sample calculations. Submission of values for f(θ) only in a tabular or graphical format (*i.e.*, without a formula) is not acceptable.

(d) Following are sample calculations. (The number of significant figures shown here should *not* be interpreted as a limitation on the number of significant figures used in actual calculations.)

(1) For a typical tower, as described in paragraph (b)(1) of this section, assume that G=120 electrical degrees:

θ	f(θ)
0	1.0000
30	0.7698
60	0.3458

(2) For a top-loaded tower, as described in paragraph (b)(2) of this section, assume A=120 electrical degrees, B=20 electrical degrees, and G=140 electrical degrees, (120+20):

θ	f(θ)
0	1.0000
30	0.7364
60	0.2960

(3) For a sectionalized tower, as described in paragraph (b)(3) of this section, assume A=120 electrical degrees, B=20 electrical degrees, C=220 electrical degrees, D=15 electrical degrees, G=140 electrical degrees (120+20), H=235 electrical degrees (220+15), and Δ=115 electrical degrees (235 − 120):

θ	f(θ)
0	1.0000
30	0.5930
60	0.1423

[46 FR 11993, Feb. 12, 1981]

§ 73.182 Engineering standards of allocation.

(a) Sections 73.21 to 73.37, inclusive, govern allocation of facilities in the AM broadcast band 535–1705 kHz. § 73.21 establishes three classes of channels in this band, namely, clear, regional and local. The classes and power of AM broadcast stations which will be assigned to the various channels are set forth in § 73.21. The classifications of the AM broadcast stations are as follows:

(1) Class A stations operate on clear channels with powers no less than 10kW nor greater than 50 kW. These stations are designed to render primary and secondary service over an extended area, with their primary services areas protected from objectionable interference from other stations on the same and adjacent channels. Their secondary service areas are protected from objectionable interference from co-channel stations. For purposes of protection, Class A stations may be divided into two groups, those located in any of the contiguous 48 States and those located in Alaska in accordance with § 73.25.

(i) The mainland U.S. Class A stations are those assigned to the channels allocated by § 73.25. The power of these stations shall be 50 kW. The Class A stations in this group are afforded protection as follows:

(A) Daytime. To the 0.1 mV/m groundwave contour from stations on the same channel, and to the 0.5 mV/m groundwave contour from stations on adjacent channels.

(B) Nighttime. To the 0.5 mV/m-50% skywave contour from stations on the same channels.

(ii) Class A stations in Alaska operate on the channels allocated by § 73.25 with a minimum power of 10 kW, a maximum power of 50 kW, and an antenna efficiency of 282 mV/m/kW at 1 kilometer. Stations operating on these channels in Alaska which have not been designated as Class A stations in response to licensee request will continue to be considered as Class B stations. During daytime hours a Class A station in Alaska is protected to the 100 μV/m groundwave contour from co-channel stations. During nighttime hours, a Class A station in Alaska is protected to the 100 μV/m-50 percent skywave contour from co-channel stations. The 0.5 mV/m groundwave contour is protected both daytime and nighttime from stations on adjacent channels.

NOTE: In the Report and Order in MM Docket No. 83–807, the Commission designated 15 stations operating on U.S. clear channels as Alaskan Class A stations. Eleven of these stations already have Alaskan Class A facilities and are to be protected accordingly. Permanent designation of the other

four stations as Alaskan Class A is conditioned on their constructing minimum Alaskan Class A facilities no later than December 31, 1989. Until that date or until such facilities are obtained, these four stations shall be temporarily designated as Alaskan Class A stations, and calculations involving these stations should be based on existing facilities but with an assumed power of 10 kW. Thereafter, these stations are to be protected based on their actual Alaskan Class A facilities. If any of these stations does not obtain Alaskan Class A facilities in the period specified, it is to be protected as a Class B station based on its actual facilities. These four stations may increase power to 10 kW without regard to the impact on co-channel Class B stations. However, power increases by these stations above 10 kW (or by existing Alaskan Class A stations beyond their current power level) are subject to applicable protection requirements for co-channel Class B stations. Other stations not on the original list but which meet applicable requirements may obtain Alaskan Class A status by seeking such designation from the Commission. If a power increase or other change in facilities by a station not on the original list is required to obtain minimum Alaskan Class A facilities, any such application shall meet the interference protection requirements applicable to an Alaskan Class A proposal on the channel.

(2) Class B stations are stations which operate on clear and regional channels with powers not less than 0.25 kW nor more than 50 kW. These stations render primary service only, the area of which depends on their geographical location, power, and frequency. It is recommended that Class B stations be located so that the interference received from other stations will not limit the service area to a groundwave contour value greater than 2.0 mV/m nighttime and to the 0.5 mV/m groundwave contour daytime, which are the values for the mutual protection between this class of stations and other stations of the same class.

NOTE: See §§ 73.21(b)(1) and 73.26(b) concerning power restrictions and classifications relative to Class B, Class C, and Class D stations in Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands. Stations in the above-named places that are reclassified from Class C to Class B stations under § 73.26(b) shall not be authorized to increase power to levels that would increase the nighttime interference-free limit of co-channel Class C stations in the conterminous United States.

(3) Class C stations operate on local channels, normally rendering primary service to a community and the suburban or rural areas immediately contiguous thereto, with powers not less than 0.25 kW, nor more than 1 kW, except as provided in § 73.21(c)(1). Such stations are normally protected to the daytime 0.5 mV/m contour. On local channels the separation required for the daytime protection shall also determine the nighttime separation. Where directional antennas are employed daytime by Class C stations operating with more than 0.25 kW power, the separations required shall in no case be less than those necessary to afford protection, assuming nondirectional operation with 0.25 kW. In no case will 0.25 kW or greater nighttime power be authorized to a station unable to operate nondirectionally with a power of 0.25 kW during daytime hours. The actual nighttime limitation will be calculated. For nighttime protection purposes, Class C stations in the 48 contiguous United States may assume that stations in Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands operating on 1230, 1240, 1340, 1400, 1450, and 1490 kHz are Class C stations.

(4) Class D stations operate on clear and regional channels with daytime powers of not less than 0.25 kW (or equivalent RMS field of 141 mV/m at one kilometer if less than 0.25 kW) and not more than 50 kW. Class D stations that have previously received nighttime authority operate with powers of less than 0.25 kW (or equivalent RMS fields of less than 141 mV/m at one kilometer) are not required to provide nighttime coverage in accordance with § 73.24(j) and are not protected from interference during nighttime hours. Such nighttime authority is permitted on the basis of full nighttime protection being afforded to all Class A and Class B stations.

(b) When a station is already limited by interference from other stations to a contour value greater than that normally protected for its class, the individual received limits shall be the established standard for such station with respect to interference from each other station.

(c) The four classes of AM broadcast stations have in general three types of

service areas, *i.e.*, primary, secondary and intermittent. (See §73.14 for the definitions of primary, secondary, and intermittent service areas.) Class A stations render service to all three areas. Class B stations render service to a primary area but the secondary and intermittent service areas may be materially limited or destroyed due to interference from other stations, depending on the station assignments involved. Class C and Class D stations usually have only primary service areas. Interference from other stations may limit intermittent service areas and generally prevents any secondary service to those stations which operate at night. Complete intermittent service may still be obtained in many cases depending on the station assignments involved.

(d) The groundwave signal strength required to render primary service is 2 mV/m for communities with populations of 2,500 or more and 0.5 mV/m for communities with populations of less than 2,500. See §73.184 for curves showing distance to various groundwave field strength contours for different frequencies and ground conductivities, and also see §73.183, ''Groundwave signals.''

(e) A Class C station may be authorized to operate with a directional antenna during daytime hours providing the power is at least 0.25 kW. In computing the degrees of protection which such antenna will afford, the radiation produced by the directional antenna system will be assumed to be no less, in any direction, than that which would result from non-directional operation using a single element of the directional array, with 0.25 kW.

(f) All classes of broadcast stations have primary service areas subject to limitation by fading and noise, and interference from other stations to the contours set out for each class of station.

(g) Secondary service is provided during nighttime hours in areas where the skywave field strength, 50% or more of the time, is 0.5 mV/m or greater (0.1 mV/m in Alaska). Satisfactory secondary service to cities is not considered possible unless the field strength of the skywave signal approaches or exceeds the value of the groundwave field strength that is required for primary service. Secondary service is subject to some interference and extensive fading whereas the primary service area of a station is subject to no objectionable interference or fading. Only Class A stations are assigned on the basis of rendering secondary service.

NOTE: Standards have not been established for objectionable fading because of the relationship to receiver characteristics. Selective fading causes audio distortion and signal strength reduction below the noise level, objectionable characteristics inherent in many modern receivers. The AVC circuits in the better designed receivers generally maintain the audio output at a sufficiently constant level to permit satisfactory reception during most fading conditions.

(h) Intermittent service is rendered by the groundwave and begins at the outer boundary of the primary service area and extends to a distance where the signal strength decreases to a value that is too low to provide any service. This may be as low as a few μV/m in certain areas and as high as several millivolts per meter in other areas of high noise level, interference from other stations, or objectionable fading at night. The intermittent service area may vary widely from day to night and generally varies over shorter intervals of time. Only Class A stations are protected from interference from other stations to the intermittent service area.

(i) Broadcast stations are licensed to operate unlimited time, limited time, daytime, share time, and specified hours. (See §§73.1710, 73.1725, 73.1720, 73.1715, and 73.1730.) Applications for new stations shall specify unlimited time operation only.

(j) Section 73.24 sets out the general requirements for modifying the facilities of a licensed station and for establishing a new station. Sections 73.24(b) and 73.37 include interference related provisions that be considered in connection with an application to modify the facilities of an existing station or to establish a new station. Section 73.30 describes the procedural steps required to receive an authorization to operate in the 1605–1705 kHz band.

(k) Objectionable nighttime interference from a broadcast station occurs

when, at a specified field strength contour with respect to the desired station, the field strength of an undesired station (co-channel or first adjacent channel, after application of proper protection ratio) exceeds for 10% or more of the time the values set forth in these standards. The value derived from the root-sum-square of all interference contributions represents the extent of a station's interference-free coverage.

(1) With respect to the root-sum-square (RSS) values of interfering field strengths referred to in this section, calculation of nighttime interference-free service is accomplished by considering the signals on the three channels of concern (co- and first adjacencies) in order of decreasing magnitude, adding the squares of the values and extracting the square root of the sum, excluding those signals which are less than 50% of the RSS values of the higher signals already included.

(2) With respect to the root-sum-square values of interfering field strengths referred to in this section, calculation of nighttime interference for non-coverage purposes is accomplished by considering the signals on the three channels of concern (co- and first adjacencies) in order of decreasing magnitude, adding the squares of the values and extracting the square root of the sum, excluding those signals which are less than 25% of the RSS values of the higher signals already included.

(3) With respect to the root-sum-square values of interfering field strengths referred to in this section, calculation is accomplished by considering the signals on the three channels of concern (co- and first adjacencies) in order of decreasing magnitude, adding the squares of the values and extracting the square root of the sum. The 0% exclusion method applies only to the determination of an improvement factor value for evaluating a station's eligibility for migration to the band 1605–1705 kHz.

(4) The RSS value will not be considered to be increased when a new interfering signal is added which is less than the appropriate exclusion percentage as applied to the RSS value of the interference from existing stations, and which at the same time is not greater than the smallest signal included in the RSS value of interference from existing stations.

(5) It is recognized that application of the above ''50% exclusion'' method (or any exclusion method using a per cent value greater than zero) of calculating the RSS interference may result in some cases in anomalies wherein the addition of a new interfering signal or the increase in value of an existing interfering signal will cause the exclusion of a previously included signal and may cause a decrease in the calculated RSS value of interference. In order to provide the Commission with more realistic information regarding gains and losses in service (as a basis for determination of the relative merits of a proposed operation) the following alternate method for calculating the proposed RSS values of interference will be employed wherever applicable.

(6) In the cases where it is proposed to add a new interfering signal which is not less than 50% (or 25%, depending on which study is being performed) of the RSS value of interference from existing stations or which is greater that the smallest signal already included to obtain this RSS value, the RSS limitation after addition of the new signal shall be calculated without excluding any signal previously included. Similarly, in cases where it is proposed to increase the value of one of the existing interfering signals which has been included in the RSS value, the RSS limitation after the increase shall be calculated without excluding the interference from any source previously included.

(7) If the new or increased signal proposed in such cases is ultimately authorized, the RSS values of interference to other stations affected will thereafter be calculated by the ''50% exclusion'' (or 25% exclusion, depending on which study is being performed) method without regard to this alternate method of calculation.

(8) Examples of RSS interference calculations:

(i) Existing interferences:

Station No. 1—1.00 mV/m.
Station No. 2—0.60 mV/m.
Station No. 3—0.59 mV/m.
Station No. 4—0.58 mV/m.

The RSS value from Nos. 1, 2 and 3 is 1.31 mV/m; therefore interference from No. 4 is excluded for it is less than 50% of 1.31 mV/m.

(ii) Station A receives interferences from:

Station No. 1—1.00 mV/m.
Station No. 2—0.60 mV/m.
Station No. 3—0.59 mV/m.

It is proposed to add a new limitation, 0.68 mV/m. This is more than 50% of 1.31 mV/m, the RSS value from Nos. 1, 2 and 3. The RSS value of Station No. 1 and of the proposed station would be 1.21 m/Vm which is more than twice as large as the limitation from Station No. 2 or No. 3. However, under the above provision the new signal and the three existing interferences are nevertheless calculated for purposes of comparative studies, resulting in an RSS value of 1.47 mV/m. However, if the proposed station is ultimately authorized, only No. 1 and the new signal are included in all subsequent calculations for the reason that Nos. 2 and 3 are less than 50% of 1.21 mV/m, the RSS value of the new signal and No. 1.

(iii) Station A receives interferences from:

Station No. 1—1.00 mV/m.
Station No. 2—0.60 mV/m.
Station No. 3—0.59 mV/m.

No. 1 proposes to increase the limitation it imposes on Station A to 1.21 mV/m. Although the limitations from stations Nos. 2 and 3 are less than 50% of the 1.21 mV/m limitation, under the above provision they are nevertheless included for comparative studies, and the RSS limitation is calculated to be 1.47 mV/m. However, if the increase proposed by Station No. 1 is authorized, the RSS value then calculated is 1.21 mV/m because Stations Nos. 2 and 3 are excluded in view of the fact that the limitations they impose are less than 50% of 1.21 mV/m.

NOTE: The principles demonstrated in the previous examples for the calculation of the 50% exclusion method also apply to calculations using the 25% exclusion method after appropriate adjustment.

(l) Objectionable nighttime interference from a station shall be considered to exist to a station when, at the field strength contour specified in paragraph (q) of this section with respect to the class to which the station belongs, the field strength of an interfering station operating on the same channel or on a first adjacent channel after signal adjustment using the proper protection ratio, exceeds for 10% or more of the time the value of the permissible interfering signal set forth opposite such class in paragraph (q) of this section.

(m) For the purpose of estimating the coverage and the interfering effects of stations in the absence of field strength measurements, use shall be made of Figure 8 of § 73.190, which describes the estimated effective field (for 1 kW power input) of simple vertical omnidirectional antennas of various heights with ground systems having at least 120 quarter-wavelength radials. Certain approximations, based on the curve or other appropriate theory, may be made when other than such antennas and ground systems are employed, but in any event the effective field to be employed shall not be less than the following:

Class of station	Effective field (at 1 km)
All Class A (except Alaskan)	362 mV/m.
Class A (Alaskan), B and D	282 mV/m.
Class C	241 mV/m.

Note (1): When a directional antenna is employed, the radiated signal of a broadcasting station will vary in strength in different directions, possibly being greater than the above values in certain directions and less in other directions depending upon the design and adjustment of the directional antenna system. To determine the interference in any direction, the measured or calculated radiated field (unattenuated field strength at 1 kilometer from the array) must be used in conjunction with the appropriate propagation curves. (See § 73.185 for further discussion and solution of a typical directional antenna case.)

Note (2): For Class B stations in Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands, 241 mV/m shall be used.

(n) The existence or absence of objectionable groundwave interference from stations on the same or adjacent channels shall be determined by actual measurements made in accordance with the method described in § 73.186, or in the absence of such measurements, by reference to the propagation curves of § 73.184. The existence or absence of objectionable interference due to skywave propagation shall be determined by reference to Formula 2 in § 73.190.

(o) *Computation of skywave field strength values:*—(1) *Fifty percent skywave field strength values (clear channel).* In computing the fifty percent skywave field strength values of a Class A clear channel station, use shall be made of Formula 1 of § 73.190, entitled ''Skywave Field Strength'' for 50 percent of the time.

(2) *Ten percent skywave field strength values.* In computing the 10% skywave field strength for stations on a single

signal or an RSS basis, Formula 2 in §73.190 shall be used.

(3) *Determination of angles of departure.* In calculating skywave field strength for stations on all channels, the pertinent vertical angle shall be determined by use of the formula in §73.190(d).

(p) The distance to any specified groundwave field strength contour for any frequency may be determined from the appropriate curves in §73.184 entitled ''Ground Wave Field Strength vs. Distance.''

(q) Normally protected service contours and permissible interference signals for broadcast stations are as follows (for Class A stations, see also paragraph (a) of this section):

Class of station	Class of channel used	Signal strength contour of area protected from objectionable interference [1] (μV/m)		Permissible interfering signal (μV/m)	
		Day [2]	Night	Day [2]	Night [3]
A	Clear	SC 100 AC 500	SC 500 50% SW AC 500 GW	SC 5 AC 250	SC 25 AC 250
A (Alaskan)	.....do	SC 100 AC 500	SC 100 50% SW AC 500 GW	SC 5 AC 250	SC 5 AC 250
B	Clear Regional	500	2000 [2]	25 AC 250	25 250
C	Local	500	No presc. [4]	SC25	Not presc.
D	Clear Regional	500	Not presc	SC 25 AC 250	Not presc.

[1] When a station is already limited by interference from other stations to a contour of higher value than that normally protected for its class, this higher value contour shall be the established protection standard for such station. Changes proposed by Class A and B stations shall be required to comply with the following restrictions. Those interferers that contribute to another station's RSS using the 50% exclusion method are required to either reduce their contributions to that RSS by 10%, or to a level at which their contributions no longer enter into the 50% RSS value, whichever is the lesser amount of reduction. Those interferers that contribute to a station's RSS using the 25% exclusion method but do not contribute to that station's RSS using the 50% exclusion method may make changes not to exceed their present contribution. Interferers not included in a station's RSS using the 25% exclusion method are permitted to increase radiation as long as the 25% exclusion threshold is not equalled or exceeded. In no case will a reduction be required that would result in a contributing value that is below the pertinent value specified in the table. This note does not apply to Class C stations; or to the protection of Class A stations which are normally protected on a single signal, non-RSS basis.

[2] Groundwave.

[3] Skywave field strength for 10 percent or more of the time.

[4] During nighttime hours, Class C stations in the contiguous 48 States may treat all Class B stations assigned to 1230, 1240, 1340, 1400, 1450 and 1490 kHz in Alaska, Hawaii, Puerto Rico and the U.S. Virgin Islands as if they were Class C stations.

Note: SC=Same channel; AC=Adjacent channel; SW=Skywave; GW=Groundwave

(r) The following table of logarithmic expressions is to be used as required for determining the minimum permissible ratio of the field strength of a desired to an undesired signal. This table shall be used in conjunction with the protected contours specified in paragraph (q) of this section.

Frequency separation of desired to undesired signals (kHz)	Desired Groundwave to:		Desired 50% Skywave to Undesired 10% Skywave (dB)
	Undesired groundwave (dB)	Undesired 10% Skywave (dB)	
0	26	26	26
10	6	6	not presc.

(s) Two stations, one with a frequency twice of the other, should not be assigned in the same groundwave service area unless special precautions are taken to avoid interference from the second harmonic of the station operating on the lower frequency. Additionally, in selecting a frequency, consideration should be given to the fact that occasionally the frequency assignment of two stations in the same area may bear such a relation to the intermediate frequency of some broadcast receivers as to cause ''image'' interference, However, since this can usually be rectified by readjustment of the intermediate frequency of such receivers, the Commission, in general, will not take this kind of interference into consideration when authorizing stations.

(t) The groundwave service of two stations operating with synchronized

carriers and broadcasting identical programs will be subject to some distortion in areas where the signals from the two stations are of comparable strength. For the purpose of estimating coverage of such stations, areas in which the signal ratio is between 1:2 and 2:1 will not be considered as receiving satisfactory service.

NOTE: Two stations are considered to be operated synchronously when the carriers are maintained within 0.2 Hz of each other and they transmit identical program s.

[56 FR 64862, Dec. 12, 1991; 57 FR 43290, Sept. 18, 1992, as amended at 58 FR 27950, May 12, 1993]

§ 73.183 Groundwave signals.

(a) Interference that may be caused by a proposed assignment or an existing assignment during daytime hours should be determined, when possible, by measurements on the frequency involved or on another frequency over the same terrain and by means for the curves in §73.184 entitled ''Ground Wave Field Strength versus Distance.''

NOTE: Groundwave field strength measurements will not be accepted or considered for the purpose of establishing that interference to a station in a foreign country other than Canada, or that the field strength at the border thereof, would be less than indicated by the use of the ground conductivity maps and engineering standards contained in this part and applicable international agreements. Satisfactory groundwave measurements offered for the purpose of demonstrating values of conductivity other than those shown by Figure M3 in problems involving protection of Canadian stations will be considered only if, after review thereof, the appropriate agency of the Canadian government notifies the Commission that they are acceptable for such purpose.

(b)(1) In all cases where measurements taken in accordance with the requirements are not available, the groundwave strength must be determined by means of the pertinent map of ground conductivity and the groundwave curves of field strength versus distance. The conductivity of a given terrain may be determined by measurements of any broadcast signal traversing the terrain involved. Figure M3 (See Note 1) shows the conductivity throughout the United States by general areas of reasonably uniform conductivity. When it is clear that only one conductivity value is involved, Figure R3 of §73.190, may be used. It is a replica of Figure M3, and is contained in these standards. In all other situations Figure M3 must be employed. It is recognized that in areas of limited size or over a particular path, the conductivity may vary widely from the values given; therefore, these maps are to be used only when accurate and acceptable measurements have not been made.

(2) For determinations of interference and service requiring a knowledge of ground conductivities in other countries, the ground conductivity maps comprising Appendix 1 to Annex 2 of each of the following international agreements may be used:

(i) For Canada, the U.S.-Canada AM Agreement, 1984;

(ii) For Mexico, the U.S.-Mexico AM Agreement, 1986; and

(iii) For other Western Hemisphere countries, the Regional Agreement for the Medium Frequency Broadcasting Service in Region 2.

Where different conductivities appear in the maps of two countries on opposite sides of the border, such differences are to be considered as real, even if they are not explained by geophysical cleavages.

(c) Example of determining interference by the graphs in §73.184:

It is desired to determine whether objectionable interference exists between a proposed 5 kW Class B station on 990 kHz and an existing 1 kW Class B station on first adjacent channel, 1000 kHz. The distance between the two stations is 260 kilometers and both stations operate nondirectionally with antenna systems that produce a horizontal effective field of 282 in mV/m at one kilometer. (See §73.185 regarding use of directional antennas.) The ground conductivity at the site of each station and along the intervening terrain is 6 mS/m. The protection to Class B stations during daytime is to the 500 μV/m (0.5 Vm) contour using a 6 dB protection factor. The distance to the 500 μV/m groundwave contour of the 1 kW station is determined by the use of the appropriate curve in §73.184. Since the curve is plotted for 100 mV/m at a 1 kilometer, to find the distance of the 0.5 mV/m contour of the 1 kw station, it is necessary to determine the distance to the 0.1773 m/Vm contour.

$(100 \times 0.5 / 282 = 0.1773)$