. Control stations are limited to 20 watts transmitter output power.

Effective antenna height (EAH) meters (feet)	Effective radiated power (watts)
Up to 150 (492)	250
150-300 (492-984)	150
300-450 (984-1476)	75
450-600 (1476-1968)	40
600-750 (1968-2460)	20
750-900 (2460-2952)	15
900-1200 (2952-3936)	10
Above 1200 (3936)	5

(h) 450-470 MHz. Power limits in this frequency band are the same as for the 150-216 MHz band as specified in paragraph (d) of this section.

(i) 470-512 MHz.

(1) The tables in this paragraph must be used to determine the effective radiated power (ERP) with respect to the height above average terrain (HAAT) of the proposed land mobile base station and the (ERP) for the associated control station. Control station antenna height must not exceed 31 m (100 ft) HAAT.

(i) Base stations operating on the frequencies available for land mobile use in any listed urbanized area and having an HAAT less than 152 m (500 ft) will protect co-channel and adjacent channel television stations in accordance with in Tables C-6 and C-10 of this paragraph except for Channel 15 in New York and Cleveland and Channel 16 in Detroit, where protection will be in accordance with Tables C-7 and C-10.

(ii) For base stations having antenna heights between 152-914 m (500-3000 ft) HAAT, the ERP must be reduced below 1 kilowatt in accordance with Table C-10 except for Channel 15 in New York and Cleveland and Channel 16 in Detroit, where the ERP must be reduced in accordance with Table C-12. For heights of more than 152 m (500 ft) HAAT, the distance to the radio path horizon will be calculated assuming smooth earth. If the distance so determined equals or exceeds the distance to the Grade B contour of a co-channel TV station as defined in § 73.683(a), an authorization will not be granted unless it can be shown that actual terrain considerations provide the desired protection at the Grade B contour, or that the effective radiated power will be further reduced so that, assuming free space attenuation, the desired protection at the Grade B contour will be achieved.

(iii) Mobile units and control stations operating on the frequencies available for land mobile use in any given urbanized area must protect co-channel and adjacent channel television stations in accordance with the values set forth in Table C-8 and paragraph (i)(iv) of this section except for Channel 15 in New York and Cleveland, and channel 16 in Detroit, where protection will be in accordance with Table C-9 and paragraph (i)(iv) of this section.

(iv) The minimum distance between a land mobile base station that has associated mobile units and a protected adjacent channel television station is 145 km (90 miles).

(v) The television stations to be protected (co-channel, adjacent channel, IM, and IF) in any given urbanized area, in accordance with the provisions of paragraphs (i)(i), (i)(ii), (i)(iii), and (i)(iv) of this section, are identified in the Commission's publication "TV stations to be considered in the preparation of Applications for Land Mobile Facilities in the Band 470-512 MHz." The publication is available from the Federal Communications Commission, Gettysburg, PA 17325.

(2) Average elevation of the terrain.

(i) In determining the average elevation of the terrain, the elevations between 3 km and 16 km (2 to 10 miles) from the antenna site are employed. Profile graphs must be drawn for a minimum of eight radials beginning at the antenna site and extending 16 km (10 miles). The radials should be drawn starting with true north. At least one radial should be constructed in the direction of the nearest co-channel and adjacent channel UHF television stations. The profile graph for each radial must be plotted by contour intervals of from 12 m to 30 m (40 ft to 100 ft) and, where the data permits, at least 50 points of elevation (generally uniformly spaced) should be used for each radial. For very rugged terrain 61 m to 122 m (200 ft to 400 ft) contour intervals may be used. Where the terrain is uniform or gently sloping, the smallest contour interval indicated on the topographic chart may be used. The average elevation of the 13 km (8 mi) distance between 3 km and 16 km (2 to 10 mi) from the antenna site should be determined from the profile graph for each radial. This may be obtained by averaging a large number of equally spaced points, by using a planimeter, or by obtaining the median elevation (that exceeded by 50 percent of the distance) in sectors and averaging those values. In the preparation of the profile graphs, the elevation or contour intervals may be taken from U.S. Geological Survey Topographic Maps, U.S. Army Corps of Engineers Maps, or Tennessee Valley Authority Maps. Maps with a scale of 1:250,000 or larger (such as 1:24,000) must be used. Digital Terrain Data Tapes, provided by the National Cartographic Institute, U.S. Geological Survey, may be utilized in lieu of maps, but the number of data points must be equal to or exceed that specified above. If such maps are not published for the area in question, the next best topographic information should be used.

(ii) Applicants for base stations in the Miami urbanized area may, in lieu of calculating the height of average terrain, use 3 m (10 ft) as the average terrain height.

**Table C-6 Maximum Base Station ERP (watts) for Co-channel Frequencies (50 dB Protection)**

Distance in km (mi) <sup>1</sup>	Antenna height (HAAT) in meters (feet)									
	15 (50)	30 (100)	45 (150)	61 (200)	76 (250)	91 (300)	106 (350)	122 (400)	137 (450)	152 (500)
260 (162)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
257 (160)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	800
249 (155)	1,000	1,000	1,000	1,000	1,000	875	775	700	625	575
241 (150)	1,000	1,000	950	775	725	625	550	500	450	400
233 (145)	850	750	650	575	500	440	400	350	320	300
225 (140)	600	575	475	400	350	300	275	250	230	225
217 (135)	450	400	335	300	255	240	200	185	165	150
209 (130)	350	300	245	200	185	160	145	125	120	100
201 (125)	225	200	170	150	125	110	100	90	80	75
193 (120)	175	150	125	105	90	80	70	60	55	50

<sup>1</sup> Distance from transmitter site of protected UHF television station.

**Table C-7 Maximum Base Station ERP (watts) for Co-channel Frequencies (40 dB Protection)**

Distance in km (mi) <sup>1</sup>	Antenna height (HAAT) in meters (feet)									
	15 (50)	30 (100)	45 (150)	61 (200)	76 (250)	91 (300)	106 (350)	122 (400)	137 (450)	152 (500)
209 (130)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
201 (125)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	850	750	725
193 (120)	1,000	1,000	1,000	1,000	900	750	675	600	550	500
185 (115)	1,000	1,000	800	725	600	525	475	425	375	350
177 (110)	850	700	600	500	425	375	325	300	275	225
169 (105)	600	475	400	325	275	250	225	200	175	150
161 (100)	400	325	275	225	175	150	140	125	110	100
153 (95)	275	225	175	125	110	95	80	70	60	50
145 (90)	175	125	100	75	50	--	--	--	--	--

<sup>1</sup> Distance from transmitter site of protected UHF television station.

<b>Table C-8 Mobile and Control Stations - Distance Between Associated Base Stations and Protected Co-channel TV Station [50 dB protection]</b>	
<b>ERP of mobile unit and control station (watts)</b>	<b>Distance Kilometers (mi)</b>
200	249 (155)
150	243 (151)
100	233 (145)
50	217 (135)
25	201 (125)
10	188 (117)
5	180 (112)

<b>Table C-9 Mobile and Control Stations - Distance Between Associated Base Station and Protected Co-channel TV Station [40 dB protection]</b>	
<b>ERP of mobile unit and control station (watts)</b>	<b>Distance Kilometers (mi)</b>
200	209 (130)
150	201 (125)
100	193 (120)
50	185 (115)
25	177 (110)
10	169 (105)
5	161 (100)

<b>Table C-10 Maximum Base Station ERP for Adjacent Channel Frequencies</b>										
Distance in km (mi) <sup>1 2</sup>	Antenna height HAAT in meters (feet)									
	15 (50)	30 (100)	45 (150)	61 (200)	76 (250)	91 (300)	106 (350)	122 (400)	137 (450)	152 (500)
108 (67)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
106 (66)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	750
104 (65)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	825	650	600
103 (64)	1,000	1,000	1,000	1,000	1,000	1,000	775	625	500	400
101 (63)	1,000	1,000	1,000	1,000	1,000	650	450	325	325	225
99 (62)	1,000	1,000	1,000	1,000	525	375	250	200	150	125
98 (61)	1,000	1,000	700	450	250	200	125	100	75	50
96 (60)	1,000	1,000	425	225	125	100	75	50	--	--

<sup>1</sup> Distance from transmitter site of protected UHF television station.

<sup>2</sup> The minimum distance is 90 miles (145 km) where there are mobile units associated with the base station. See § 88.429(i)(1)(iv).

<b>Table C-11 Maximum Base Station ERP (watts) with HAAT more than 152 meters [50 dB Protection]</b>						
Distance in km (mi) <sup>1 2</sup>	Antenna height (HAAT) in meters (feet) <sup>2</sup>					
	152 (500)	305 (1000)	457 (1500)	610 (2000)	762 (2500)	914 (3000)
261 (162)	1000	501	282	170	110	71
241 (150)	400	209	110	60	36	23
225 (140)	225	102	50	28	16	10
209 (130)	100	48	21	11	7	5
193 (120)	50	19	9	5	3	2

<sup>1</sup> Distance from transmitter site of protected UHF television station.

<sup>2</sup> For intermediate values of height and/or distance, use linear interpolation to obtain the maximum permitted ERP.

Distance in km (mi) <sup>1 2</sup>	Antenna height (HAAT) in meters (feet) <sup>2</sup>					
	152 (500)	305 (1000)	457 (1500)	610 (2000)	762 (2500)	914 (3000)
209 (130)	1000	447	219	117	71	46
193 (120)	500	209	95	50	30	19
177 (110)	225	91	35	19	11	8
161 (100)	100	30	10	5	3	2
153 (95)	50	13	5	3	2	1

<sup>1</sup> Distance from transmitter site of protected UHF television station.

<sup>2</sup> For intermediate values of height and/or distance, use linear interpolation to obtain the maximum permitted ERP.

(j) 806-824 MHz/851-869 MHz and 896-901/935-940 MHz.

(1) Systems to be located within 24 km (15 mi) of the geographic center of the 50 urbanized areas listed below will be considered "urban" systems (Except where included below, see § 88.1601 for geographic centers). All others will be considered "suburban" systems.

Akron, OH, Albany, NY, Atlanta, GA, Baltimore, MD, Birmingham, AL, Boston, MA, Buffalo, NY, Chicago, IL, Cincinnati, OH, Cleveland, OH, Columbus, OH, Dallas, TX, Dayton, OH, Denver, CO, Detroit, MI, Fort Lauderdale, FL (26°07'30", 80°09'00"), Fort Worth, TX (32°44'55", 97°19'44"), Houston, TX, Indianapolis, IN, Jacksonville, FL, Kansas City, MO, Los Angeles, CA, Louisville, KY, Miami, FL, Memphis, TN, Milwaukee, WI, Minneapolis, MN, New Orleans, LA, New York, NY, Norfolk, VA, Oklahoma City, OK, Omaha, NE, Philadelphia, PA, Phoenix, AZ, Pittsburgh, PA, Portland, OR, Providence, RI, Rochester, NY, Sacramento, CA, St. Louis, MO, St. Petersburg, FL (27°46'18", 82°38'19"), San Antonio, TX, San Bernardino, CA (34°06'30", 117°17'28"), San Diego, CA, San Francisco, CA, San Jose, CA (37°20'16", 121°53'24"), Seattle, WA, Springfield, MA, Toledo, OH, Washington, DC

(2) The effective radiated power and antenna height for base stations used in suburban-conventional systems of communications may not exceed 500 watts (27 dBw) and 152 m (500 ft) above average terrain (AAT) respectively, or the equivalent as determined from Table C-13. These are maximum values, and applicants are required to justify power levels and antenna heights requested. For service area requirements less than 32 km (20 mi) in radius, see Table C-14.

(3) The effective radiated power and antenna height for base stations used in trunked and urban-conventional systems may not exceed 1 kilowatt (30 dBw) and 304 m (1000 ft) above average terrain (AAT), respectively, or the

equivalent thereof as determined from Table C-13. These are maximum values, and applicants will be required to justify power levels and antenna heights requested. For service area requirements less than 32 km (20 mi) in radius, see Table C-15.

(4) The maximum transmitter output power for mobile stations is 100 watts.

Antenna height (HAAT) in meters (feet)	ERP (watts)	
	Urban/trunked	Suburban
Over 1524 (5000)	65	15
1372-1524 (4501-5000)	65	15
1220-1371 (4001-4500)	70	29
1067-1219 (3501-4000)	75	25
915-1066 (3001-3500)	100	30
763-914 (2501-3000)	140	35
610-762 (2001-2500)	200	50
458-609 (1501-2000)	350	80
305-457 (1001-1500)	600	160
153-304 (501-1000)	1000	220
Up to 152 (500)	1000	500

<sup>1</sup> Applicants in the Los Angeles area who demonstrate a need to serve both downtown and fringe areas will be permitted to utilize an ERP of 1 kw at the following mountaintop sites: Santiago Peak, Sierra Peak, Mount Lukens, and Mount Wilson.

<sup>2</sup> Licensees in San Diego will be permitted to utilize an ERP of 500 watts at the following mountaintop sites: Palomar, Otay, Woodson, and Miguel.

**Table C-14 Equivalent Power and Antenna Heights for Suburban-Conventional Base Stations in the 851-869 MHz and 935-940 MHz Bands which have a requirement for less than a 32 km (20 mi) Service Area Radius**

Service area radius in km (mi)	Base station antenna height (HAAT) in meters (feet)					
	122-152 (401-500)	92-122 (301-400)	61-92 (201-300)	31-61 (101-200)	15-31 (51-100)	0-15 (0-50)
32 (20)	500	500	500	500	500	500
30 (19)	400	500	500	500	500	500
29 (18)	310	385	500	500	500	500
27 (17)	235	300	385	500	500	500
26 (16)	175	220	285	440	500	500
24 (15)	130	160	215	330	500	500
22 (14)	95	120	155	240	480	500
21 (13)	70	85	115	175	350	500
19 (12)	50	60	80	125	250	500
18 (11)	35	45	60	90	180	360
16 (10)	25	30	40	60	120	240
14 (9)	15	20	25	40	80	160
13 (8)	10	12	15	25	50	100
11 (7)	6	7	10	15	30	60
10 (6)	3	4	5	7	15	30
8 (5) or less	1	2	3	4	8	16

**Table C-15 Equivalent Power and Antenna Heights for Urban-Conventional and Trunked System Base Stations in the 851-869 MHz and 935-940 MHz Bands which have a requirement for less than a 32 km (20 mi) Service Area Radius**

Service area radius km (mi)	Base station antenna height (HAAT) in meters (feet)							
	228-305 (751-1000)	152-228 (501-750)	121-152 (401-500)	91-121 (301-400)	60-91 (201-300)	30-60 (101-200)	15-30 (51-100)	0-15 (0-50)
32 (20)	1000	1000	1000	1000	1000	1000	1000	1000
30 (19)	800	1000	1000	1000	1000	1000	1000	1000
29 (18)	640	830	1000	1000	1000	1000	1000	1000
27 (17)	480	625	960	1000	1000	1000	1000	1000
26 (16)	360	470	720	900	1000	1000	1000	1000
24 (15)	270	350	540	675	875	1000	1000	1000
22 (14)	200	260	400	500	650	1000	1000	1000
21 (13)	140	180	280	350	450	700	1000	1000
19 (12)	100	130	200	250	325	500	1000	1000
18 (11)	70	90	140	175	230	350	700	1000
16 (10)	45	60	90	110	145	220	440	1000
14 (9)	30	40	60	75	100	150	300	600
13 (8)	20	25	40	50	65	100	200	400
11 (7)	15	20	30	40	50	80	160	300
10 (6)	8	10	16	20	25	40	80	100
8 (5)	5	6	9	12	15	25	50	10
or less								

(k) **929-930 MHz.** The maximum effective radiated power (ERP) is 1 kilowatt at an antenna height above average terrain (AAT) of 305 m (1000 ft). For antenna heights above 305 m (1000 ft) AAT, the ERP will be reduced as shown in Table C-16.

Antenna height (HAAT) in meters (feet)	Effective radiated power (ERP) (watts)
Up to 305 (1000)	1000
305-457 (1001-1500)	600
457-610 (1500-2000)	350
610-762 (2000-2500)	200
762-915 (2500-3000)	140
915-1067 (3000-3500)	100
1067-1220 (3500-4000)	75
1220-1372 (4000-4500)	70
1372-1525 (4500-5000)	65
Over 1525 (5000)	65

(o) 1427-1435 MHz. Requested transmitter power will be considered and authorized on a case-by-case basis.

(m) 2450-2483.5 MHz. The maximum transmitter output power is 5 watts.

(n) Above 2500 MHz. Requested transmitter power will be considered and authorized on a case-by-case basis.

**§ 88.433 Spectrum efficiency standards.**

(a) Use of non-standard bandwidths will be authorized provided that the following minimum spectrum efficiency standards are met. For systems operating in a paired mode, the requirements pertain to the base station frequencies.

25-50 MHz	One communications link per 20 kHz
72-76 MHz	One communications link per 5 kHz
150-174 MHz	One communications link per 5 kHz
220-222 MHz	One communications link per 5 kHz
420-512 MHz	One communications link per 6.25 kHz
806-869 MHz	One communications link per 25 kHz
896-940 MHz	One communications link per 12.5 kHz

(b) A communications link may convey either data or voice. Data systems may use fewer than the minimum number of communications links provided that the total through-put rate (information net of system overhead) is at least 4800 baud times the required number of communications links.

(c) Pertinent requirements. When non-standard bandwidths are used the frequency stability requirements of § 88.425 do not apply, but the out-of-band emission limits of § 88.421 must be met.

(d) All stations using frequencies between 150-512 MHz must meet the minimum spectrum efficiency standards in paragraph (a) by the following dates:

Market Number in § 88.1601	Date
1-15	January 1, 2004
16-30	January 1, 2005
31-45	January 1, 2006
46-60	January 1, 2007
61-75	January 1, 2008
76-100	January 1, 2010
Outside Top 100 Markets	January 1, 2012

A system is located in a market if it has a base station located within 161 km (100 mi) of the coordinates in § 88.1601. If located within 161 km (100 mi) of more than one market, the earliest market date applies.

#### OPERATING REQUIREMENTS

##### § 88.437 General.

(a) Licensees of radio stations in the private land mobile radio services are responsible for the proper operation and use of each transmitter operating by authority of the license. Licensees must exercise direction and control to assure that all authorized facilities are employed only in a permissible manner and only by persons with authority to use and operate such equipment. Except for frequencies used in accordance with § 88.461(a), no person shall enter or program into a transmitter frequencies for which the licensee using the transmitter is not authorized.

(b) Licensees are bound by the provisions of the Communications Act of 1934, as amended, and by the rules and regulations of the Commission governing the radio service in which their facilities are licensed. Licensees may not, through written or oral agreements or otherwise, relieve themselves of any duty or obligation imposed upon them, by law, as licensees.

(c) Each licensee must restrict all transmissions to the minimum practicable transmission time and employ an efficient operating procedure designed to maximize the utilization of the spectrum. Communications involving imminent threats to safety of life or property are to be afforded priority by all licensees. No licensee may transmit continuously on shared channels.

(d) Licensees must take reasonable precautions to avoid causing harmful interference. This includes monitoring the transmitting frequency for communications in progress and such other measures as may be necessary to minimize the potential for causing interference.

(e) Stations licensed in this part may not continuously radiate an unmodulated carrier, except where specifically permitted by this part or specifically authorized in the station authorization.

(f) Suspension of operation. The radiations of the transmitter must be suspended immediately upon detection or notification of a deviation from the

technical requirements of the station authorization and until such deviation is corrected. For transmissions concerning imminent threats to safety of life or property, the transmissions must be suspended as soon as the emergency is terminated.

**§ 88.445 Trunked operations.**

(a) Trunked operations will be authorized in the 220-222 MHz and in the bands above 800 MHz except as restricted in § 88.737.

(b) Trunked operations will be authorized in the 150-174 MHz and 421-512 MHz bands as follows:

(1) The applicant has obtained written concurrence from all co-channel base station licensees located within 113 km (70 mi) or;

(2) The applicant has obtained written concurrence from all co-channel base station licensees located within 80 km (50 mi) and all co-channel base station licensees located between 113 km (70 mi) and 80 km (50 mi) whose stations exceed the power limitation of § 88.429.

**§ 88.449 Prohibited uses.**

Stations licensed under this part may not:

(a) Transmit program material of any kind for use in connection with broadcasting, except that SMR customers may utilize SMR service for broadcast on-air activities; or

(b) Render a communications common carrier service, except that a communications common carrier operating communications circuits that normally carry essential communication of such a nature that their disruption would endanger life or public property is eligible to hold authorizations for standby radio facilities for the transmission of messages only during periods when the normal circuits are inoperative due to circumstances beyond the control of the user. During such periods the radio facilities may be used to transmit any communication that would be carried by the regular circuit.

(c) Licensees without channel exclusivity may not engage in communications unrelated to business or safety of life or property.

**§ 88.453 Emergency communications.**

(a) The licensee of any station authorized under this part may, during a period of emergency in which the normal communication facilities are disrupted as a result of hurricane, flood, earthquake or similar disaster, utilize such station for emergency communications in a manner other than that specified in the station authorization or in the rules and regulations governing the operation of such stations. The Commission may at any time order the licensee to stop such special use of the authorized facilities.

(b) Any station licensed under this part may communicate with any other station without restriction as to type, service, or licensee when the communications involved relate directly to the imminent safety-of-life or property.

**§ 88.457 Civil defense communications.**

The licensee of any station authorized under this part may, on a voluntary basis, transmit communications necessary for the implementation of civil defense activities assigned such station by local civil defense authorities during an actual or simulated emergency, including drills and tests. The Commission may at any time order the licensee to stop such special use of the authorized facilities.

**§ 88.461 Interstation communications.**

(a) When coordination or cooperation is required, any station licensed under this part may communicate with any other station licensed under this part, with U.S. Government stations, and with foreign stations, provided that where the communication involves foreign stations prior approval of the Commission must be obtained, and such communication must be permitted by the government that authorizes the foreign station.

(b) Except for mutual aid channels in the 821-824/866-869 MHz band (see §§ 88.831-88.841), communications by governmental police agency stations with foreign stations will be approved only to be conducted in accordance with Article 5 of the Inter-American Radio Agreement, Washington, D.C., 1949. Request for such authority must be submitted in duplicate, indicate which station with which communication will be conducted, and specify the frequency, power, emission, etc., that will be used.

**§ 88.465 Delegated use of authorized frequencies.**

(a) Mobile units or frequencies may be installed in vehicles operated by persons other than the licensee as provided in the following paragraphs. The licensee is responsible for taking any necessary precaution to effectively eliminate the possibility of unauthorized operation of transmitters when not under the control of the licensee. If the number of units or frequencies so installed, together with units in vehicles operated by the licensee, exceeds the number of mobile units authorized to the licensee, a modification to the licensee's authorization will be required.

(b) Mobile units or frequencies licensed in the Public Safety Radio Service may be installed in any vehicle that in an emergency would require cooperation and coordination with the licensee, and in any vehicle used in the performance, under contract, of official activities of the licensee. This provision does not permit the installation of mobile units or frequencies in non-emergency vehicles not performing governmental functions under contract but with which the licensee might wish to communicate.

(c) Mobile units or frequencies may be installed in a vehicle or be hand-carried for use by any person with whom cooperation or coordination is required for medical services activities.

(d) Mobile units or frequencies licensed in the Non-Commercial Radio or Specialized Mobile Radio Services may be installed in vehicles of persons furnishing, under contract to or agreement with the licensee and for the duration of the contract or agreement, a facility or service directly related to the activities of the licensee.

(e) Mobile units or frequencies may be installed in the facilities of those who assist the licensee in emergencies and with whom the licensee must communicate in situations involving imminent safety to life or property.

#### **§ 88.469 Operation in aircraft.**

(a) Mobile stations authorized under this part may be operated aboard aircraft that are regularly flown at altitudes below 1.6 km (1 mi) above the earth's surface. Transmitter output power may not exceed ten watts and aircraft operations are secondary to land-based systems.

(b) Exceptions to the altitude and power limitations set forth in paragraph (a) of this section may be authorized on a showing of unusual operational requirements that justify departure from those standards, provided that the interference potential to regular land-based operations would not be increased.

(c) Operation of radiolocation mobile stations are exempt from the limitations and conditions of paragraph (a) of this section.

#### **§ 88.473 Mobile relay stations.**

(a) Mobile relay stations will be authorized in the 220-222, 450-470, 470-512, 806-824/851-869, and 896-901/935-940 MHz bands.

(1) On frequencies below 450 MHz, except for the 220-222 MHz band, mobile relay stations may be authorized within the contiguous 48 states to operate on frequencies listed in Subparts D and E, provided that the licensee has an exclusive use overlay license for that frequency at that site or has concurrence of all other licensees within 80 km (50 mi).

(2) On frequencies below 450 MHz, except for the 220-222 MHz band, mobile relay stations may be authorized outside the contiguous 48 states to operate on any frequency listed in Subparts D and E.

(3) Medical service systems in the 150-160 MHz band may be cross-banded for coordinated operations with mobile relay stations operating in the 450-470 MHz band.

(4) Mobile relay stations may be authorized on frequencies below 450 MHz reserved for low power operation listed in § 88.907. For such stations, the maximum output power may not exceed 1 watt and the mobile relay antenna system cannot be more than 13 m (40 ft) above ground.

(b) Technical requirements for mobile relay stations.

(1) Mobile relay stations with an output power of more than one watt must utilize coded signal or tone control devices to activate the station. The station must be deactivated when reception of the activating continuous coded tone signal stops.

(2) Except as provided in paragraph (3) of this section, a mobile relay station must be equipped for automatic deactivation of the transmitter within 5 seconds after the signals controlling the station cease. It also must have an automatic time delay or clock device that will, during periods that it is not controlled from a manned fixed control point, deactivate the station three minutes after the carrier stops.

(3) For licensees operating railroads or providing essential services to railroads, each mobile relay station must automatically deactivate when its associated receiver or receivers are not receiving a signal on the frequency or frequencies that normally activate it.

#### § 88.477 Fixed relay stations.

Except where specifically provided for, fixed relay stations will be authorized to operate only on frequencies designated for fixed use.

#### § 88.481 Mobile repeater stations.

A mobile station authorized to operate on a mobile service frequency above 25 MHz may be used as a mobile repeater to extend the communications range of hand-carried transmitters subject to the following:

(a) Mobile repeaters and/or associated hand-carried transmitters may be assigned non-exclusive base/mobile frequencies for this use in addition to the number of frequencies normally assignable to the licensee.

(b) Low-power frequencies below 450 MHz listed in § 88.907 may be assigned for use by mobile repeaters or by hand-carried transmitters whose communications are directed to mobile repeaters, when separate frequencies are assigned for that purpose.

(c) Except as provided in paragraph (d) of this section, hand-carried transmitters whose communications will be automatically relayed by mobile stations must be limited to a maximum output power of 2.5 watts.

(d) Hand-carried transmitters used in connection with mobile repeaters by licensees operating railroads may operate only above 150 MHz and, except when the same frequency is also used by the same station for direct communication

with vehicular mobile units or with one or more base stations, are limited to a maximum output power of 6 watts.

(e) The mobile repeater must be activated by means of a continuous coded tone, the absence of which will deactivate the transmitter. The coded tone is not required if the mobile repeater can be switched to an automatic mode and is also equipped with an automatic timer that deactivates the transmitter if an uninterrupted carrier remains on for more than three minutes.

#### **§ 88.485 Control stations.**

(a) Control stations associated with base stations will be authorized to operate on frequencies available for fixed use.

(b) Control stations associated with mobile relay stations will be assigned the frequency of the associated mobile station.

(c) Control stations may be authorized on a temporary basis to operate on Public Safety Radio Service frequencies available for base and mobile stations between 152 and 450 MHz, if it is shown that operations cannot be conducted on fixed use frequencies. Such operation will not be authorized initially or renewed for periods in excess of one year. Any such authorization will be subject to immediate termination if harmful interference is caused to stations in the mobile service, or if the particular frequency is required for mobile service operations in the area concerned.

(d) A base station that is used intermittently as a control station for one or more associated mobile relay stations of the same licensee must operate only on the frequency assigned to the associated mobile relay station when operating as a base station, and on the mobile frequency assigned to the associated mobile station when operating as a control station. Authority for such dual classification and use must be shown on the station authorization. When operating as a control station, the licensee must meet all control station requirements.

#### **§ 88.489 Station identification.**

(a) Except as provided for in paragraph (e) of this section, each station or system licensed under this part must be identified by the transmission of the assigned call sign during each transmission or exchange of transmissions, or once each 15 minutes (30 minutes in the Public Safety Radio Service) during periods of continuous operation. The call sign must be transmitted by voice in the English language or by International Morse Code in accordance with paragraph (b) of this section. If the station employs either analog or digital voice scrambling, or non-voice emission, transmission of the required identification must be in the unscrambled mode using A3E, F3E, or G3E emission, or International Morse Code, with all encoding disabled. Permissible alternative identification procedures are as follows:

(1) A base station (including a mobile relay station) controlled by radio may be identified by the transmission of the call sign of the station where