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minimum height requirements, or submit evidence that the present antenna system meets the minimum requirements with respect to field strength, before favorable consideration will be given thereto. (See §73.186.) In the event it is proposed to make substantial changes in an existing antenna system, the changes shall be such as to meet the minimum height requirements or will be permitted subject to the submission of field strength measurements showing that it meets the minimum requirements with respect to effective field strength.

(2) These minimum actual physical vertical heights of antennas permitted to be installed are shown by curves A, B, and C of Figure 7 of §73.190 as follows:

(i) Class C stations, and stations in Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands on 1230, 1240, 1340, 1400, 1450 and 1490 kHz that were formerly Class C and were redesignated as Class B pursuant to §73.26(b), 45 meters or a minimum effective field strength of 180 mV/m for 1 kW at 1 kilometer (90 mV/m for 0.25 kW at 1 kilometer). (This height applies to a Class C station on a local channel only. Curve A shall apply to any Class C stations in the 48 conterminous States that are assigned to Regional channels.)

(ii) Class A (Alaska), Class B and Class D stations other than those covered in §73.189(b)(2)(i), a minimum effective field strength of 215 mV/m for 1 kW at 1 kilometer.

(iii) Class A stations, a minimum effective field strength of 275 mV/m for 1 kW at 1 kilometer.

(3) The heights given on the graph for the antenna apply regardless of whether the antenna is located on the ground or on a building. Except for the reduction of shadows, locating the antenna on a building does not necessarily increase the efficiency and where the height of the building is in the order of a quarter wave the efficiency may be materially reduced.

(4) At the present development of the art, it is considered that where a vertical radiator is employed with its base on the ground, the ground system should consist of buried radial wires at least one-fourth wave length long. There should be as many of these

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radials evenly spaced as practicable and in no event less than 90. (120 radials of 0.35 to 0.4 of a wave length in length and spaced 3° is considered an excellent ground system and in case of high base voltage, a base screen of suitable dimensions should be employed.)

(5) In case it is contended that the required antenna efficiency can be obtained with an antenna of height or ground system less than the minimum specified, a complete field strength survey must be supplied to the Commission showing that the field strength at a mile without absorption fulfills the minimum requirements. (See §73.186.) This field survey must be made by a qualified engineer using equipment of acceptable accuracy.

(6) The main element or elements of a directional antenna system shall meet the above minimum requirements with respect to height or effective field strength. No directional antenna system will be approved which is so designed that the effective field of the array is less than the minimum prescribed for the class of station concerned, or in case of a Class A station less than 90 percent of the ground wave field which would be obtained from a perfect antenna of the height specified by Figure 7 of §73.190 for operation on frequencies below 1000 kHz, and in the case of a Class B or Class D station less than 90 percent of the ground wave field which would be obtained from a perfect antenna of the height specified by Figure 7 of §73.190 for operation on frequencies below 750 kHz.

[28 FR 13574, Dec. 14, 1963, as amended at 31 FR 8069, June 8, 1966; 33 FR 15420, Oct. 17, 1968; 44 FR 36033, June 20, 1979; 50 FR 18844, May 2, 1985; 51 FR 2707, Jan. 21, 1986; 51 FR 4753, Feb. 7, 1986; 52 FR 10570, Apr. 2, 1987; 56 FR 64868, Dec. 12, 1991; 81 FR 2760, Jan. 19, 2016]

§73.190 Engineering charts and related formulas.

(a) This section consists of the following Figures: 2, r3, 5, 6a, 7, 8, 9, 10, 11, 12, and 13. Additionally, formulas that are directly related to graphs are included.

(b) Formula 1 is used for calculation of 50% skywave field strength values.

FORMULA 1. Skywave field strength, 50% of the time (at SS + 6):

The skywave field strength, $F_c(50)$, for a characteristic field strength of 100 mV/m at 1 km is given by:

$$F_c(50) = (97.5 - 20 \log D) - (2\pi + 4.95 \tan^2 \phi_M) \sqrt{\left(\frac{D}{1000}\right)} \text{ dB}(\mu\text{V/m}) \quad (\text{Eq. 1})$$

The slant distance, D , is given by:

$$D = \sqrt{40,000 + d^2} \text{ km} \quad (\text{Eq. 2})$$

The geomagnetic latitude of the midpoint of the path, Φ_M , is given by:

$$\Phi_M = \arcsin[\sin a_M \sin 78.5^\circ + \cos a_M \cos 78.5^\circ \cos(69 + b_M)] \text{ degrees} \quad (\text{Eq. 3})$$

The short great-circle path distance, d , is given by:

$$d = 111.18 d^\circ \text{ km} \quad (\text{Eq. 4})$$

Where:

$$d^\circ = \arccos[\sin a_T \sin a_R + \cos a_T \cos a_R \cos(b_R - b_T)] \text{ degrees} \quad (\text{Eq. 5})$$

Where:

a_T is the geographic latitude of the transmitting terminal (degrees)

a_R is the geographic latitude of the receiving terminal (degrees)

b_T is the geographic longitude of the transmitting terminal (degrees)

b_R is the geographic longitude of the receiving terminal (degrees)

a_M is the geographic latitude of the midpoint of the great-circle path (degrees) and is given by:

b_M is the geographic longitude of the midpoint of the great-circle path (degrees) and is given by:

$$a_M = 90 - \arccos \left[\sin a_R \cos \left(\frac{d^\circ}{2} \right) + \cos a_R \sin \left(\frac{d^\circ}{2} \right) \left(\frac{\sin a_T - \sin a_R \cos d^\circ}{\cos a_R \sin d^\circ} \right) \right] \quad (\text{Eq. 6})$$

$$b_M = b_R + k \left[\arccos \left(\frac{\cos \left(\frac{d^\circ}{2} \right) - \sin a_R \sin a_M}{\cos a_R \cos a_M} \right) \right] \quad (\text{Eq. 7})$$

Note (1): If $|F_M|$ is greater than 60 degrees, equation (1) is evaluated for $|F_M| = 60$ degrees.

Note (2): North and east are considered positive; south and west negative.

Note (3): In equation (7), $k = -1$ for west to east paths (*i.e.*, $b_R > b_T$), otherwise $k = 1$.

(c) Formula 2 is used for calculation of 10% skywave field strength values.

FORMULA 2. Skywave field strength, 10% of the time (at SS + 6):

The skywave field strength, $F_c(10)$, is given by:

$$F_c(10) = F_c(50) + \Delta \text{ dB}(\mu\text{V/m})$$

Where:

$$\Delta = 6 \text{ when } |F_M| < 40$$

$$\Delta = 0.2 |F_M| - 2 \text{ when } 40 \leq |F_M| \leq 60$$

$$\Delta = 10 \text{ when } |F_M| > 60$$

(d) Figure 6a depicts angles of departure versus transmission range. These angles may also be computed using the following formulas:

$$\theta^\circ = \tan^{-1} \left(k_n \cot \frac{d}{444.54} \right) - \frac{d}{444.54}$$

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Where:

d = distance in kilometers

n = 1 for 50% field strength values

n = 2 or 3 for 10% field strength values

and where

$K_1 = 0.00752$

$K_2 = 0.00938$

$K_3 = 0.00565$

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NOTE: Computations using these formulas should not be carried beyond 0.1 degree.

(e) In the event of disagreement between computed values using the formulas shown above and values obtained directly from the figures, the computed values will control.

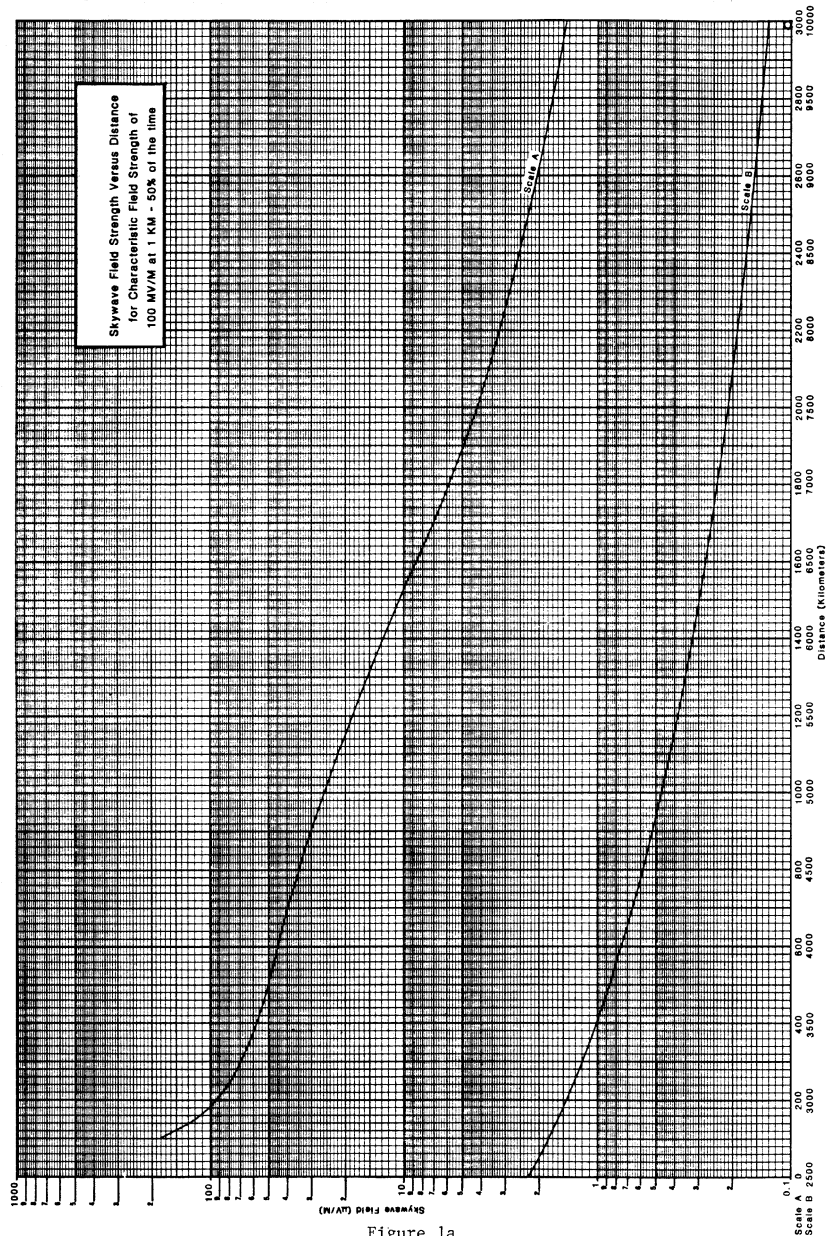
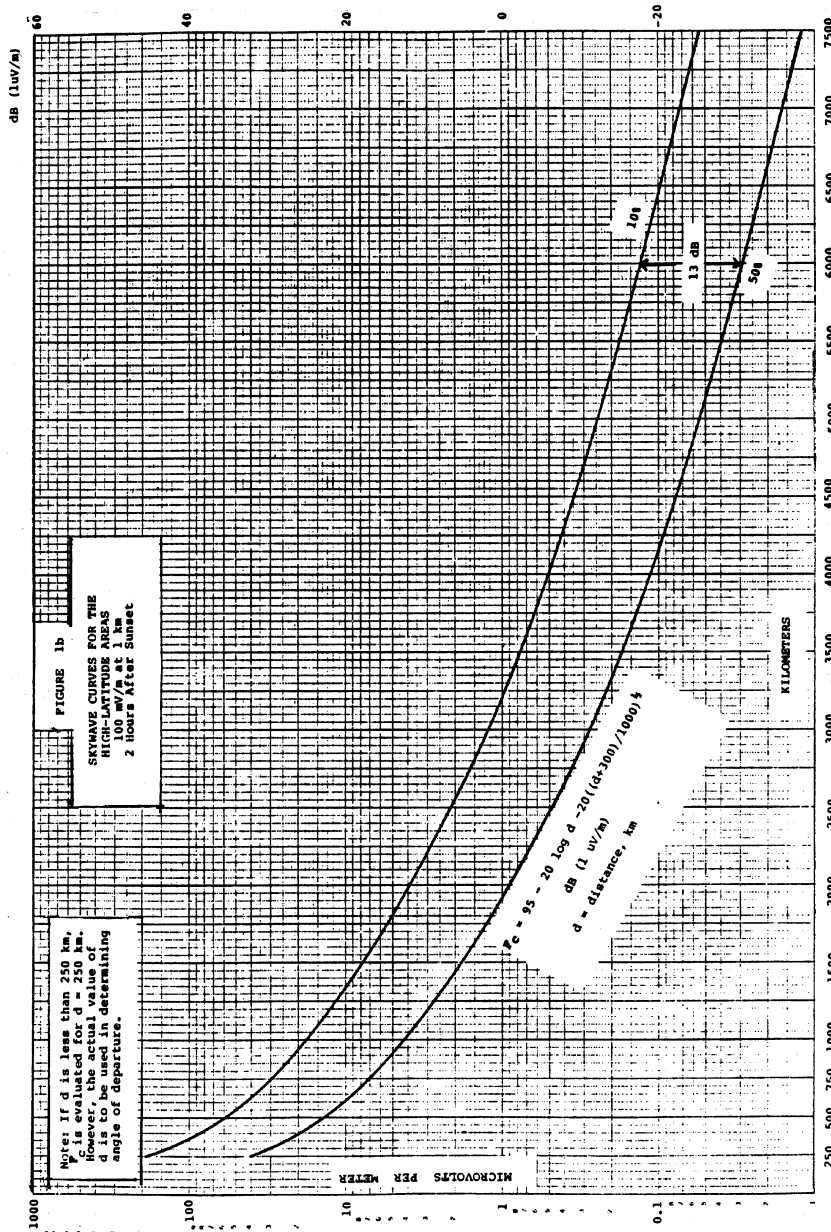
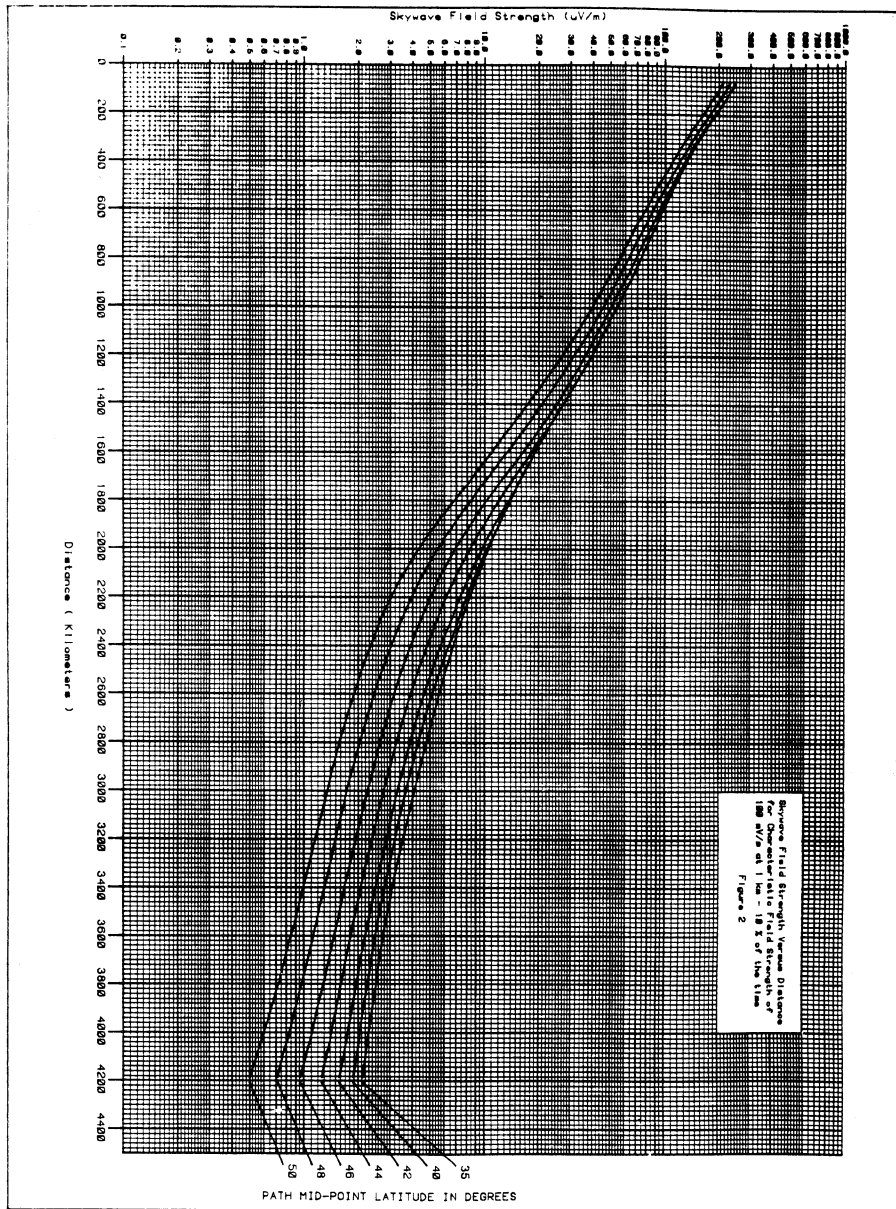


Figure 1a





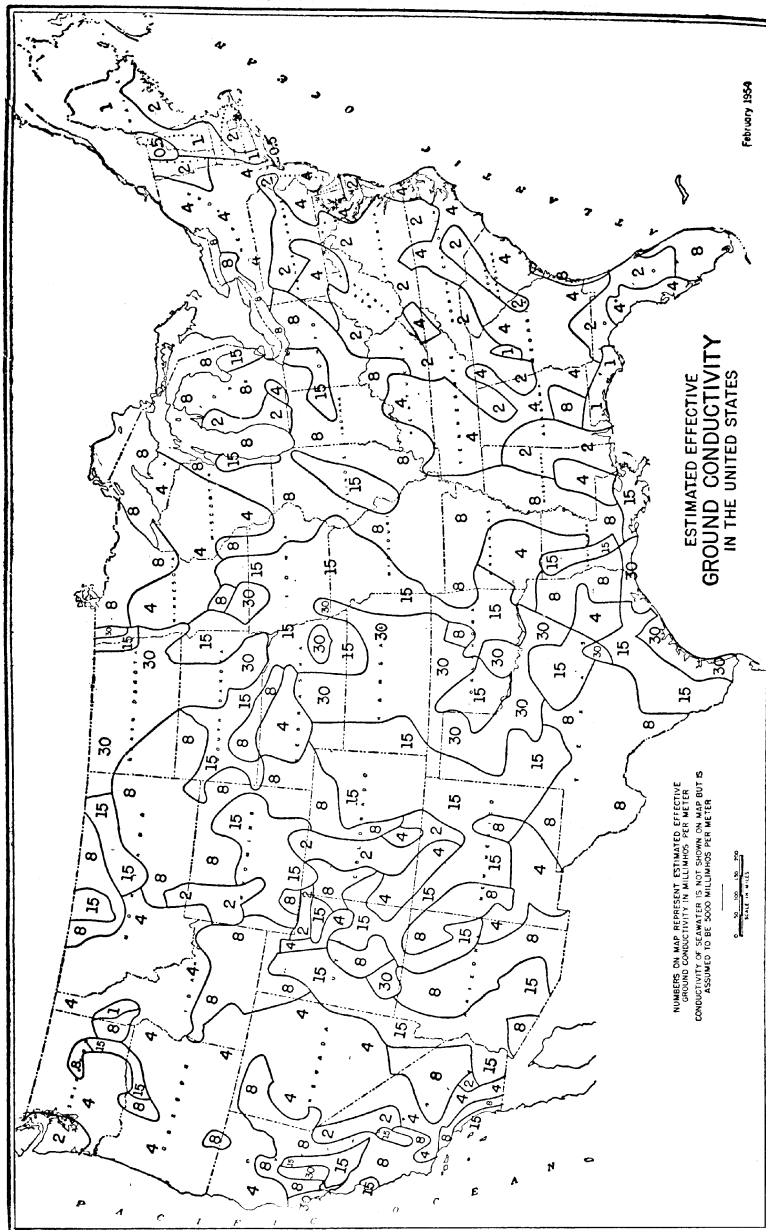
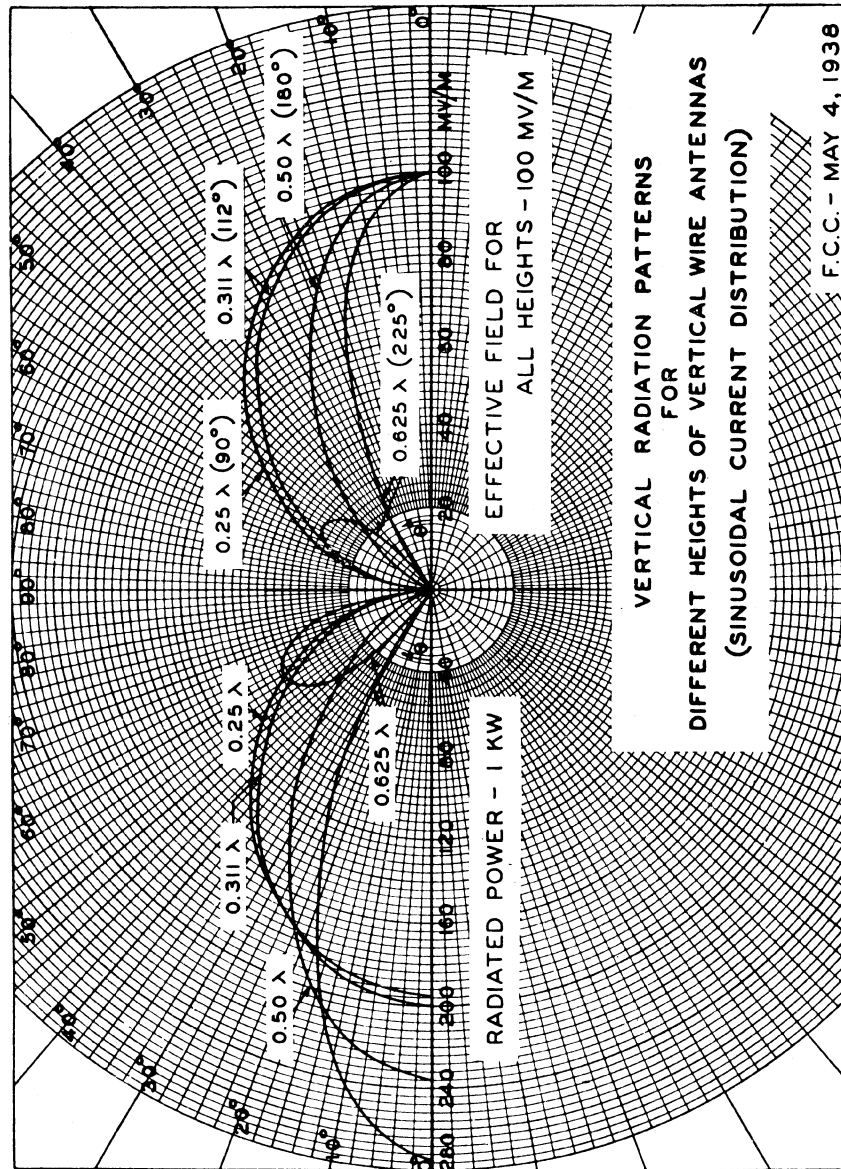
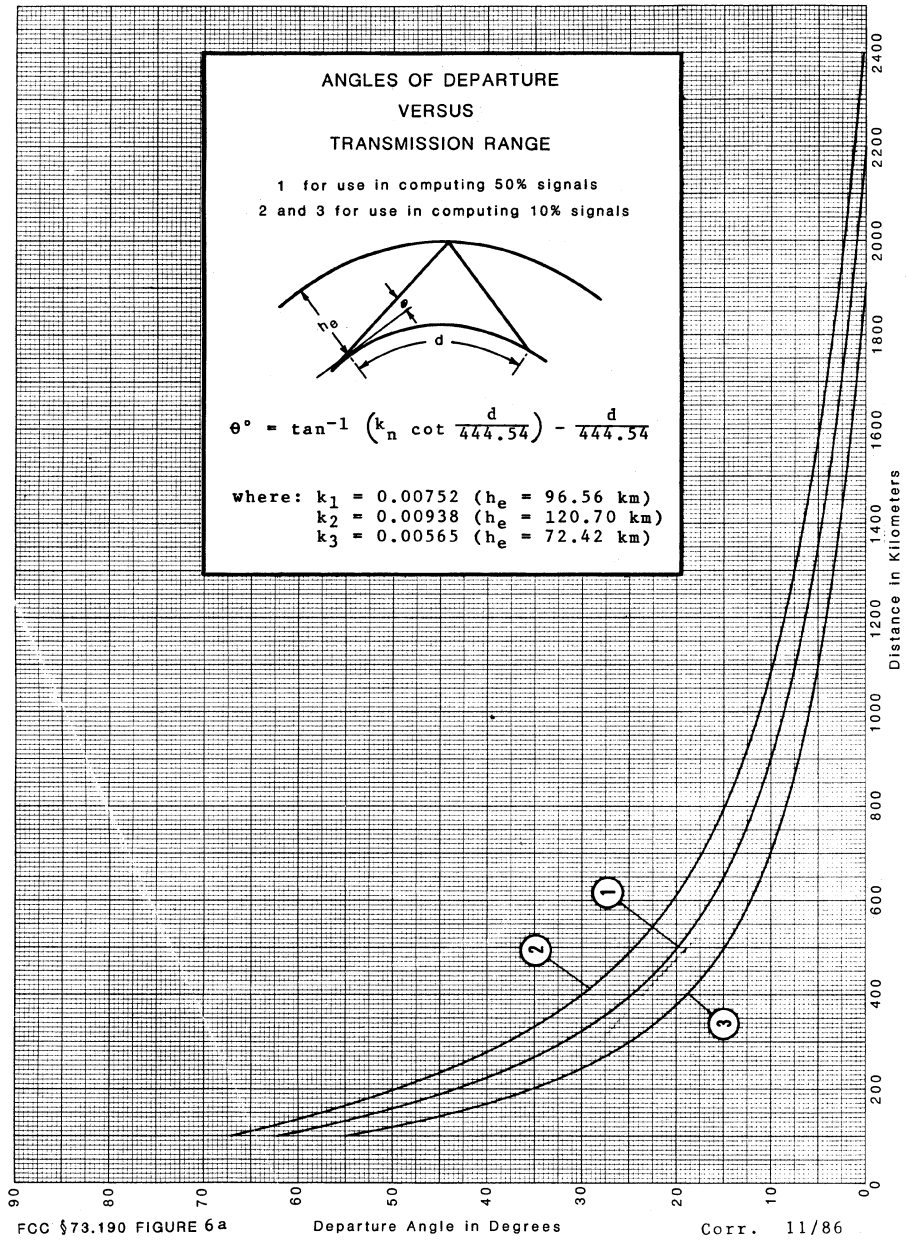


FIGURE E3.



F.C.C. - MAY 4, 1938

Figure 5



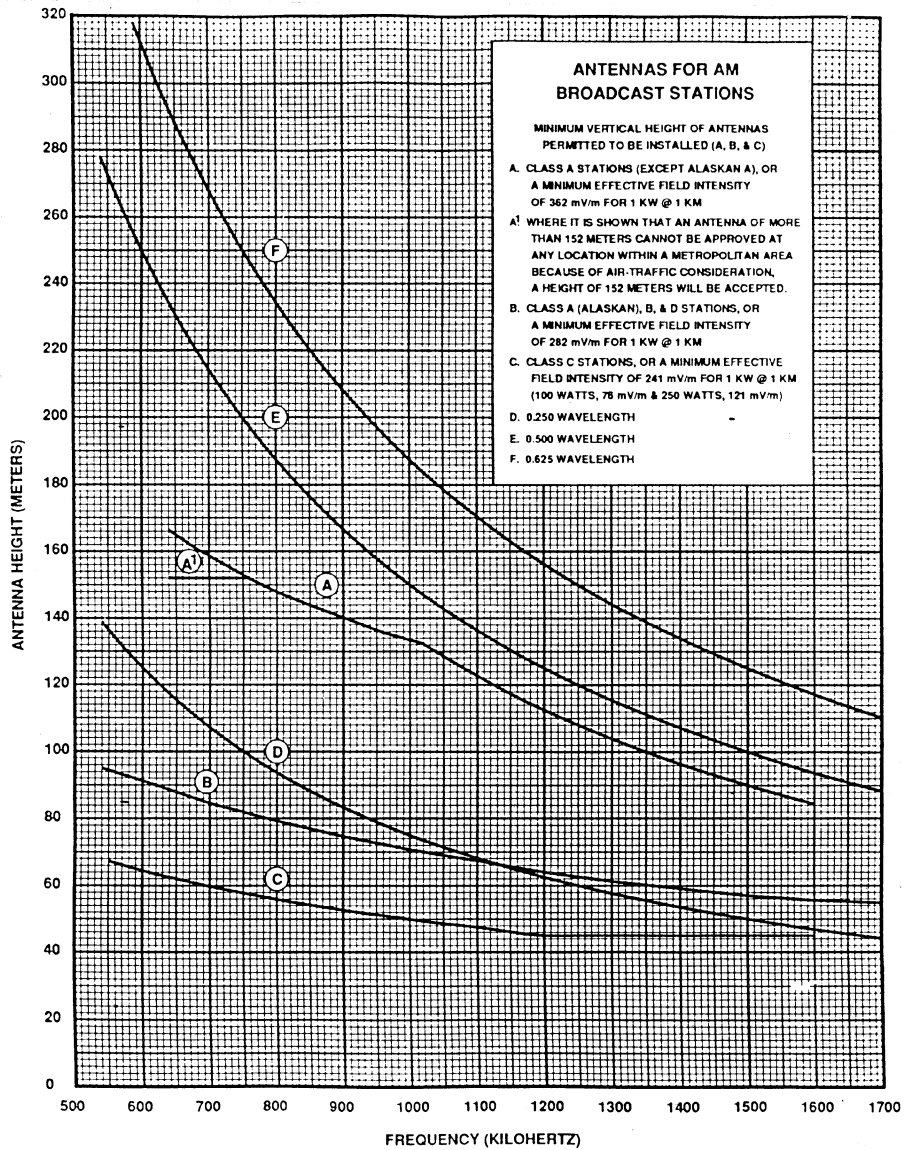


Figure 7

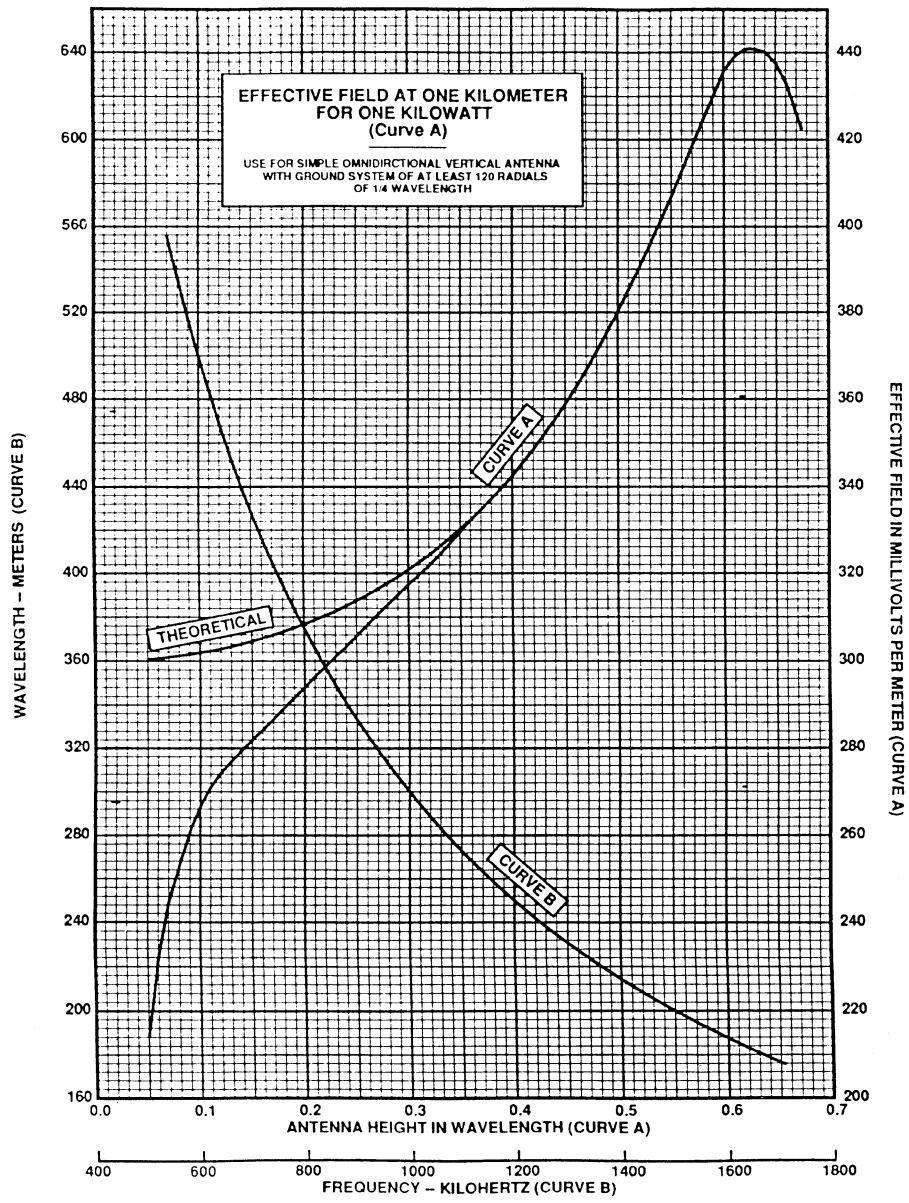


Figure 8

PERMISSIBLE DAYTIME RADIATION FOR CLASS II STATIONS

500 KC

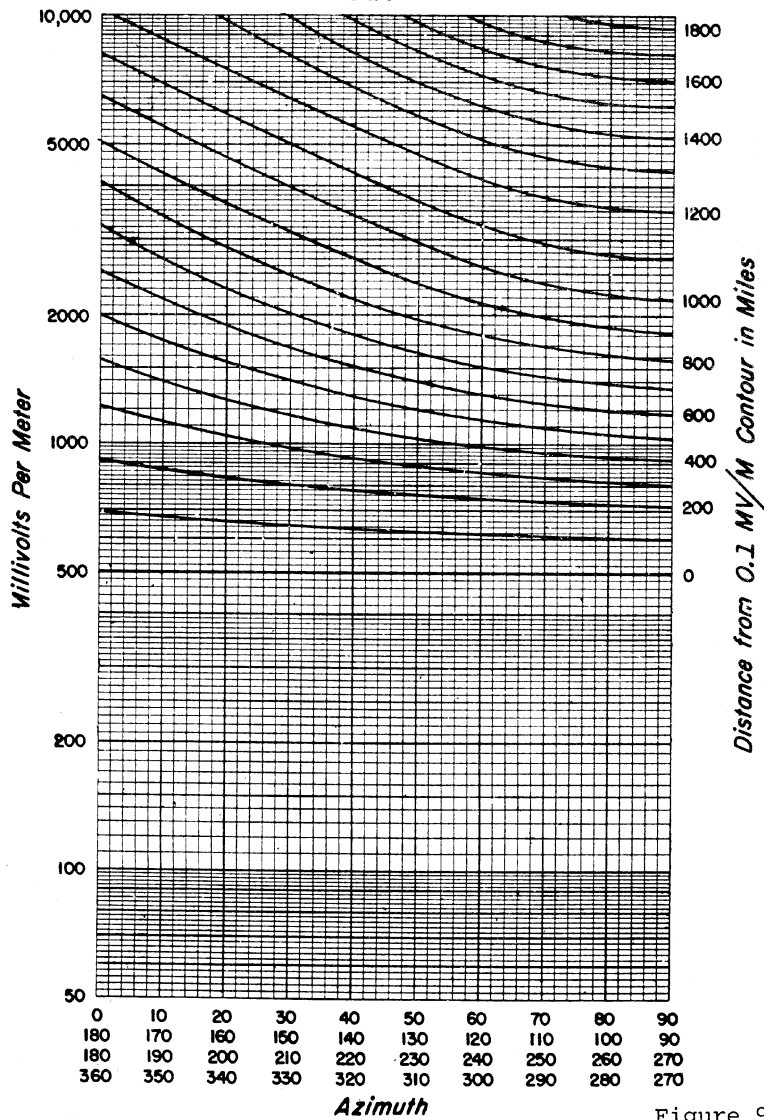


Figure 9

PERMISSIBLE DAYTIME RADIATION FOR CLASS II STATIONS

1000 KC

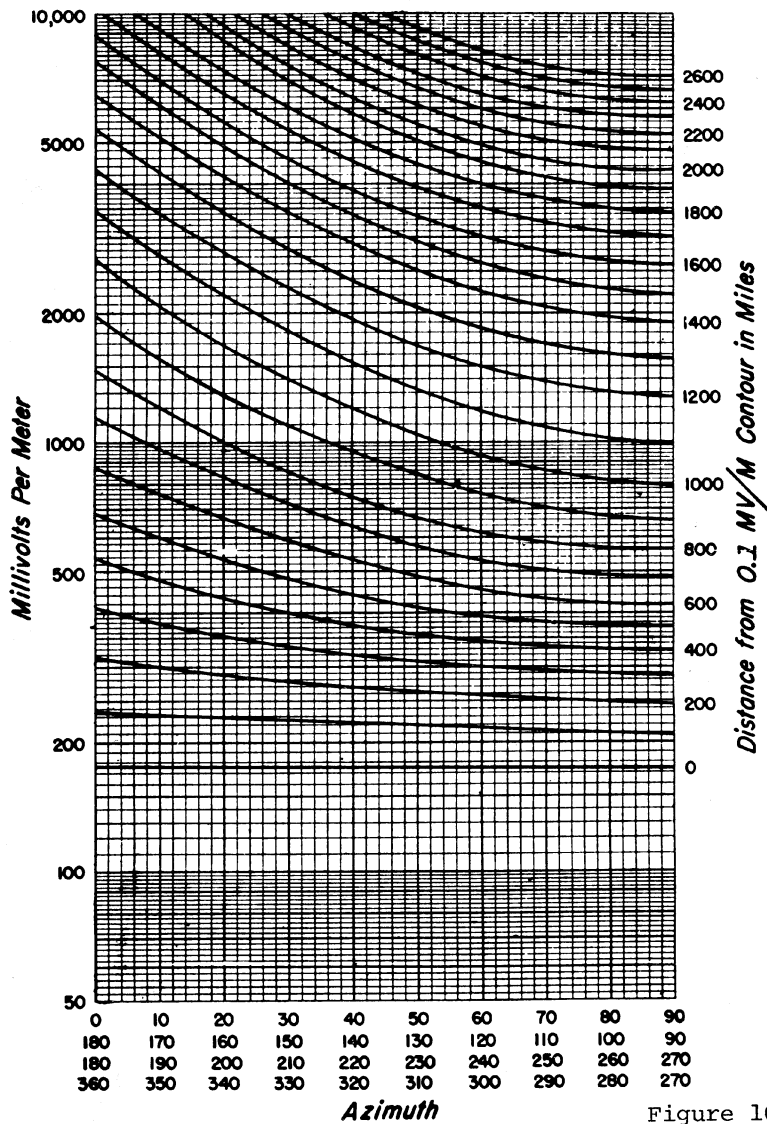


Figure 10

PERMISSIBLE DAYTIME RADIATION FOR CLASS II STATIONS

1600 KC

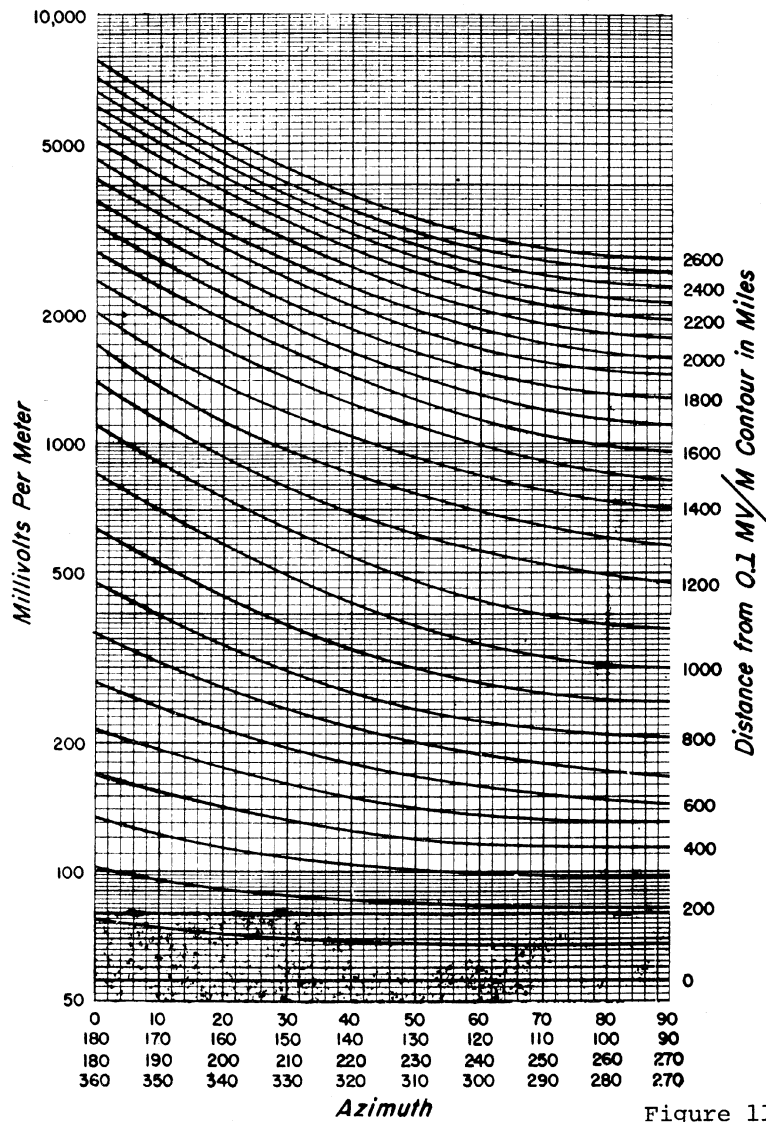
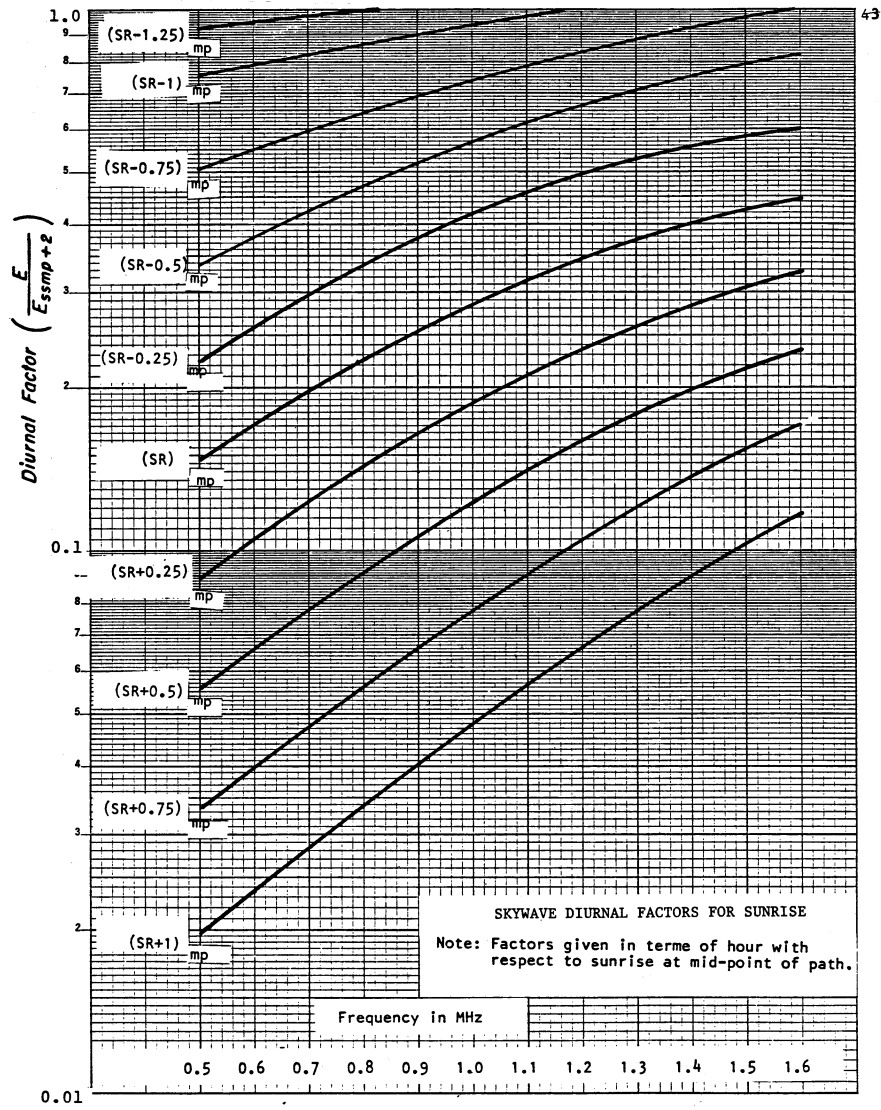
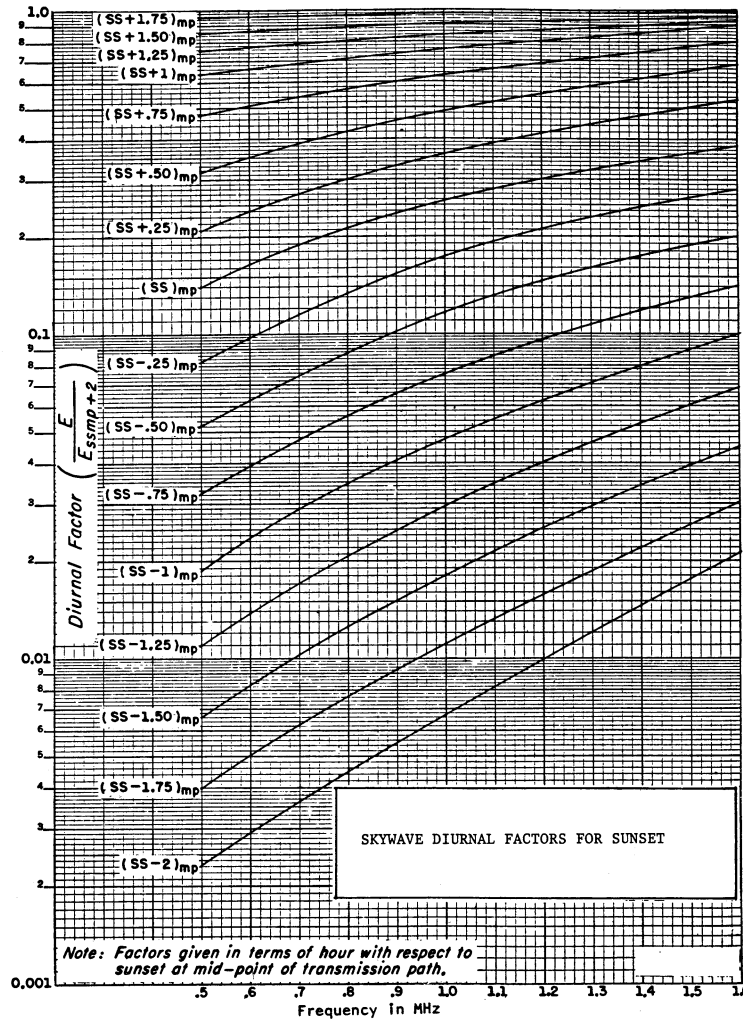


Figure 11





FCC §73.190 Figure 13

[28 FR 13574, Dec. 14, 1963, as amended at 30 FR 12720, Oct. 6, 1965; 33 FR 15420, Oct. 17, 1968; 48 FR 42959, Sept. 20, 1983; 49 FR 43963, Nov. 1, 1984; 50 FR 18844, May 2, 1985; 51 FR 4753, Feb. 7, 1986; 52 FR 36879, Oct. 1, 1987; 56 FR 64869, Dec. 12, 1991]

Subpart B—FM Broadcast Stations

§ 73.201 Numerical designation of FM broadcast channels.

The FM broadcast band consists of that portion of the radio frequency spectrum between 88 MHz and 108 MHz. It is divided into 100 channels of 200 kHz each. For convenience, the fre-

quencies available for FM broadcasting (including those assigned to non-commercial educational broadcasting) are given numerical designations which are shown in the table below:

Frequency (Mc/s)	Channel No.
88.1	201
88.3	202