

STANDARDS OF GOOD ENGINEERING PRACTICE CONCERNING STANDARD BROADCAST STATIONS

(550-1600 kc.)

EFFECTIVE AUGUST 1, 1939

(Revised to July 15, 1949)*

INTRODUCTION

There are presented herein the Standards of Good Engineering Practice giving interpretations and further considerations concerning the Rules and Regulations of the Communications Commission governing standard broadcast stations. While the Rules and Regulations form the basis of good engineering practice, these standards may go beyond the Rules and Regulations and set up engineering principles for consideration of various allocation problems. These standards have been approved by the Commission and thus are considered as reflecting the opinion of the Commission in all matters involved.

The Rules and Regulations contain references to these standards; however, as further standards may be issued after the Rules and Regulations are published, the absence of such references does not relieve the responsibility of meeting the requirements specified herein. The Standards of Good Engineering Practice are collected in this publication for the convenience of all considering broadcast station operation and problems.

The Standards of Good Engineering Practice set forth herein are those deemed necessary for the construction and operation of standard broadcast stations to meet the requirements of technical regulations and for operation in public interest along technical lines not specifically enunciated in the regulations. These standards are based on the best engineering data available from evidence supplied in formal and informal hearings and extensive surveys conducted in the field by the Commission's personnel. Numerous informal conferences have been held with radio engineers, manufacturers of radio equipment and others for the guidance of the Commission in the formulation of these standards.

These standards are complete in themselves and supersede any previous announcements or policies which may have been enunciated by the Commission on engineering matters concerning standard broadcast stations.

While these standards provide for flexibility and set forth the conditions under which they are applicable, it is not expected that material deviation therefrom as to fundamental principles will be recognized unless full information is submitted as to the reasonableness of such departure and the need therefor.

These Standards of Good Engineering Practice will necessarily change as progress is made in the art, and accordingly it will be necessary to make revisions from time to time. The Commission will accumulate and analyze engineering data available as to the progress of the art so that its standards may be kept current with the developments.

*This reproduction is based upon the Standards revised by the Commission to October 30, 1947, but also includes the following FCC Amendments (which actually bring the Standards up to date as of July 15, 1949:

FCC Amendment No. SGEP-AM-1 (Sunrise and Sunset Tables, Section 26)

FCC Amendment No. SGEP-AM-2 (Use of Common Antenna)

FCC Amendment No. SGEP-3 (Ground Wave Signals)

FCC Amendment No. SGEP-4 (Canadian Conductivity Map)

As additional amendments are made they will be indicated or printed in NAB MEMBER SERVICE.

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STANDARDS OF GOOD ENGINEERING PRACTICE CONCERNING STANDARD BROADCAST STATIONS

(550-1600 kc.)

1. ENGINEERING STANDARDS OF ALLOCATION

Section 3.28 requires that individual broadcast station assignments shall be made in accordance with the standards of good engineering practice prescribed and published from time to time by the Commission. These standards for each class of station are set out below.

Sections 3.21 to 3.34, inclusive, govern the allocation of facilities in the standard broadcast band of 550 to 1600 kc, inclusive. Section 3.21 establishes three classes of channels in this band, namely, clear channels for the use of high-powered stations, regional channels for the use of medium-powered stations, and local channels for the use of low-powered stations. The classes and power of standard broadcast stations which will be assigned to the various channels are set forth in section 3.22. The classifications of the standard broadcast stations are as follows:

Class I stations are dominant stations operating on clear channels as follows:

(1) Class I stations operate with powers of not less than 10 or more than 50 kw. These stations are designed to render primary and secondary service over an extended area and at relatively long distances, hence have their primary service areas¹ free from objectionable interference from other stations on the same and adjacent channels and secondary service areas free from objectionable interference from stations on the same channels.^{2 3}

(2) From an engineering point of view, Class I stations may be divided into two groups:

(a) The Class I stations in Group 1 are those assigned to the channels allocated by section

3.25, paragraph (a), on which duplicate nighttime operation is not permitted, that is, no other station is permitted to operate on a channel with a Class I station of this group within the limits of the United States (the Class II stations assigned the channels operate limited time or daytime only), and during daytime the Class I station is protected to the 100 uv/m groundwave contour. Protection is given this class of station to the 500 uv/m groundwave contour from adjacent channel stations for both day and nighttime operations.² The power of each such Class I station shall not be less than 50 kw.

(b) The Class I stations in Group 2 are those assigned to the channels allocated by section 3.25, paragraph (b), on which duplicate operation is permitted, that is, other Class I or Class II stations operating unlimited time may be assigned to such channels. During nighttime hours of operation a Class I station of this group is protected to the 500 uv/m 50 percent skywave contour and during daytime hours of operation to the 100 uv/m groundwave contour from stations on the same channel. Protection is given to the 500 uv/m groundwave contour from stations on adjacent channels for both day and nighttime operation.² The operating powers of Class I stations on these frequencies shall be not less than 10 kw nor more than 50 kw.

Hereafter, for the purpose of convenience, the two groups of Class I stations will be termed Class Ia or Ib in accordance with the assignment to channels allocated by section 3.25 (a) or 3.25 (b).

Class II stations are secondary stations which operate on clear channels with powers not less than 0.25 kw or more than 50 kw. These stations are required to use a directional antenna or other means to avoid causing interference within the normally protected service areas of Class I stations or other Class II stations.

¹ See section 3.11 for the definitions of primary and secondary service areas.

² See tables IV and V.

³ The secondary service area of a Class I station is not protected from adjacent channel interference. However, if it is desired to make a determination of the area in which adjacent channel groundwave interference (10 kc. removed) to skywave service exists, it may be considered as the area where the ratio of the desired 50 percent skywave of the Class I station to the undesired groundwave of a station 10 kc. removed is 1 to 4.

These stations normally render primary service only, the area of which depends on the geographical location, power, and frequency. This may be relatively large but is limited by and subject to such interference as may be received from Class I stations. However, it is recommended that Class II stations be so located that the interference received from Class I stations will not limit the service area to greater than the 2500 uv/m groundwave contour, which is the value for the mutual protection of this class of station with other stations of the same class.²

Class III stations operate on regional channels and normally render primary service to the metropolitan district and the rural area contained therein and contiguous thereto, and are subdivided into two classes:

(a) Class III-A stations which operate with powers not less than 1 kw or more than 5 kw are normally protected to the 2500 uv/m groundwave contour nighttime and the 500 uv/m groundwave contour daytime.²

(b) Class III-B stations which operate with powers not less than 0.5 kw or more than 1 kw nighttime and 5 kw daytime are normally protected to the 4000 uv/m groundwave contour nighttime and 500 uv/m groundwave contour daytime.²

² See tables IV and V.

^{3a} The following approximate method may be used. It is based on the assumption of 0.25 wavelength antenna height and 88 mv/m at 1 mile effective field for 250 watts power, using the 10 percent skywave field intensity curve of Figure 1-A. Zones defined by circles of various radii specified below are drawn about the desired station and the interfering 10 percent skywave signal from each station in a given zone is considered to be the value tabulated below. The effective interfering 10 percent skywave signal is taken to be the RSS value of all signals originating within these zones. (Stations beyond 500 miles are not considered.)

Zone	Inner radius	Outer radius	10 percent skywave signal <i>mv/m</i>
A.....		60	0.10
B.....	60	80	.12
C.....	80	100	.14
D.....	100	250	.16
E.....	250	350	.14
F.....	350	450	.12
G.....	450	500	.10

Where the power of the interfering station is not 250 watts, the 10 percent skywave signal should be adjusted by the square root of the ratio of the power to 250 watts.

Class IV stations operate on local channels normally rendering primary service only to a city or town and the suburban and rural areas contiguous thereto with powers not less than 0.1 kw or more than 0.25 kw. These stations are normally protected to 500 uv/m groundwave contour daytime. On local channels the separation required for the daytime protection shall also determine the nighttime separation. The actual nighttime limitation will be calculated.^{3a} Class IV stations may be assigned to regional channels on condition that interference will not be caused to any Class III station in accordance with the above, that the channel is used adequately and properly for Class III stations⁴, and that the Class IV station will be subject to such interference as may be received from the Class III stations. That is, the Class IV station assigned to a regional channel shall protect the Class III station to the required contour, but the Class III station is under no obligation to protect the Class IV station so assigned. However, it is recommended that the Class IV stations be so located that the interference received will not be greater than to the 4000 uv/m groundwave contour nighttime and 500 uv/m daytime.

The class of any station is determined by the channel assignment, the power, and the field intensity contour to which it renders service free of interference from other stations as determined by these standards. No station will be permitted to change to a class normally protected to a contour of less intensity than the contour to which the station actually renders interference-free service. Any station of a class normally protected to a contour of less intensity than that to which the station actually renders interference-free service, will be automatically reclassified according to the class normally protected, the minimum consistent with its power and channel assignment. Likewise, any station to which the interference is

⁴ The assignment of a Class IV station to a regional channel normally is not considered as making the best usage of the assignment and will be made only when it is shown among other things that—

(1) There are no other transmission facilities in the town or towns in the proposed service area.

(2) There is no local channel assignment available for that area.

(3) Adequate economic support is not available for a Class III station.

(4) It is not practical from an engineering point of view to establish a Class III station and it would not prevent the establishment of any Class III station on that channel or an adjacent channel.

reduced so that service is rendered to a contour normally protected for a higher class will be automatically changed to that class if consistent with its power and channel assignment.

When it is shown that primary service is rendered by any of the above classes of stations, beyond the normally protected contour, and when primary service to approximately 90 percent of the population (population served with adequate signal) of the area between the normally protected contour and the contour to which such station actually serves, is not supplied by any other station or stations carrying the same general program service, the contour to which protection may be afforded in such cases will be determined from the individual merits of the case under consideration.

A Class II, III-B or IV station may be assigned to a channel available for such class, when a need therefor is shown, even though objectionable interference will be received to a field intensity contour greater than that specified as the normally protected contour for its class, provided that no objectionable interference will be caused by it to existing stations, and provided further, that the population residing in the area between the normally protected contour for its class and the contour to which objectionable interference will be received, does not exceed approximately 10 percent of the population in its actual primary service area. In case the station is located in a metropolitan area, the interference-free contour shall include 90 percent of the population of the metropolitan area.

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 contour shall be the established standard for such station with respect to interference from all other stations.

Tables IV and V give a complete summary of the protected service contours and permissible interference signals for broadcast stations on the same and adjacent channels, respectively.

The several classes of broadcast stations have in general three service areas;^{4a} namely, primary, secondary, and intermittent service areas.

^{4a} See section 3.11 for the definitions of primary, secondary, and intermittent service areas.

Class I stations render service to all three service areas. Class II 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 III and IV stations usually have only primary service areas as interference from other stations generally prevents any secondary service and may limit the intermittent service area. However, complete intermittent service may be obtained in many cases depending on the station assignments involved.

The signals necessary to render the different types of service are listed below.

TABLE I.—Primary service

Area:	Field intensity groundwave ¹
City business or factory areas	10 to 50 mv/m
City residential areas	2 to 10 mv/m
Rural—all areas during winter or northern areas during summer	0.1 to 0.5 mv/m
Rural—southern areas during summer	0.25 to 1.0 mv/m

¹ See appendix I for curves showing distance to various ground wave field intensity contours for different frequency and ground conductivities and annex I.

All these values are based on an absence of objectionable fading, either in changing intensity or selective fading, the usual noise level in the areas⁵ and an absence of limiting interference from other broadcast stations. The values apply both day and night but generally fading or interference from other stations limits the primary service at night in all rural areas to higher values of field intensity than the values given.

In determining the population of the primary service area, it may be considered that the following signals are satisfactory to overcome man-made noise in towns of the population given.

⁵ Standards have not been established for interference from atmospheric or man-made electric noise as no uniform method of measuring noise or static has been established. In any individual case objectionable interference from any source, except other broadcast signals, may be determined by comparing the actual noise interference reproduced during reception of a desired broadcast signal to the degree of interference that would be caused by another broadcast signal within 20 cycles of the desired signal and having a carrier ratio of 20 to 1 with both signals modulated 100 percent on peaks of usual programs. Standards of noise measurements and interference ratio for noise are now being studied.

TABLE II

Population:	Field intensity groundwave
Up to 2,500-----	0.5 mv/m
2,500 to 10,000-----	2.0 mv/m
10,000 and up-----	Values given in Table I.

These values are subject to wide variations in individual areas and especial attention must be given to interference from other stations. The values are not considered satisfactory in any case for service to the city in which the main studio of the station is located. The values in Table I shall apply except as individual consideration may determine.

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.

SECONDARY SERVICE

Secondary service is delivered in the areas where the skywave for 50 percent or more of the time has a field intensity of 500 uv/m or greater.⁶ It is not considered that satisfactory secondary service can be rendered to cities unless the skywave approaches in value the groundwave required for primary service. The secondary service is necessarily subject to some interference and extensive fading whereas the primary service area of a station is subject to no objectionable interference or fading.⁷ Class I stations only are assigned on the basis of rendering secondary service.

INTERMITTENT SERVICE

The intermittent service is rendered by the groundwave and begins at the outer boundary of the primary service area and extends to the value of signal where it may be considered as having no further service value. This may be down to only a few microvolts in certain areas and up to several millivolts in other areas of high noise level, interference from other stations, or objectionable fading at night. The

⁶ The secondary service area of a Class Ia station should be considered as having this limit only for determination of service in comparison with other stations.

⁷ Standards have not been established for objectionable fading as such standards would necessarily depend on the receiver characteristics which have been changed considerably in this regard during the last several years. Selective fading causing audio distortion and the signal fading below the noise level are the objectionable characteristics of fading on modern design receivers. The AVC circuits in the better designed modern receivers in general maintain the audio output sufficiently constant to be satisfactory during most fading.

intermittent service area may vary widely from day to night and generally varies from time to time as the name implies. Only Class I stations are assigned for protection from interference from other stations into the intermittent service area.

Section 3.23 provides that the several classes of broadcast stations may be licensed to operate unlimited time, limited time, daytime, sharing time, and specified hours, with full explanation given in the section.

Section 3.24 sets out the general requirements for obtaining an increase in facilities of a licensed station and for a new station. Section 3.24 (b) concerns the matter of interference that may be caused by a new assignment or increase in facilities of an existing assignment.

Objectionable interference from another broadcast station⁸ is the degree of interference produced when, at a specified field intensity contour with respect to the desired station, the field intensity of an undesired station (or the root-sum-square value of field intensities of two or more stations on the same frequency) exceeds for ten (10) percent or more of the time the values set forth in these standards.

With respect to the root-sum-square values of interfering field intensities referred to herein, except in the case of Class IV stations on local channels, calculation is accomplished by considering the signals 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 percent of the RSS value of the higher signals already included.

The RSS value will not be considered to be increased when a new interfering signal is added which is less than 50 percent of 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.

It is recognized that application of the above "50 percent exclusion" method 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

⁸ See footnote 6.

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.

In the cases where it is proposed to add a new interfering signal which is not less than 50 percent of the RSS value of interference from existing stations or which is greater than 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.

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 percent exclusion" method without regard to this alternate method of calculation.

Examples of RSS interference calculations:

1. Existing interferences:

Station No. 1.....	1.0 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 percent of 1.31 mv/m

2. Station A receives interference from:

Station No. 1.....	1.0 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 percent of 1.31 mv/m, the RSS value of Nos. 1, 2, and 3. The RSS value of Station No. 1 and of the proposed station would be 1.21 mv/m 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, re-

sulting 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 percent of 1.21 mv/m the RSS value of the new signal and No. 1.

3. Station A receives interference from:

Station No. 1.....	1.0 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 percent 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 percent of 1.21 mv/m.

Objectionable interference from a station on the same channel shall be considered to exist to a station when, at the field intensity contour specified in Table IV with respect to the class to which the station belongs, the field intensity of an interfering station (or the root-sum-square value of the field intensities of two or more interfering stations) operating on the same channel, exceeds for ten (10) percent or more of the time the value of the permissible interfering signal set forth opposite such class in Table IV.

Objectionable interference from a station on an adjacent channel shall be considered to exist to a station when, at the normally protected contour of a desired station, the field intensity of the groundwave of an undesired station operating on an adjacent channel (or the root-sum-square value of the field intensities of two or more such undesired stations operating on the same adjacent channel) exceeds a value specified in Table V.

For the purpose of calculating the presence and the degree of objectionable interference, stations of the several classes shall be assumed, in the absence of actual measurements or data on the design of the antenna system, to pro-

duce effective fields, for 1 kw of input power to the antenna, as follows:

TABLE III

Class of station:	Effective field
I-----	225 mv/m
II and III-----	175 mv/m
IV-----	150 mv/m

In case a directional antenna is employed, the interfering signal of a broadcasting station will vary in different directions, being greater than the above values in certain directions and less in others, depending upon the design and adjustment of the directional antenna system. To determine the interference in any direction, in the absence of actual interference measurements, the measured or calculated radiated field (unabsorbed field intensity at 1 mile from the array) must be used in conjunction with the appropriate propagation curves.⁹

The existence or absence of objectionable interference from stations on the same or adjacent channels shall be determined by one of the following methods:

(a) By actual measurements made according to the method hereafter described; or, in the absence of such measurements:

(b) By reference to the propagation curves in Figure 1 or Figure 1-A and Appendix I.

The existence or absence of objectionable interference may be proved by field intensity measurements or recordings made with suitable apparatus, duly calibrated. Such field intensity measurements of skywave shall be made for a period of time not less than 10 days and an adequate check shall be made on the skywave signal of other stations to determine the general conditions of propagation while such measurements are taken.¹⁰ In computing the fifty (50) percent skywave field intensity values of a

⁹ See annex II for further discussion and solution of a typical directional antenna case.

¹⁰ See annex III for detailed requirements and also section on "Field Intensity Measurements in Allocation."

Class I station of a given power and also in computing the ten (10) percent skywave field intensity of an alleged interfering Class I or Class II station on a clear channel, use shall be made of the appropriate graph set forth in figure 1 entitled "Average Skywave Field Intensity" (corresponding to the second hour after sunset at the recording station). These graphs are drawn for a radiated field of 100 mv/m at 1 mile on the horizontal plane from a 0.311λ antenna. In computing the ten (10) percent skywave field intensity of an alleged interfering station, other than Class I or Class II, at a specified distance, use shall be made of the appropriate curve in Figure 1-A entitled "10 percent Skywave Signal Range." This graph is drawn for a radiated field of 100 mv/m at 1 mile at the vertical angle pertinent to transmission by one reflection. This curve supersedes the ten (10) percent skywave curve of Figure 1, only for regional and local channels at the present time.¹¹ Adoption of revised skywave curves for use on clear channels will await the outcome of the Clear Channel Hearing (Docket No. 6741) and the negotiations for a new North American Regional Broadcasting Agreement.

The distance to any specified groundwave field intensity contour may be determined from appropriate groundwave curves plotted for the frequency under consideration and the conductivity and dielectric constant of the earth between the station and desired contour. The frequency and the conductivity of the earth must be considered in every case and where the distance is great, due allowance must be made for loss due to curvature of the earth. Figure 2 entitled "Groundwave Field Intensity," drawn for a frequency of 1000 kc, conductivity of 10^{-13} dielectric constant 15, and an effective field of 100 mv/m at 1 mile, may be employed when applicable.

¹¹ The Commission will not authorize a directive antenna for a Class VI station assigned a local channel.

TABLE IV.—Protected service contours and permissible interference signals for broadcast stations

Class of station	Class of channel used	Permissible power	Signal intensity contour of area protected from objectionable interference ¹		Permissible interfering signal on same channel ²	
			Day ³	Night	Day ³	Night ⁴
Ia	Clear	50 kw	SC 100 uv/m AC 500 uv/m	Not duplicated	5 uv/m	Not duplicated.
Ib	do	10 kw to 50 kw	SC 100 uv/m AC 500 uv/m	500 uv/m (50 percent sky wave).	5 uv/m	25 uv/m
II	do	0.25 kw to 50 kw	500 uv/m	2500 uv/m ⁵ (groundwave)	25 uv/m	125 uv/m ⁵
III-A	Regional	1 kw to 5 kw	500 uv/m	2500 uv/m (groundwave)	25 uv/m	125 uv/m
III-B	do	0.5 to 1 kw night and 5 kw day	500 uv/m	4000 uv/m (groundwave)	25 uv/m	200 uv/m
IV	Local ⁶	0.1 kw to 0.25 kw	500 uv/m	4000 uv/m (groundwave)	25 uv/m	200 uv/m

¹ When it is shown that primary service is rendered by any of the above classes of stations, beyond the normally protected contour, and when primary service to approximately 90 percent of the population (population served with adequate signal) of the area between the normally protected contour and the contour to which such station actually serves, is not supplied by any other station or stations, the contour to which protection may be afforded in such cases will be determined from the individual merits of the case under consideration. 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 contour shall be the established standard for such station with respect to interference from all other stations.

² For adjacent channels see Table V.

³ Groundwave.

⁴ Skywave field intensity for 10 percent or more of the time.

⁵ These values are with respect to interference from all stations except Class Ib, which stations may cause interference to a field intensity contour of higher value. However, it is recommended that Class II stations be so located that the interference received from Class Ib stations will not exceed these values. If the Class II stations are limited by Class Ib stations to higher values, then such values shall be the established standard with respect to protection from all other stations.

⁶ Class IV stations may also be assigned to regional channels according to section 3.29.

SC=Same channel.

AC=Adjacent channel.

The following table is to be used for determining the minimum ratio of the field intensity of a desired to an undesired signal for interference free service. In the case of a desired groundwave signal interfered with by two or more skywave signals on the same frequency, the RSS value of the latter is used.

TABLE V.—Interference ratios

Frequency separation of desired to undesired signals	Desired groundwave to—		Desired 50 percent skywave to undesired 10 percent skywave
	Undesired groundwave	Undesired 10 percent skywave	
0 kc	20:1	20:1	20:1
10 kc	1:1	1:5	(1)
20 kc	1:30		

¹ See footnote 3, p. 1.

From the above, it is apparent that in many cases stations operating on channels 10 and 20 kc apart may be operated with antenna systems side by side or otherwise in proximity without any indications of interference if the interference is defined only in terms of permissible ratios hereinbefore listed in Table V headed "Interference Ratios." As a practical matter, serious interference problems may arise when two or more stations with the same general service area are operated on channels 10, 20, and 30 kc apart.

Accordingly, no station will be licensed for operation with less than 40 kc separation from

another station, if the area enclosed by the 25 mv/m groundwave contours of the two stations overlap. Frequency separation of 20 kc and 10 kc are considered inappropriate for stations with the same general urban coverage and therefore no station will be licensed for operation with less than 30 kc frequency separation if the area enclosed by the 25 mv/m groundwave contour of either one overlaps the area enclosed by the 2 mv/m groundwave contour of the other.

Two stations, one with a frequency twice that 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 lower frequency. 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 so-called "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 in allocation problems.

Two stations operating with synchronized carriers¹² and carrying the identical program

¹² NOTE.—Two stations are considered to be operated synchronously when the carriers are maintained within one-fifth of a cycle per second of each other and they transmit identical programs.

will have their groundwave service subject to some distortion in areas where the signals from the two stations are of comparable intensity. For the purpose of estimating coverage of such stations, areas in which the signal ratio is between 1 to 2 and 2 to 1 will not be considered as having satisfactory service.

ANNEX I GROUNDWAVE SIGNALS

Interference that may be caused by a proposed assignment or an existing assignment during day time should always be determined, when possible, by measurements on the frequency involved or on another frequency over the same terrain and by means of the curves in Figure 4, interpolated for the desired frequency.

In determining the interference from field intensity measurements, two general steps are necessary: First, establish the outer boundary of the protected service area of the desired station in the direction of the station that may cause interference with it. Second, at this boundary, measure the interfering signal from the undesired station. The ratio of the desired to the undesired signal given on page seven should be applied to the measured signals and if the required ratio is observed, then no interference is contemplated. The effective field of the antenna in the pertinent directions of the stations must be established and all measurements must be made in accordance with the section on "Field Intensity Measurements in Allocation."

In all cases where measurements taken in accordance with the requirements are not available,¹³ the groundwave intensity must be determined by means of the conductivity of the terrain and the groundwave curves of field intensity versus distance. The conductivity of a given terrain may be determined by measurements of any broadcast signal traversing the terrain involved, or in case such measurements are not available, then conductivity must be taken from the map of ground conductivity in the United States, Figure 3. This map shows the conductivity throughout the entire United States by general areas of reasonably uniform

¹³ The Commission will not authorize operation on a proposed assignment for the purpose of making measurements.

conductivity. In areas of limited size, or over a particular path, the conductivity may vary widely from the values given. This map is to be used only when accurate and acceptable measurements have not been made. Figure 3a is a similar map of ground conductivity in Canada prepared by the Canadian Department of Transport. It is considered to supercede Figure 3 as regards conductivity within the boundary of Canada. It is to be noted that at some locations there are differences in conductivity on either side of the border, which cannot be explained by geophysical cleavages. Pending adjustment in the maps for inconsistencies, all variations at the border will be treated as real.

Where a signal traverses a path over which different conductivities are shown to exist or are given by the map, the distance to a particular groundwave field intensity contour shall be determined by the use of the equivalent distance method. Reasonably accurate results may be expected in determining field intensities at a distance from the antenna by application of the equivalent distance method when the unattenuated field of the antenna, the various ground conductivities and the location of discontinuities are known. This method considers a wave to be propagated across a given conductivity according to the curve for a homogeneous earth of that conductivity. When the wave crosses from a region of one conductivity into a region of a second conductivity the equivalent distance of the receiving point from the transmitter changes abruptly, but the field intensity does not. From a point just inside the second region the transmitter appears to be at that distance where on the curve for a homogeneous earth of the second conductivity the field intensity equals the value that occurred just across the boundary in the first region. Thus the equivalent distance from the receiving point to the transmitter may be either greater or less than the actual distance. An imaginary transmitter is considered to exist at that equivalent distance. The technique is not intended to be used as a means of evaluating unattenuated field or ground conductivity by the analysis of measured data. The technique to be used for such determinations is given in section 2 of these Standards.

As an example of the use of the equivalent distance method suppose on a frequency of 1000kc an unattenuated field of 100 mv/m at one mile is radiated and that over a path having a conductivity of 10×10^{-14} e. m. u. for a distance 15 miles, 5×10^{-14} e. m. u. for the next 20 miles and 15×10^{-14} e. m. u. thereafter, it is desired to determine the distance to the 0.5 mv/m and 0.025 mv/m contours. By the use of the appropriate curves in figure 4 it is seen that at a distance of 15 miles on the curve labeled 10×10^{-14} e. m. u. the field is 3.45 mv/m. The equivalent distance to this field intensity for a conductivity of 5×10^{-14} e. m. u. is 11 miles. Continuing on the propagation curve for the second conductivity the 0.5 mv/m contour is encountered at a distance of 27.9 miles from the imaginary transmitter. Since the imaginary transmitter was 4 miles nearer (15-11 miles) to the 0.5 mv/m contour, the distance from the contour to the actual transmitter is 31.9 miles (27 + 4 miles). The distance to the 0.025 mv/m contour is determined by continuing on the propagation curve for the second conductivity to a distance of 31 miles (11 + 20 miles) at which point the field is read to be 0.39 mv/m. At this point the conductivity changes to 15×10^{-14} e. m. u. and from this curve the equivalent distance is determined to be 58 miles which is 27 miles more distant than would obtain had a conductivity of 5×10^{-14} e. m. u. prevailed. Using now the curve representing the conductivity of 15×10^{-14} e. m. u. the 0.025 mv/m contour is determined to be at an equivalent distance of 172 miles. Since the

imaginary transmitter was considered to be 4 miles closer at the first boundary and 27 miles farther at the second boundary the net effect is to consider the imaginary transmitter 23 miles (27-4 miles) more distant than the actual transmitter so that the actual distance to the 0.025 mv/m contour is determined to be 149 miles (172-23 miles).

Figure 4 gives the groundwave field intensity curves with field intensity plotted against distance for various values of conductivity and by blocks of frequencies. To cover the standard broadcast band some 20 graphs in all are required and are attached as Appendix I. In all cases the curves are plotted on the basis of 100 mv/m effective field at a mile. An example of determining the interference by this method follows:

It is desired to find the interference that a 5 kw Class III station on 990 kc may cause to a 1 kw class III station on 1000 kc. The stations are separated by 130 miles. It is assumed that both stations use nondirectional antennas¹⁵ having such height as to produce an effective field for 1 kw of 175 mv/m.¹⁶ From Figure 3, the conductivity at each station and intervening terrain is determined as 6×10^{-14} . The protection to Class III during daytime is to the 500 uv/m contour. The distance to the 500 uv/m groundwave contour of the 1 kw station is determined by the use of the

¹⁵ See Annex II in case of use of directional antennas.

¹⁶ In all cases the effective field should be established from the dimensions of the radiating system. The value assumed here is in accordance with section 3.45 and the Standards of Good Engineering Practice promulgated pursuant thereto.

curves in Figure 4 as being 39.5 miles. Since these curves are plotted for 100 mv/m at a mile, to find the distance to the 500 uv/m contour of the 1 kw station, it is necessary to determine the distance on the appropriate curve to the

$$\left(\frac{100 \times 500}{175} = 285\right)$$

285 uv/m contour. Thus, the estimated radius of the service area for the desired station is established as 39.5 miles. Subtract this distance from the distance between the two stations, leaving 90.5 miles for the interfering signal to travel. Again from the appropriate curve in Figure 4 it is found that the signal from the 5 kw station at this distance would be 158 uv/m. Since the stations are separated by 10 kc, the undesired signal at that point can have a value up to 500 uv/m without interference, but if the interference signal had been found to be greater than this value, then interference would have been determined. For other channel separations the appropriate ratio of desired to undesired signal would have been used. This principle holds for all cases except where a skywave signal 10 percent or more of the time from the undesired station is in excess of 5 times the desired signal when the frequency separation is 10 kc. In this case the interference must be estimated on the basis of the skywave interference and the propagation curve in Figure 1 or Figure 1-A used to determine the interfering signals rather than Figure 4 for the groundwave signals.

ANNEX II

COMPUTATION ON INTERFERING SIGNAL FROM A DIRECTIONAL ANTENNA

In case of an antenna directional in the horizontal plane, the groundwave interference can be readily computed from the calculated horizontal pattern by determining the vectors toward the service area of the station to be protected and apply these values to the groundwave curves set out in Annex I.

For signals from stations operating on clear channels, in case of determining skywave interference from an antenna with a vertical pattern

different from that on which Figure 1 is predicated, it is necessary to compare the appropriate vectors in the vertical plane.

The skywave curves entitled "Average Skywave Field Intensity" (corresponding to the second hour after sunset at the recording station) as shown in Figure 1 are based on antenna systems having height of 0.311 wavelength (112°) and producing a vertical pattern as shown in Figure 5. A nondirectional antenna system, as well as a directional antenna system having vertical patterns other than essentially the same as shown, must be converted to the pattern of a 0.311 wavelength antenna having the same field intensity at the critical angle as does the pattern of the antenna involved. Example:

Figure 6 is a graph entitled "Variation with Distance of Two Important Parameters in the Theory of Skywave Propagation." The curve for θ showing the angle above the horizon at which radiation occurs plotted against distance, must be used for this purpose. For instance, assuming the station with which interference may be expected is located at a distance of 450 miles from a proposed station, the critical angle of radiation as determined from this curve is approximately 15°. Therefore, if the vertical pattern of the proposed station in the direction of the other station is such that at 15° above the horizon the radiation is 1.3 times that from an antenna having a vertical pattern as shown in Figure 5 and producing the same field intensity at 1 mile in the horizontal plane, the interfering signal would be 1.3 times that determined from Figure 1 for an antenna having the same field intensity in the horizontal plane. That is, if the field intensity in the horizontal plane of the proposed station is 124 mv/m the interfering field intensity exceeded 10 percent of the time at the other station would be

$$140 \times 1.30 \times \frac{124}{100} \text{ or } 225 \text{ uv/m}$$

and would cause interference to the 4.5 mv/m groundwave contour of the existing station.

For signals from stations on regional and local channels, in computing the ten (10) percent skywave (interference) field intensity values of

Class III and Class IV stations,¹⁷ Figure 1-A is to be used in place of Figure 1. Since Figure 1-A is predicated upon a radiated field of 100 mv/m at 1 mile in the pertinent direction, no comparison with the vertical pattern of a 0.311 wavelength antenna is to be made. Instead the appropriate radiated field in the vertical plane corresponding to the distance to the receiving station, divided by 100, is multiplied into the value of ten (10) percent skywave field intensity determined from Figure 1-A. There are two new factors to be considered, however, namely the variation of received field with latitude of the path and the variation of pertinent vertical angle due to variations of ionosphere height and ionosphere scattering.

Figure 1-A, "10 percent Skywave Signal Range Chart," shows the ten (10) percent skywave signal as a function of the latitude of the transmission path and the distance from a transmitting antenna with a radiated field of 100 mv/m at the pertinent angle for the distance. The latitude of the transmission path is defined as the geographic latitude of the midpoint between the transmitter and the receiver. Latitude 35° should be used in case the midpoint of the path lies below 35° N. and latitude 50° should be used in case the midpoint of the path lies above 50° N.

Figure 6-A, entitled "Angles of Departure vs. Transmission Range," is to be used in determining the angles in the vertical pattern of the antenna of an interfering station to be considered as pertinent to transmission by one reflection. Corresponding to any given distance, the curves 4 and 5 indicate the upper and lower angles within which the radiated field is to be considered. The maximum value of field intensity occurring between these angles will be used to determine the multiplying factor for the ten (10) percent skywave field intensity determined from Figure 1-A. (Curves 2 and 3 are considered to represent the variation due to the variation of the effective height of the E-layer while curves 4 and 5 extend the range of pertinent angles to include a factor which allows for scattering. The dotted lines are included for information only.)

¹⁷ Certain simplifying assumptions may be made in the case of Class IV stations on local channels: See footnote 3a.

In the case of nondirectional vertical antennas, the vertical distribution of relative fields for several heights, assuming sinusoidal distribution of current along the antenna, is shown in Figure 5. In the case of directional antennas the vertical pattern in the great circle direction toward the point of reception in question must first be calculated. Then for the distance to the points, the upper and lower pertinent angles are determined from Figure 6-A. The ratio of the largest value of radiated field occurring between these angles, to 100 mv/m (for which Figure 1-A is drawn) is then used as the multiplying factor for the value of the field read from the curves of Figure 1-A. Note that while the accuracy of the curves is not as well established by measurements for distances less than 250 miles as for distances in excess of 250 miles, the curves represent the most accurate data available today. Pending accumulation of additional data to establish firm standards for skywave calculations in this range, the curves may be used. In cases where the radiation in the vertical plane, in the pertinent azimuth, contains a large lobe at a higher angle than the pertinent angle for one reflection, the method of calculating interference will not be restricted to that described above, but each such case will be considered on the basis of the best knowledge available.

For example, suppose it is desired to determine the amount of interference to a Class III station at Portland, Oregon, caused by another Class III station at Los Angeles, Calif., which is radiating a signal of 560 mv/m unattenuated at 1 mile in the great circle direction of Portland, using a 0.5 wavelength antenna. The distance is 825 miles. From Figure 6-A the upper and lower pertinent angles are 7° and 3.5° and, from Figure 5 the maximum radiation within these angles is 99 percent of the horizontal radiation or 554 mv/m at 1 mile. The latitude of the path is 39.8° N. and from Figure 1-A, the 10 percent skywave field at 825 miles is 0.050 mv/m for 100 mv/m radiated. Multiplying by 554/100 to adjust the value to the actual radiation gives 0.277 mv/m. At 20 to 1 ratio the limitation to the Portland station is to the 5.5 mv/m contour.

When the distance is large, more than one reflection may be involved and due considera-

tion must be given each appropriate vector in the vertical pattern, as well as the constants of the earth where reflection takes place between the transmitting station and the service area to which interference may be caused.

ANNEX III

INTERFERENCE FROM SKYWAVE SIGNALS

Set out below is the detailed method of making measurements of the skywave signals to determine an interfering signal for 10 percent of the time.

The signal must be received on an acceptable field intensity meter duly calibrated and recorded on a continuous recording meter of suitable accuracy and sensitivity. Measurements at distances less than 350 miles from the station should be made with a vertical antenna only. At greater distances either a vertical antenna, loop, or other suitable antenna may be used. Two complete recording units are required so that two signals can be recorded simultaneously.

A monitor station on which interference free measurements can be made must be selected for simultaneous recordings. This station should be in the general direction of the principal station to be recorded. Preferably, such monitor station should have known antenna characteristics and the conductivity of the surrounding terrain should be known. The transmitters should be located in the same general area and the frequencies of the stations as close as possible. The reception of the two stations should be on the same antenna or on antennas in the same area so that both are influenced by the same surrounding objects.

Recordings may be made on both stations from sundown over the entire path until midnight at the recording station. These records should be analyzed for each night and for the entire period of recording and graphs drawn which show field intensity versus percent time. The 10 percent signal determined for the principal station for the entire period must be modified by a correction factor determined from a comparison of the 10 percent signal from the monitor station to the value determined from the 10 percent curve of Figure 1 for the same distance, power, and pertinent antenna characteristic. Thus, if the 10 percent signal from

the Figure 1 10 percent curve is 500 uv/m and the measured 10 percent signal on the monitor station 350 uv/m, then the 10 percent signal from the principal station should be multiplied by the factor of $500/350$ or 1.43 to determine the interfering signal. Recordings for at least 10 nights are required. If it is not practical to follow this procedure, due to interference to the reception of the principal station recorded, the following procedure is required:

Record the monitor station and the principal station during the earliest hour that the principal station can be recorded. The measurements must be for at least 1 continuous hour each night and preferably not less than 2 hours each night. In all cases the monitor station must be recorded simultaneously. These measurements must be taken for at least 10 nights. Establish the 10 percent value of the fields during the period when both are measured. The 10 percent value of the field for the principal station must be corrected in the following manner:

Compare the 10 percent value of the signal for the monitor station with the 10 percent value determined from Figure 1 for the same distance reduced to the same power for comparable radiation at the appropriate angle. Thus, if the 10 percent signal from the Figure 1 10 percent curve is 500 uv/m and the measured 10 percent signal on the monitor station is 400 uv/m then the 10 percent signal from the principal station should be multiplied by the correction factor of $500/400$ or 1.25. The value obtained in this way is to be considered the interference value of signals for use in all allocation problems.

When it is claimed that the propagation over the path involved is normally less than the average, measurements must be made on two or more other stations of different paths for at least 30 days and the signals of all stations involved recorded in the above manner to establish that propagation conditions in general were normal and that the path under consideration was low as claimed due to some natural conditions. A full explanation of the theory or practical findings must be made.

In all other cases where the signal is substantially greater or less than the average determined from Figure 1, complete informa-

tion must be supplied as to why the signal measured has departed from the average. If the reason for this condition is based on the location of the antenna, its characteristics, the conductivity of the surrounding area or other natural limitations, a full explanation of the nature and character of such conditions must be supplied and also information as to whether the licensee could, by moving its station or by making other changes within its control, alter the situation so that the abnormal condition of propagation would no longer exist.

The interference signal determined by the above methods should be used to determine interference to a station in the same manner as the groundwave signals were employed, as set out in Annex I. These methods of measurement should be used to determine skywave service signal for 50 percent of the time.

2. FIELD INTENSITY MEASUREMENTS IN ALLOCATION

A. FIELD INTENSITY MEASUREMENTS TO ESTABLISH EFFECTIVE FIELD INTENSITY AT 1 MILE

Section 3.45 provides that certain minimum field intensities are acceptable in lieu of the required minimum physical vertical heights of the antennas proper. Also in other allocation problems, it is necessary to determine the effective field at 1 mile. The following requirements shall govern the taking and submission of data on the field intensity produced:

Beginning as near to the antenna as possible without including the induction field and to provide for the fact that a broadcast antenna not being a point source of radiation (not less than one wave length or 5 times the vertical height in the case of a single element, i. e., nondirectional antenna or 10 times the spacing between the elements of a directional antenna), measurements shall be made on eight or more radials, at intervals of approximately one-tenth mile up to 2 miles from the antenna, at intervals of approximately one-half mile from 2 miles to 6 miles from the antenna, at intervals of approximately 2 miles from 6 miles to 15 or 20 miles from the antenna, and a few additional measurements if needed at greater distances from the antenna. Where the antenna

is rurally located and unobstructed measurements can be made, there shall be as many as 18 or 20 measurements on each radial. However, where the antenna is located in a city where unobstructed measurements are difficult to make, measurements shall be made on each radial at as many unobstructed locations as possible, even though the intervals are considerably less than stated above, particularly within 2 miles of the antenna. In cases where it is not possible to obtain accurate measurements at the closer distances (even out to 5 or 6 miles due to the character of the intervening terrain), the measurements at greater distances should be made at closer intervals.¹⁸

These data should be plotted for each radial in accordance with either of the two methods set forth below:

- (1) Using log-log coordinate paper, plot field intensities as ordinate and distance as abscissa.
- (2) Using semi-log coordinate paper, plot field intensity times distance as ordinate on the log scale and distance as abscissa on the linear scale.

However, regardless of which of these methods is employed, the proper curve to be drawn through the points plotted shall be determined by comparison with theoretical curves as follows: Plot theoretical curves (see paper by Mr. K. A. Norton, October 1936, Proc. I. R. E.) for several values of conductivities and dielectric constants, approximating the conductivity and dielectric constants indicated by the measurements on another sheet of the same coordinate paper. Place this sheet over the sheet on which the actual points have been plotted, hold to the light if necessary and adjust until the curve most closely matching the points is found. This curve should then be drawn on the sheet on which the points were plotted, together with the inverse distance curve corresponding to that curve. The field at 1 mile for the radial concerned shall be the ordinate on the inverse distance curve at 1 mile.

When all radials have been analyzed in this manner, a curve shall be plotted on polar coordinate paper from the fields obtained, which

¹⁸ It is suggested that "wave tilt" measurements may be made to determine and compare locations for taking field intensity measurements, particularly to determine that there are no abrupt changes in ground conductivity or that reflected waves are not causing abnormal intensities.

gives the inverse distance field pattern at 1 mile. The radius of a circle, the area of which is equal to the area bounded by this pattern, is the effective field. (See section 3.16.)

While making the field intensity survey, the output power of the station shall be maintained at the licensed power as determined by the direct method. To do this it is necessary to determine accurately the total antenna resistance (the resistance variation method, the substitution method or bridge method is acceptable) and to measure the antenna current by means of an ammeter of acceptable accuracy.¹⁹

Complete data taken in conjunction with the field intensity measurements shall be submitted to the Commission in affidavit form including the following:

(1) Tabulation by number of each point of measurement to agree with the map required in (2) below and the field intensity meter reading, the attenuation constant, the field intensity (E), the distance from the antenna (D) and the product of the field intensity and distance (ED) (if data for each radial are plotted on semi-logarithmic paper, see above) for each point of measurement.

(2) Map showing each point of measurement numbered to agree with tabulation required above.

(3) Description of method used to take field intensity measurements.

(4) The family of theoretical curves used in determining the curve for each radial properly identified by conductivity and dielectric constants.

(5) The curves drawn for each radial and the field intensity pattern (see subsection B 5 *a*, *b*, and *c*).

(6) Antenna resistance measurement:

a. Antenna resistance at operating frequency.

b. Description of method employed.

c. Tabulation of complete data.

d. Curve showing antenna resistance versus frequency.

(7) Antenna current or currents maintained during field intensity measurements.

(8) Description, accuracy, date, and by whom each instrument was last calibrated.

¹⁹ See section 3.54 and "Further Requirements for Direct Measurement of Power" and "Indicating Instruments Pursuant to Section 3.53."

(9) Name, address, and qualifications of the engineer making the measurements.

(10) Any other pertinent information.

B. FIELD INTENSITY MEASUREMENTS TO ESTABLISH PERFORMANCE OF DIRECTIONAL ANTENNAS

Section 3.33 (*b*) requires that proof of performance of directional antenna systems be submitted before any operation during the regular broadcast day may be permitted. These data shall be taken upon proper request and authorization therefor during the experimental period, and shall show that the pattern obtained is essentially the same as that predicted by the application and required by terms of the authorization, and that any specific requirements set out are fully met.

To establish this performance, measurements shall be made in accordance with the preceding section A along sufficient number of radials to establish the effective field from the antenna system. In the case of a relatively simple directional antenna pattern, approximately eight radials in addition to the radials in the directions the field intensity values are specified by the authorization are sufficient. However, when more complicated patterns are involved, that is, patterns having several or sharp lobes or nulls, measurements shall be taken along as many additional radials as necessary to establish the pattern definitely.

In cases where the authorization requires a showing that actual field intensities of specified values be obtained in the various portions of the service area, sufficient measurements throughout these areas shall be made to show that at least the values specified are obtained. (See paragraph 2*d* of this section.)

In either of the above cases the following information shall be submitted in triplicate, even though such information was submitted with the original application:

(1) Complete description of antenna array.

a. Number of elements.

b. Manufacturer's name and type of each element (i. e., guyed or self-supporting, triangular or square, uniform cross-section or tapered, etc.).

c. If top loaded, give details.

d. Height of vertical lead of each element in feet (height above base insulator or base, if grounded).

e. Over-all height in feet of each element above ground level.

f. Over-all height in feet of each element above mean sea level.

g. Orientation of array with respect to true north and time (specify degrees leading or lagging) and space phasing of elements. (Space phasing should be given in feet as well as in degrees.)

h. Details of ground system for each element (length and number of radials, dimensions of ground screen, if used, and depth buried).

i. Current in each element (at point where antenna ammeter is located) and current and resistance at point of common input to the antenna system.²⁰

j. Schematic sketch and description of method of feeding power to elements, including phasing and coupling equipment and locations of antenna ammeters (both regular, point of common input, and remote) in the circuits.

k. If not fully described above, give complete details and sketches if needed.

l. Full description of painting and lighting installed on each element.

m. If phase monitor is employed, state phase readings (specifying whether leading or lagging) and ratio of current indications for each element.²¹

(2) Horizontal field intensity patterns for each power involved showing:

a. Directional field intensity at 1 mile and effective field intensity from the antenna determined from the field intensity measurements as set forth above.

b. Direction true north shall be shown at zero azimuth.

c. Direction of each station or city specified in the instrument of authorization in which direction a limiting field was specified and the actual field intensity obtained in each of such directions (all directions shall be determined by accurate calculation or from Lambert Con-

formal Conic Projection Map such as United States Coast and Geodetic Survey Map No. 3060a, or map of equal accuracy, and all distances shall be determined by accurate calculation or from United States Albers Equal Area Projection Map, Scale $2,500,000^1$ or map of equal accuracy. These may be obtained from the United States Coast and Geodetic Survey and from the United States Department of Interior, Geological Survey, for the sums of 40 cents and \$1, respectively).

d. Actual field intensity contours for 25, 10, and 5 mv/m and any other contours specified by the instrument of authorization on a map having the largest practical scale. These contours need not be shown for distances over 15 miles from the antenna except that the field intensity contours on the far sides of the business and residential areas of the city in which the main studio is located shall be shown. This does not waive the requirement for measurements at greater distance under A above.

(3) Complete tabulation of all data used in plotting the above patterns.

(4) Any other pertinent information.

(5) Plotting of field intensity patterns:

a. All patterns shall be plotted on standard letter-size polar coordinate paper (main engraving approximately 7" x 10").

b. All patterns shall be plotted to the largest scale possible on the paper specified in (a) above, using divisions and subdivisions having values of 1, 2, 2.5, or 5 times 10^x . (No other values shall be used.)

c. All values of field intensity less than 10 percent of the r. m. s. field intensity of the pattern shall be shown on an enlarged scale in accordance with (a and b) above.

As a check on the shape of the field intensity pattern obtained in accordance with the above, it is suggested that measurements be taken on each of the radials at approximately 1 mile from the antenna system for operation, both directional and nondirectional, and the ratios of these values plotted on polar coordinate paper in accordance with the above specifications.

²⁰ See "Further Requirements for Direct Measurement of Power" and "Construction, General Operation, and Safety of Life Requirements."

²¹ See "Indicating Instruments Pursuant to Section 3.58."

C. MEASUREMENT OF THE FIELD INTENSITY OF BROADCAST STATIONS FOR PRESENTATION IN SUPPORT OF APPLICATIONS OR EVIDENCE AT HEARINGS BEFORE THE COMMISSION

Section 3.24 requires that among other things an application for a new standard broadcast station or increase in facilities of an existing station make a satisfactory showing that objectionable interference will not be caused to an existing station or stations.

In the determination of such interference in accordance with section 3.28, actual measurements will take precedence over theoretical values provided such measurements are properly taken and presented.

When measurements of either groundwave signal intensity or skywave signal intensity are presented in evidence, they shall be supported by a field intensity survey of the station observed, which survey should be sufficiently complete in accordance with sections A and B above to determine the field at 1 mile in the pertinent directions for that station.

When measurements are made on skywave signal intensity (either service or interference) they shall be graphic recordings as follows:

(1) Recordings shall be made on 10 or more nights for sufficient periods each night to obtain reasonable average values.²²

(2) Observations shall be made on other stations to determine whether skywave transmission conditions are normal or not.

(3) Scales on the graphic paper shall be such as to permit easy reading of both time and field intensity, and calibration shall be clearly indicated.

(4) Pertinent notes, such as predominance of signal of a certain station, when recording composite signals shall be made on the recording.

(5) Full description shall be given the point where recordings were made (geographically as well as field intensity of the station to which interference is being determined).

(6) Full explanation of to what extent signals from other stations on the same channel affected the accuracy of the recordings and what steps, if any, were taken to eliminate or compensate for such signals.

²² See Annex III in section "Engineering Standards of Allocation" for detailed requirements.

If the observed station is owned or controlled by the party on whose behalf the measurements are made, then, in addition to the above, detailed reports on the measurement of the antenna resistance and on the amount of power actually radiated (as determined by the direct method) during the course of the field intensity measurements shall be presented. The applicant (or participant) shall also furnish a complete description of the antenna and ground system in use at the transmitting station during the period of observations and a statement as to whether or not this is the identical equipment regularly used by the station.

When measurements of both the "desired" and "undesired" station are made in one area to determine the point where objectionable interference from groundwave signals occurs, several measurements of each station shall be made within a few miles of the point where the ratio of signals is that selected as the appropriate ratio for the determination of objectionable interference.

All information on the above, including description and accuracy of equipment used, when and by whom last calibrated, and the name and qualifications of the engineer making the measurements, when filed with an application, shall be in affidavit form. At the time of the hearing on applications involving such observations, the applicant should be prepared to present, as sworn testimony, complete data on the above.

3. DATA REQUIRED WITH APPLICATIONS INVOLVING DIRECTIONAL ANTENNA SYSTEMS

Section 3.33 (a) requires that an application for authority to install a directional antenna specify a definite site and that full details of the directional antenna are given with the application. Any application not complete in these details will be returned to the applicant as "defective" under section 1.72.

In order to comply with the above and to permit proper consideration of any application involving a directional antenna, the following shall be submitted in triplicate, properly verified by the engineer designing the antenna, with each such application:

(1) Name, address, and qualifications of the engineer.

(2) Complete description of the proposed antenna system.

a. Number of elements.

b. Type of each element [i. e., guyed or self-supporting, uniform cross section or tapered (specify base width), grounded or insulated, etc.].

c. If top loaded, give details.

d. Height of vertical lead of each element in feet (height above base insulator or base, if grounded).

e. Over-all height in feet of each element above ground level.

f. Over-all height in feet of each element above mean sea level.

g. Orientation of array with respect to true north and time phasing of fields from elements (specify degrees leading or lagging) and space phasing of elements (identifying elements). (Space phasing should be given in feet, as well as in degrees.)

h. Details of ground system for each element (length and number of radials, dimensions of ground screen, if used, and depth buried).

i. Ratio of fields from elements (identifying elements).

j. If not fully described above, give complete details and sketches if needed.

(3) Calculated horizontal field intensity patterns for each power involved showing:

a. Directional field intensity at 1 mile and effective field.

b. Direction true north shall be shown at zero azimuth.

c. Direction and distance to each existing station with which interference may be involved, operating either directional or nondirectional (all directions shall be determined by accurate calculation or from Lambert Conformal Conic Projection Map such as United States Coast and Geodetic Survey Map No. 3060a, or map of equal accuracy, and all distances shall be determined by accurate calculation or from United States Albers Equal Area Projection Map, scale $\frac{1}{2,500,000}$ or map of equal accuracy.

These may be obtained from the United States Coast and Geodetic Survey and the United States Department of Interior, Geological Survey, for the sums of 40 cents and \$1, respectively).

d. Calculated field intensity contours for 250, 25, and 5 mv/m and the population residing within each of such contours in addition to the information required by section 29 (*d*) of F. C. C. Form 301, on a map having the largest practical scale.

(4) Calculated vertical field intensity patterns (for nighttime power) in the direction of each minimum and the maximum and in the direction of each station with which nighttime interference may be involved, operating either directional or nondirectional for angles from 0° to 90° above the ground plane, based on the groundwave field intensity at 1 mile from the antenna for the direction involved.

(5) Data used in computing the above patterns including:

a. Formula used for calculating both horizontal and vertical patterns, and sample calculations. (Derivation of formula if other than standard is used.)

b. All assumptions made and basis therefor, including electrical height, current distribution and efficiency of each element, and ground conductivities.

c. Complete tabulation of calculation data used in plotting patterns, including data for determination of r. m. s. value of horizontal and directional patterns.

(6) Any other pertinent information.

(7) Plotting of field intensity patterns:

a. All patterns shall be plotted on standard letter-size polar coordinate paper (main engraving approximately 7" x 10").

b. All patterns shall be plotted to the largest scale possible on the paper specified in section (*a*) above using scale divisions and subdivisions having values of 1, 2, 2.5, or 5 items 10^x. (No other values shall be used.)

c. All values of field intensity less than 10 percent of the effective field intensity of the pattern shall be shown on an enlarged scale in accordance with (*a* and *b*) above.

d. In the event actual inverse distance field intensities expected to be determined in practice (that is, the values determined from actual measurements particularly in sharp nulls) are different from the above calculated values, the expected values as well as the calculated values shall be shown on both the full patterns and the enlarged sections.

4. LOCATIONS OF TRANSMITTERS OF STANDARD BROADCAST STATIONS

Section 3.24 (e) requires that the location of the transmitter shall comply with the requirements of good engineering practice. There are set out below the general requirements considered appropriate at this time. These standards will change as the art progresses and changes will be made in accordance with the best information available.

All applications for approval of transmitter sites for regular broadcast stations must be submitted on F. C. C. Form 304. In some cases the applicant may be required to submit additional information, including the results of a field intensity survey, particularly where there is any question as to whether the area can be served properly from the proposed location or where the population of the blanket area is too large.

F. C. C. Form 304 requires among other things that triplicate copies of the following be submitted:

(a) Map or maps having reasonable scales (not less than one-half inch per mile) clearly showing:

(1) Proposed location and present location if existing station;

(2) The character of the surrounding areas, particularly the retail business, wholesale business, manufacturing, residential, and unpopulated areas (by symbols, cross-hatching, colored crayons, or other means);

(3) The density and distribution of population;

(4) The heights of all tall buildings or other structures in the vicinity of the antenna, indicating their location and how marked for air navigation;

(5) The location of airports, airways, and other radio stations, including receiving stations, except broadcast or amateur;

(6) The terrain and types of soil.

(b) Aerial photograph or photographs taken of the proposed location of the antenna showing clearly the character of the area within the 250 mv/m contour. (Ordinary photographs will be accepted if they clearly show the terrain to the 250 mv/m contour and are taken in at least eight directions from the site: north, north-east, east, etc.)

Where available, United States Geological Survey topography quadrangle sheets should be submitted. In the event the map submitted does not give the topography, the height above sea level of the proposed location, hills, ridges, and other obstructions should be shown. A statement as to whether or not other obstructions in the vicinity are painted and lighted or otherwise marked should always be made. In some cases additional maps, sketches, or descriptions may be necessary to show clearly the conditions. Attention is invited to the fact that the submission of complete and accurate information will materially expedite action on a proposed location, as well as enable the Commission to reach a correct decision thereon.

Aerial photographs of adequate scale are normally considerably superior to photographs taken from the proposed site. However, if the latter clearly show the character of the surrounding area, they are acceptable. Photographs taken from a location lower than the surrounding terrain or where the view is obstructed by immediately surrounding objects are of little value. Taking the photographs from a step ladder or other support will aid materially.

As a guide, the Engineering Department has established certain engineering principles based on the extensive experience of the Engineering Department and all data available along this line, including that presented at the informal engineering hearings of October 5, 1936, January 18, 1937, and June 6, 1938.

The four primary objectives to be obtained in the selection of a site for a transmitter of a broadcast station are as follows:

(1) To serve adequately the center of population in which the studio is located and to give maximum coverage to adjacent areas.

(2) To cause and experience minimum interference to and from other stations.

(3) To present a minimum hazard to air navigation consistent with objectives 1 and 2.

(4) To fulfill certain other requirements given below.

The following table is offered as a general guide to be used in determining the approximate site of broadcast transmitters:

TABLE A

Power of station	Population of city of metropolitan area ¹	Approximate radius of blanket area 250 mv/m ²	Site—distance from center of city (business or geographical)	Maximum percentage of total population in blanket area ¹
100 w	5,000-50,000	Miles 0.15	Miles 1/4-1	1
100 w	50,000 or more	.15	(3)	-----
250-500 w	5,000-150,000	0.3-.5	1-3	1
250-500 w	150,000 or more	.3-.5	(3)	-----
1 kw	5,000 to 200,000	.6-.9	2-5	1
1 kw	200,000 or more	.6-.9	(3)	-----
5-10 kw	All	1.5-2.5	5-10	1
25-50 kw	All	3.0-4.5	10-15	1

¹ The total population is the population of the city sought to be served except in those instances when the station is to be located in an area classified by the Department of Commerce, Bureau of Census, as a metropolitan area, in which case the population of the metropolitan area shall apply. *Provided, however,* That when the power of the station is such that all the metropolitan area cannot be served, the population that will actually be served shall determine. The population figures are those determined by the latest official census and where greater population is claimed, the burden of proof is on the applicant.

² These radii are only approximate and the actual blanket area (area within the 250 mv/m contour) may be materially different depending on the antenna employed and other factors.

³ In these instances it is usually necessary to locate the station within the city in order to render satisfactory service throughout the city. Such sites shall be in or near the center of the business district and under no circumstances will a site in the residential area be approved.

In case the power and the population of the city are such that it should be located at some distance from the center of the city, the approximate distance is given as well as the population of the so-called "blanket area." The "blanket area" of a broadcast station is defined as that area adjacent to the transmitter in which the usual broadcast receiver would be subject to some type of interference to the reception of other stations due to the strong signal from the station. The normal blanket area of a broadcast station is that area lying within the 250 mv/m contour line. The average radii of the blanket areas for broadcast stations of the various powers are given in the above table.

In those cases where it is impossible or impractical to locate a station in accordance with the above specifications, the Commission will give consideration to approving locations where not more than 1 percent of the population (as above specified) is included within the 500 mv/m contour, provided the applicant submits an affidavit setting forth the reasons why the normal specifications cannot be complied with, and further that the applicant will assume full responsibility for adjustment of any reasonable complaints arising from the excessively strong signals of the applicant's station. Particular attention must be given to avoiding cross modulation.

In this connection, attention is invited to the fact that it has been found very unsatisfactory to locate broadcast stations so that high signal intensities occur in areas with overhead electric power or telephone distribution systems and sections where the wiring and plumbing are old or improperly installed. These areas are usually found in the older or poorer sections of a city. These conditions give rise to cross-modulation interference due to the nonlinear conductivity characteristics of contacts between wiring, plumbing, or other conductors. This type of interference is independent of the selectivity characteristics of the receiver and normally can be eliminated only by correction of the condition causing the interference. Cross modulation tends to increase with frequency and in some areas it has been found impossible to eliminate all sources of cross modulation, resulting in an unsatisfactory condition for both licensee and listeners.

Broadcast station transmitters will not be permitted to be located in these areas even though the population is within the requirements of Table A, unless the licensee assumes full responsibility for and it appears it can adjust all complaints satisfactorily.

If the city under consideration is of irregular shape, the station is of high power, a directional antenna system is employed, or if other unusual conditions obtain, the table may not apply and special consideration must be given. However, the general principles set out will still apply.

In selecting a site in the center of a city it is usually necessary to place the radiating system on the top of a building. This building should be large enough to permit the installation of a satisfactory ground and/or counterpoise system. Great care must be taken to avoid selecting a building surrounded by taller buildings or where any nearby building higher than the antenna is located in the direction which it is desired to serve. Such a building will tend to cast "radio shadows" which may materially reduce the coverage of the station in that direction. Irrespective of the height of surrounding buildings, the building on which the antenna is located should not have height of approximately one-quarter wavelength. A study of antenna systems located on buildings tends

to indicate that where the building is approximately a quarter wavelength in height, the efficiency of radiation may be materially reduced.

If from Table A it is determined that a site should be selected removed from the city, there are several general conditions to be followed in determining the exact site. The table gives the approximate distance from the center of the city. Three maps should be given consideration if available:

(1) Map of the density of population and number of people by sections in the area.

(2) Geographical contour map with contour intervals of 20 to 50 feet.

(3) Map showing the type, nature and depth of the soil in the area with special reference to the condition of the moisture throughout the year. (See Table B.)

From these maps a site should be selected that is approximately the required distance from the city, with a minimum population in the "blanket area" and with a minimum number of intervening hills between it and the center of the city. In general, because of ground conditions, it is better to select a site in a low area rather than on top of a hill, and the only condition under which a site on top of a hill should be selected is that it is only possible by this means to avoid a substantial number of hills, between the site and the center of a city with the resulting radio shadows. If a site is to be selected to serve a city which is on a general sloping area, it is generally better to select a site below the city than above the city.

If a compromise must be made between probable radio shadows from intervening hills and locating the transmitter on top of a hill, it is generally better to compromise in favor of the low area, where an efficient radiating system may be installed which will more than compensate for losses due to shadows being caused by the hills, if not too numerous or too high. Several transmitters have been located on top of hills, but so far as data has been supplied not a single installation has given superior efficiency of propagation and coverage.

The ideal location of a broadcast transmitter is in a low area of marshy or "crawfishy" soil or area, which is damp the maximum percentage of time and from which a clear view

over the entire center of population may be had, and the tall buildings in the business section of the city would cast a shadow across the minimum residential area.

The type and condition of the soil or earth immediately around a site is very important. Important, to an equal extent, is the soil or earth between the site and the principal area to be served. Sandy soil is considered the worst type, with glacial deposits and mineral-ore areas next. Alluvial, marshy areas and salt-water bogs have been found to have the least absorption of the signal. One is fortunate to have available such an area and, if not available, the next best condition must be selected.

Table B indicates the values of inductivity and conductivity which it is recommended be used for various types of country in the absence of surveys over the particular area involved. Naturally, values obtained from the use of these figures will be only approximate and should, if possible, be replaced by actual measurements in the area under consideration.

TABLE B

Type of terrain	Inductivity	Conductivity	Absorption factor at 50 miles, 1000 kc. ¹
Sea water, minimum attenuation....	81	4.64×10^{-11}	1.0
Pastoral, low hills, rich soil, typical of Dallas, Tex., Lincoln, Nebr., and Wolf Point, Mont., areas.	20	3×10^{-13}	0.50
Pastoral, low hills, rich soil, typical of Ohio and Illinois.	14	10^{-13}	0.17
Flat country, marshy, densely wooded, typical of Louisiana near Mississippi River.	12	7.5×10^{-14}	0.13
Pastoral, medium hills, and forestation, typical of Maryland, Pennsylvania, New York, exclusive of mountainous territory and sea coasts.	13	6×10^{-14}	0.09
Pastoral, medium hills, and forestation, heavy clay soil, typical of central Virginia.	13	4×10^{-14}	0.05
Rocky soil, steep hills, typical of New England.	14	2×10^{-14}	0.025
Sandy, dry, flat, typical of coastal country.	10	2×10^{-14}	0.024
City, industrial areas, average attenuation.	5	10^{-14}	0.011
City, industrial areas, maximum attenuation.	3	10^{-15}	0.003

¹ This figure is stated for comparison purposes in order to indicate at a glance which values of conductivity and inductivity represent the higher absorption. This figure is the ratio between field intensity obtained with the soil constants given and with no absorption.

Careful consideration must be given to selecting a site so that the number of people in the blanket area is a minimum. The last column of Table A gives the percentage of the total population of the city or metropolitan

area that may be permitted in the blanket area. In general, broadcast transmitters operating with approximately the same power can be grouped in the same approximate area and thereby reduce the interference between them.

If the city is of irregular shape, it is often possible to take advantage of this in selecting a suitable location that will give a maximum coverage and at the same time maintain a minimum of people within the blanket area. The maps giving the density of population will be a key to this. The map giving the elevation by contours will be a key to the obstructing hills between the site and city. The map of the soil conditions will assist in determining the efficiency of the radiating system that may be erected and the absorption of the signal encountered in the surrounding area.

Another factor to be considered is the relation of the site to airports and airways. There are no regulations or laws with respect to distance from airports and airways, but a distance of 3 miles from each is used as a guide. In case a suitable location is found at less distance than this, it may be satisfactory if the towers are suitably painted and lighted in conformity with the requirements of the Civil Aeronautics Administration, or if the towers are not higher than the surrounding objects. The latter is normally considered poor engineering practice; however, in selecting a site the local aeronautical authorities should always be consulted if there is any question concerning erecting a hazard to aviation, and in case of towers over 200 feet high this should always be done. In passing on a location and antenna installation, the Engineering Department refers each case to the Civil Aeronautics Administration for its recommendation. The action of the Administration will be materially expedited by the district airline inspector and local representatives of the airports and airlines forwarding their approval or comments to the Civil Aeronautics Administration, Washington, D. C.

In finally selecting the site, consideration must be given to the required space for erecting an efficient radiating system, including the ground or counterpoise (see section 3.45). It is the general practice to use direct grounds consisting of a radial buried wire system. If the area is

such that it is not possible to get such ground system in soil that remains moist throughout the year, it probably will be found better to erect a counterpoise. (Such a site should be selected only as a last resort.) It, like the antenna itself, must of course be designed properly for the operating frequency and other local conditions.

While an experienced engineer can sometimes select a satisfactory site for a 100-watt station by inspection, it is necessary for a higher power station to make a field-intensity survey to determine that the site selected will be entirely satisfactory. There are several facts that cannot be determined by inspection that make a survey very desirable for all locations removed from the city. Often two or more sites may be selected that appear to be of equal promise. It is only by means of field-intensity surveys taken with a transmitter at the different sites or from measurements on the signal of nearby stations traversing the terrain involved that the most desirable site can be determined. There are many factors regarding site efficiency that cannot be determined by any other method.

The site selected should meet the following conditions:

(1) A minimum field intensity of 25 to 50 mv/m will be obtained over the business or factory areas of the city.

(2) A minimum field intensity of 5 to 10 mv/m will be obtained over the most distant residential section.

(3) The absorption of the signal is the minimum for any obtainable sites in the area. As a guide in this respect the absorption of the signals from other stations in that area should be followed, as well as the results of tests on other sites.

(4) The population within the blanket radius (250 mv/m) does not exceed that specified by Table A.

When making the final selection of a site, the need for a field-intensity survey to establish the exact conditions cannot be stressed too strongly. The selection of a proper site for a broadcast station is an important engineering problem and can only be done properly by experienced radio engineers.

5. MINIMUM ANTENNA HEIGHTS OR FIELD INTENSITY REQUIREMENTS

Section 3.45 requires that all applicants for new, additional, or different broadcast facilities and all licensees requesting authority to move the transmitter of an existing station, shall specify a radiating system, the efficiency of which complies with the requirements of good engineering practice for the class and power of the station.

The specifications deemed necessary to meet the requirements of good engineering practice at the present state of the art are set out in detail below.

The licensee of a standard broadcast station requesting a change in power, time of operation, frequency, or transmitter location must also request authority to install a new antenna system or to make changes in the existing antenna system which will meet the minimum height requirements, or submit evidence²³ that the present antenna system meets the minimum requirements with respect to field intensity, before favorable consideration will be given thereto. 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 intensity measurements showing that it meets the minimum requirements with respect to effective field intensity.

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

A. Class IV stations, 150 feet²⁴ or a minimum effective field intensity of 150 mv/m for 1 kw (100 watts, 47.5 mv/m and 250 watts, 75 mv/m)

B. Class II and III stations, or a minimum effective field intensity of 175 mv/m for 1 kw.

C. Class I stations, or a minimum effective field intensity of 225 mv/m for 1 kw.

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

²³ See Field Intensity Measurements in Broadcast Allocation, section A.

²⁴ This height applies to a Class IV station on a local channel only. In case a Class IV station is assigned a regional channel Curve A shall apply.

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.

To obtain the maximum efficiency of which any antenna is capable a good ground system must be employed (a counterpoise may be substituted under certain conditions).

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

It should be borne in mind that the above specifications are the minimum and where possible better antenna and ground systems should be installed.

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 intensity survey²⁵ must be supplied to the Commission showing that the field intensity at a mile without absorption fulfills the minimum requirements. This field survey must be made by a qualified engineer using equipment of acceptable accuracy.

The main element or elements of a directional antenna system shall meet the above minimum requirements with respect to height or effective field intensity. 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 I station less than 90 percent of the groundwave field which would be obtained from a perfect antenna of the height specified by Figure 7 for operation on frequencies below 1000 kc., and in the case of a Class II or III station less than 90 percent of the groundwave field which would be obtained from a perfect antenna of the height specified

²⁵ See Field Intensity Measurements in Broadcast Allocation, section A.

by Figure 7 for operation on frequencies below 750 kc.

In all cases of new construction where concentric transmission line is used between the transmitter and antenna, such line shall be installed in duplicate with adequate switching facilities for immediate connection of the second line in case of failure of the first line, or permanently installed auxiliary facilities such as an auxiliary transmitter and antenna system, auxiliary antenna system or other means whereby operation may be continued in the event of failure of the transmission line.

Before any changes are made in the antenna system, it is necessary to submit full details to the Commission for approval. These data may be submitted by letter.

6. STANDARD LAMPS AND PAINTS

Section 3.45 (d) requires that the antenna and supporting structure shall be painted and illuminated in accordance with the specifications supplied by the Commission pursuant to section 303 (g) of the Communications Act of 1934.

These individual specifications are issued for and attached to each authorization for an installation.²⁸ The details of the specifications depend on the degree of hazard presented by the particular installation. The following standard lamps and paints shall be used for the type of marking specified:

(a) *Painting.*—Each tower shall be painted throughout its height with alternate horizontal bands of international orange and white, terminating with orange bands at both top and bottom. (Orange yellow No. 5 color card, supplement to U. S. Army Quartermaster Corps Specifications No. 3-1.) The width of the orange bands shall be approximately one-seventh of the height of any structure less than 250 feet in height, and between 30 and 40 feet for structures over 250 feet in height. The width of the white bands shall be one-half that of the orange bands.

(b) *Lighting.*—(1) Towers, the over-all heights of which do not exceed 200 feet, shall be lighted as follows:

At the top of each tower there shall be installed two 100-watt lamps, enclosed in aviation red prismatic obstruction light globes. At least one of these lamps shall burn continuously from sunset to sunrise. When only one lamp is operated, the circuit shall be equipped with a relay for instant automatic switchover to the other lamp in case of lamp failure.

²⁸ Specifications normally attached to authorization.

At both the one-third and two-thirds levels of each tower there shall be installed two 100-watt lamps enclosed in aviation red prismatic obstruction light globes, at each level, one each on diagonally opposite corners of the structure.

All 100-watt lamps shall be type A-21 clear bulb traffic signal lamps (2,000 hours or equal).

All lamps shall be enclosed in aviation red prismatic obstruction light globes, and all lighting shall be exhibited from sunset to sunrise.

* * * * *

Special conditions of terrain and location with respect to airports or airways may require additional lighting of the character hereinafter specified for towers the over-all height of which exceeds 200 feet.

* * * * *

(2) Towers, the over-all heights of which exceed 200 feet but do not exceed 300 feet, shall be lighted as follows:

At the top of each tower there shall be installed a hazard beacon similar and equal in effectiveness to the standard 300 m./m. airways electric lantern. This beacon shall flash and shall be equipped with two 500-watt lamps (both lamps to burn simultaneously) and aviation red color shades. The 300 m./m. electric code beacon shall be equipped with a flashing mechanism producing 40 flashes per minute, having a luminous period of 1 second, and a period of darkness of one-half second.

The one-third and two-thirds levels of the tower shall be marked by 100-watt obstruction lights the same as specified for towers not exceeding 200 feet in height.

* * * * *

Towers over 300 feet in height (and less than 300 feet in height where special conditions obtain) may be required to install additional marking as follows:

GENERAL

Under particularly hazardous conditions and in areas of heavy air traffic, it may be necessary to add a 24-inch, 500- or 1000-watt red rotating beacon equipped with an automatic lamp changer, to mark the installation. The beacon may be installed on the roof of the transmitter building, provided the point will afford proper visibility, otherwise it may be necessary to install the beacon on a separate tower of proper height or on the radio tower itself. The recommended setting of this rotating beacon is such that the center line of the light beam shall be approximately 3° above horizontal.

Adequate red warning lights shall be placed on the structure or structures during the period of construction and until the specified obstruction lights are installed and in operation.

Under certain conditions it may be required to have the lighting controlled by a light-sensitive control device, the adjustment being such that lights will be turned on at a north sky light intensity level of 20-foot candles and turned off at a north sky light intensity level of 40-foot candles.

Under certain conditions it may be required to install and operate a radio obstruction marker of a type to be specified.

Foregoing specifications require that at both the one-third and two-thirds levels of the structure there shall be installed two 100-watt lamps enclosed in aviation red prismatic obstruction light globes, at each level, one each on diagonally opposite corners of the structure.

Under certain conditions and in the case of triangular and other towers of unusual design, it may be required to install 100-watt lamps enclosed in aviation red prismatic obstruction light globes at various corners and levels throughout the height of the structure in such manner that adequate visibility and definition would be obtained from all angles of-approach.

Towers of excessive height or peculiar (unusual) design will be made the subject of special investigation and analysis to determine proper marking and lighting.

In addition to the standard marking and lighting of the main structure, towers using guy wires will be made the subject of special study to determine proper marking and lighting of the guy wires.

The specifications relative to obstruction marking and lighting of radio towers of a certain height are general, and in locations of extreme hazard to air navigation, it may be required to install additional equipment on any height tower, in order to obtain suitable protection.

(a) Type A-21, 100-watt traffic signal, clear, medium screw base lamps enclosed in aviation red prismatic obstruction light globes shall be employed in all cases where 100-watt lamps are specified.

(b) Type PS-30, 200-watt general lighting service, clear, mogul prefocus base lamps shall be employed in all cases where code beacons with 200-watt lamps are specified.

(c) Type PS-40, 500-watt general lighting service, clear, mogul prefocus base lamps shall be employed in all cases where code beacons with 500-watt lamps are specified.

(d) Type T-24, 500-watt aviation lighting service, clear, mogul bi-post base lamps shall be employed in all cases where rotating beacons with 500-watt lamps are specified.

(e) Type T-20, 1000-watt aviation lighting service, clear, mogul bi-post base lamps shall be employed in all cases where rotating beacons with 1000-watt lamps are specified.

(f) The tower paint shall be kept in good condition and repainted as often as necessary to maintain this condition. Towers now painted black and yellow shall, when repaint-

ing is necessary, be painted in accordance with the present standards.²⁶

7. FURTHER REQUIREMENTS FOR DIRECT MEASUREMENT OF POWER

Section 3.54 states that the antenna input power determined by direct measurement is the square of the antenna current times the antenna resistance at the point where the current is measured and at the operating frequency, and sets forth certain requirements relative to the determination of the resistance and measurement of the antenna current.

The Commission does not specify any particular method of making antenna resistance measurements. Measurements made by any standard method will be accepted, provided satisfactory evidence is submitted in accordance with the following as to the procedure used, accuracy of the instruments, and qualifications of the engineer conducting the measurements.

The resistance variation method, substitution method, and bridge method are acceptable methods for measuring the total antenna resistance and the following general instructions are given as a guide.

The apparatus required is as follows:

(a) Radio frequency generator to cover the frequency range necessary, power 50 watts or required power when using bridge method.

(b) Wavemeter for broadcasting frequency, accuracy 0.25 percent.

(c) Decade resistor having steps of units, tens, and hundreds ohms resistance, or equivalent, accuracy, 1.0 percent.

(d) Radio frequency galvanometer or milliammeter of approved type, accuracy 2.0 percent.

(e) Approved tuning condenser of approximately 0.001 MFD capacity and tuning inductance of approximately 60 MH.

(f) Or suitable bridge if this method is used.

The broadcast transmitter is not usually satisfactory for use as the source of radio frequencies. The maximum power dissipated in the antenna while making measurements should not be over 10 percent of the power available from the radio-frequency generator.

²⁶ Specifications normally attached to authorization.

An accurate determination of the antenna resistance can only be made by taking a series of measurements each for a different frequency. From 10 to 12 resistance measurements covering a band 50 to 60 kc. wide with the operating frequency near the middle of the band must be made to give data from which accurate results may be obtained. The values measured should be plotted with frequency as abscissa and resistance in ohms as ordinate and a smooth curve drawn. The point on the ordinate where this curve intersects the operating frequency gives the value of the antenna resistance.

In order to comply with the provisions of section 3.54 the following data should be submitted in duplicate to the Commission in affidavit form, accompanied by duplicate copies of F. C. C. Form 306 properly executed:

- (1) Complete data taken.
- (2) The graph drawn.
- (3) Description of method used to take readings (include schematic circuit diagrams of the measurement circuit and of the antenna system showing point of measurement and location in circuit of both regular and remote antenna ammeters).
- (4) Manufacturer's name of each calibrated instrument used and manufacturer's rated accuracy.
- (5) Accuracy, date and by whom each instrument was last calibrated.
- (6) Qualifications of engineer making measurements.

Licensees of broadcast stations authorized to employ directional antenna systems desiring to determine the operating power by direct measurement of the antenna power shall determine the resistance by the following method:

Measure the resistance at the point of common radio frequency input to the directional antenna system. The following conditions and procedure shall obtain:

- (a) The antenna shall be finally adjusted for the required pattern.
- (b) The reactance at the operating frequency and at the point of measurement shall be adjusted to zero or as near thereto as practical.

(c) Suitable radio-frequency bridge or other method shall be employed to determine the resistance and reactance at the point of common radio frequency input in the same manner as set forth above for a single antenna.

(d) Resistance and reactance measurements at approximately 5, 10, 15, and 20 kc. on each side of the operating frequency shall be made. The values measured shall be plotted and the resistance at the operating frequency determined in the same manner as for a single-element antenna.

(e) A permanently installed antenna ammeter shall be placed in each element of the system as well as at the point of measurement of resistance, with the remote reading ammeters²⁷ located in the transmitter room. The application for authority to determine power by the direct method shall specify not only the current at the point of resistance measurement for the authorized input power (I^2R in accordance with section 3.54 and (f) below), but also the current of each element of the system when adjusted for the required pattern and for the authorized operating power.

(f) The license for a station of power of 5 kw. or under, which employs a directional antenna and determines the power by the direct method, will specify the antenna resistance as 92.5 percent of that determined at the point of common input in accordance with the above. The resistance specified for stations of a power over 5 kw. will be 95 percent of that determined at the point of common input.

8. POWER RATING OF VACUUM TUBES

Section 3.42 requires that the maximum rated carrier power of a standard broadcast transmitter shall be determined as the sum of the applicable power ratings of the vacuum tubes employed in the last radio stage. The approved power ratings of vacuum tubes for operation in the last radio stages of broadcast transmitters are fixed as set out in the following tables:

²⁷ In all cases regular antenna ammeters and remote antenna ammeters shall comply with the requirements of section 3.58 and "Indicating Instruments Pursuant to Section 3.58."

TABLE A.1.—Power rating of vacuum tubes for high-level modulation or plate modulation in the last radio stage

Power rating (watts)	Amperex	Collins	De-Forest	Eitel McCullough	Federal Telegraph	General Electric Co.	Heintz & Kaufman	Hygrade Sylvania	Machlett Labs.	R. C. A. Mfg. Co.	Raytheon Production Corp.	Sheldon Electric Co.	Taylor Tubes, Inc.	United Electric	Western Electric	Westinghouse Electric & Mfg. Co.
50				35-T 50-T		GL-276-A	HK-54 158			808	RK-32 RK-35 RK-37 RK-47 RK-51 RK-52	35-T	T-40 T-55	211-D 211-E 248-A 276-A		
75	HF-100 203-A 211 838 852 860	C-203-A C-211	502-A 511 552 560		F-303-A F-311-A F-352-A	GL-202-A GL-211 GL-242-C GL-835 GL-838 GL-860	154	203-A 211 852 860	ML-203-A ML-211 ML-838	203-A 211	EK-58		203-A 211	UE-100 242-A 242-B 242-C 261-A 263-A 263-A 311 361-A 838 852 938 952	242-A 242-B 242-C 261-A 263-A 263-A 311 361-A 295-A	WL-105 WL-106 WL-203-A WL-211 WL-469 WL-838 WL-860
100				100-TH 100-TL 75-T	F-102-A F-105-A		152-L 254				RK-36 RK-38 RK-48	100-TH	TW-75			WL-469 WL-468
125	HF-300 303-H 211-C 211-D 211-H 805 810 813	C-200 C-201 C-211-D		130-T 4-123-A	F-123-A	GL-803 GL-805 GL-810				4-123-A(4D21 805 806 810 810	RK-57 RK-28-A		HD-203A TL-225 TW-150 806	HV-18 806 810 803		WL-463 WL-802 WL-805 WL-810
250	204-A HF-300 212-E	C-204-A C-300	504-A 561 571	4-250-A 152-TL 152-TH	F-127-A F-204-A F-212-E F-331-A	GL-204-A GL-806 GL-861	304-H 304-L 354 HK-354-A HK-354-C HK-354-D HK-354-E HK-354-F 454-H 454-L	204-A 212-D 831 861	ML-204-A	204-A 806 831 861	RK-63		T-200 204-A 814 822	KU-23 204-A 212-E 304-A 312-E	212-D 212-E	WL-204-A WL-806 WL-861
350	270-A 849		549	250-TH 260-TL 300-T	F-100-A F-349	GL-849		840	ML-849	849		250-TH		849 849	270-A	WL-849
500	251-A 833-A			304-TL 304-TH 450-TL 450-TH		GL-833	255 654 854-H 854-L		ML-833-A	833 833-A		450-TH			251-A 357-A 357-B	WL-833 WL-833-A
750	279-A 849-A 849-H 851	C-849-A C-849-H	551	500-T	F-121-A F-351-A	GL-851	2054-A	851	ML-849-A ML-851	851				949-A 949-H 851 951	279-A 379-A	WL-851
1000	846			750-TL 750-TH	F-128-A F-348-A	GL-846	1054-L 1554	846	ML-846	846				846		WL-846
2500	228-A 1452-3000 ZF-3200		520-B 620-M	1500-T	F-328-A F-328-B F-448 F-3652-A	GL-207 GL-889	3054	820-B	ML-889-A ML-889-B ML-891-R	520-B 1652				207	228-A	WL-473 WL-889-R

See footnote at end of table D.

TABLE A.1.—Power rating of vacuum tubes for high-level modulation or plate modulation in the last radio stage—Continued

Power rating (watts)	Amperex	Collins	De-Forest	Eitel McCullough	Federal Telegraph	General Electric Co.	Heintz & Kaufman	Hygrade Sylvania	Machlett Labs.	R. C. A. Mfg. Co.	Raytheon Production Corp.	Sheldon Electric Co.	Taylor Tubes, Inc.	United Electronics	Western Electric	Westinghouse Electric & Mfg. Co.
5000	207-C 220-A 343-R 848 891 892-R		507 548 563	2000-T 3X2500A3 3X2500F3	F-125-A F-129-R F-129-R F-307-A F-320-A F-320-B F-343-A F-345-A F-363-A F-891 F-892 F-892-R	GL-891 GL-892 GL-892-R	207 848 863	ML-207 ML-891 ML-892 ML-892-R	207 848 863 891 892 892-R						220-B 220-C 343-A 220-CA 343-AA	WL-207 WL-891 WL-892 WL-892-R
10,000	232-B 342-A				F-101-B F-110-A F-110-X F-115-A F-131-A F-131-R F-323-B F-332-A F-332-B F-332-C F-342-A F-342-R F-365-A	GL-880 GL-883			ML-880 ML-883-A ML-883-AR	865 883 883-AR 889-R					232-A 232-B 232-BA 342-A	WL-885 WL-886 WL-889-R WL-889
25,000				3X12500A3	F-117-B F-124-A F-124-R 7C-30 9C-31					9C22						WL-880 WL-889-R
40,000					F-882 F-888	GL-882 GL-888				882 888					298-A	WL-882 WL-888
100,000															320-A	

TABLE B.1.—Power rating of vacuum tubes for low-level modulation or last radio stage operating as linear power amplifier

Power rating (watts)	Amperex	Collins	De-Forest	Eitel McCullough	Federal Telegraph	General Electric Co.	Heintz & Kaufman	Hygrade Sylvania	Machlett Labs.	R. C. A. Mfg. Co.	Raytheon Production Corp.	Sheldon Electric Co.	Taylor Tubes, Inc.	United Electronics	Western Electric	Westinghouse Electric & Mfg. Co.
25				75-T		GL-203-A	154		ML-203-A	203-A			T-55 TW-75 203-A 211 211-C			WL-203-A
60	HT-200 203-H 211-H 242-C			100-TH 100-TL 160-T 182-TH 182-TL	F-123-A	GL-242-C GL-803 GLL-810	152-L HK-354 HK-354-A HK-354-C HK-354-D HK-354-E HK-354-F			803 806 810	KK-32 KK-35 KK-37 KK-47 KK-51 KK-36 KK-38 KK-57 KK-58 KK-28-A KK-48	100-TH	T-125 TW-180 HD-203-A		242-B 242-C	WL-803 WL-810

1000, 5000 and 7500 cycles up to tenth harmonic or 16,000 cycles, or any intermediate frequency that readings on these frequencies indicate is desirable).

(4) The audio frequency transmitting characteristics of the equipment from the microphone terminals (including microphone amplifier unless microphone frequency correction is included in which event proper allowance shall be made accordingly) to the antenna output does not depart more than 2 decibels from that at 1000 cycles between 100 and 5000 cycles.

(5) The carrier shift (current) at any percentage of modulation does not exceed 5 percent.

(6) The carrier hum and extraneous noise (exclusive of microphone and studio noises) level (unweighted r. s. s.) is at least 50 decibels below 100 percent modulation for the frequency band of 150 to 5000 cycles and at least 40 decibels down outside this range.

(7) The transmitter shall be equipped with suitable indicating instruments in accordance with the requirements of section 3.58 and any other instruments necessary for the proper adjustment and operation of the equipment.

(8) Adequate provision is made for varying the transmitter power output between sufficient limits to compensate for excessive variations in line voltage, or other factors which may affect the power output.

(9) The transmitter is equipped with automatic frequency control equipment capable of maintaining the operating frequency within the limit specified by section 3.59.

a. The maximum temperature variation ³¹ at the crystal from the normal operating temperature shall not be greater than:

1. Plus or minus 0.1° C. when an *X* or *Y* cut crystal is employed, or

2. Plus or minus 1.0° C. when low temperature coefficient crystal ³² is employed.

b. Unless otherwise authorized, a thermometer shall be installed in such manner that the temperature at the crystal can be accurately measured within 0.05° C. for *X* or *Y* cut crystal or 0.5° for low temperature coefficient crystal.

³¹ Explanations of excessive frequency deviations will not be accepted when temperature variations are in excess of the values specified below.

³² See "Use of Low Temperature Coefficient Crystals by Broadcast Stations."

c. It is preferable that the tank circuit of the oscillator tube be installed in the temperature controlled chamber.

(10) Means are provided for connection and continuous operation of approved modulation monitor and approved frequency monitor.

a. The radio frequency energy for operation of the approved frequency monitor shall be obtained from a radio-frequency stage prior to the modulated stage unless the monitor is of such design as to permit satisfactory operation when otherwise connected and the monitor circuits shall be such that the carrier is not heterodyned thereby.

(11) Adequate margin is provided in all component parts to avoid overheating at the maximum rated power output.

B. Construction.—In general, the transmitter shall be constructed either on racks and panels or in totally enclosed frames ³³ protected as required by article 810 of the National Electrical Code ³⁴ and as set forth below:

(1) Means shall be provided for making all tuning adjustments, requiring voltages in excess of 350 volts to be applied to the circuit, from the front of the panels with all access doors closed.

(2) Proper bleeder resistors or other automatic means shall be installed across all the condenser banks to remove any charge which may remain after the high voltage circuit is opened (in certain instances the plate circuit of the tubes may provide such protection; however, individual approval of such shall be obtained by the manufacturer in case of standard equipment, and the licensee in case of composite equipment).

(3) All plate supply and other high voltage equipment, including transformers, filters, rectifiers and motor generators, shall be protected

³³ The final stages of high power transmitters may be assembled in open frames provided the equipment is enclosed by a protective fence.

³⁴ The pertinent sections of article 810 of the National Electrical Code read as follows:

"8101. *General.*—Transmitters shall comply with the following:

"*a. Enclosing.*—The transmitter shall be enclosed in a metal frame or grille, or separated from the operating space by a barrier or other equivalent means, all metallic parts of which are effectually connected to ground.

"*b. Grounding of controls.*—All external metallic handles and controls accessible to the operating personnel shall be effectually grounded. No circuit in excess of 150 volts shall have any parts exposed to direct contact. A complete dead-front type of switchboard is preferred.

"*c. Interlocks on doors.*—All access doors shall be provided with interlocks which will disconnect all voltages in excess of 350 volts when any access door is opened."

so as to prevent injury to operating personnel.

a. Commutator guards shall be provided on all high voltage rotating machinery (coupling guards on motor generators, although desirable, are not required).

b. Power equipment and control panels of the transmitter shall meet the above requirements (exposed 220 volt AC switching equipment on the front of the power control panels is not recommended; however, is not prohibited).

c. Power equipment located at a broadcast station but not directly associated with the transmitter (not purchased as part of same), such as power distribution panels, control equipment on indoor or outdoor stations and the substations associated therewith, are not under the jurisdiction of the Commission; therefore, section 3.46 does not apply.

d. It is not necessary to protect the equipment in the antenna tuning house and the base of the antenna with screens and interlocks, provided the doors to the tuning house and antenna base are fenced and locked at all times, with the keys in the possession of the operator on duty at the transmitter. Ungrounded fencing or wires should be effectively grounded, either directly or through proper static leaks. Lightning protection for the antenna system is not specifically required but should be installed.

e. The antenna, antenna lead-in, counterpoise (if used), etc., shall be installed so as not to present a hazard. The antenna may be located close by or at a distance from the transmitter building. A properly designed and terminated transmission line should be used between the transmitter and the antenna when located at a distance.³⁵

(4) Metering equipment:³⁶

a. All instruments having more than 1,000 volts potential to ground on the movement shall be protected by a cage or cover in addition to the regular case. (Some instruments are de-

signed by the manufacturer to operate safely with voltages in excess of 1,000 volts on the movement. If it can be shown by the manufacturer's rating that the instrument will operate safely at the applied potential, additional protection is not necessary.)

b. In case the plate voltmeter is located on the low potential side of the multiplier resistor with one terminal of the instrument at or less than 1000 volts above ground, no protective case is required. However, it is good practice to protect voltmeters subject to more than 5000 volts with suitable over-voltage protective devices across the instrument terminals in case the winding opens.

c. The antenna ammeters (both regular and remote and any other radio frequency instrument which it is necessary for the operator to read) shall be so installed as to be easily and accurately read without the operator having to risk contact with circuits carrying high potential radio frequency energy.

C. *Wiring and shielding.*—(1) The transmitter panels or units shall be wired in accordance with standard switchboard practice, either with insulated leads properly cabled and supported or with rigid bus bar properly insulated and protected.

(2) Wiring between units of the transmitter, with the exception of circuits carrying radio frequency energy, shall be installed in conduits or approved fiber or metal raceways to protect it from mechanical injury.

(3) Circuits carrying low level radio frequency energy between units shall be either concentric tube, two wire balanced lines, or properly shielded to prevent the pickup of modulated radio frequency energy from the output circuits.

(4) Each stage (including the oscillator) preceding the modulated stage shall be properly shielded and filtered to prevent unintentional feedback from any circuit following the modulated stage (an exception to this requirement may be made in the case of high level modulated transmitters of approved manufacture which have been properly engineered to prevent reaction).

(5) The crystal chamber, together with the conductor or conductors to the oscillator circuit shall be totally shielded.

³⁵ In all cases of new construction where a concentric transmission line is used between the transmitter and antenna, such line shall be installed in duplicate with adequate switching facilities for immediate connection of the second line in case of failure of the first line, or permanently installed auxiliary facilities such as an auxiliary transmitter and antenna system, auxiliary antenna system or other means whereby operation may be continued in the event of failure of the transmission line. It is also recommended that spare antenna and transmission line ammeters identical with those installed be kept on hand.

³⁶ In addition to the following requirements, instruments shall meet the requirements of section 3.58 and "Indicating Instruments Pursuant to Section 3.58."

ing only (no shunt circuits of any type shall be employed), and insofar as practicable, the type and scale of the transmission line meter should be the same as those of the excitation circuit feed line meter (meter in slant wire feed line or equivalent).

(i) Remote reading antenna ammeters employing vacuum tube rectifiers are acceptable provided:

1. The indicating instruments shall meet all the above requirements for linear scale instruments.

2. Data are submitted under oath showing the unit has an over-all accuracy of at least 2 percent of the full scale reading.

3. The installation, calibration, and checking are in accordance with the above requirements.

(j) In the event there is any question as to the method of providing or the accuracy of the remote meter, the burden of proof of satisfactory performance shall be upon the licensee and the manufacturer of the equipment.

C. Stations determining power by the indirect method may log the transmission line current in lieu of the antenna current provided the instrument meets the above requirements for antenna ammeters, and further provided that the ratio between the transmission line current and the antenna current is entered each time in the log. In case the station is authorized for the same operating power for both day and nighttime operation, this ratio shall be checked at least once daily. Stations which are authorized to operate with nighttime power different from the daytime power shall check the ratio for each power at least once daily.

D. No instruments indicating the plate current or plate voltage of the last radio stage, the antenna current or the transmission line current when logged, in lieu of the antenna current, shall be changed or replaced without written authority of the Commission, except by instruments of the same make, type maximum scale readings, and accuracy. Requests for authority to change an instrument may be made by letter or telegram giving the manufacturer's name, type number, serial number and full scale reading of the proposed instrument and the values of current or voltage the

instrument will be employed to indicate. Requests for temporary authority to operate without an instrument or with a substitute instrument may be made by letter or telegram stating the necessity therefor and the period involved.

E. No instrument, the seal of which has been broken, or the accuracy of which is questionable, shall be employed. Any instrument which was not originally sealed by the manufacturer that has been opened shall not be used until it has been recalibrated and sealed in accordance with the following: Repairs and recalibration of instruments shall be made by the manufacturer, by an authorized instrument repair service of the manufacturer or by some other properly qualified and equipped instrument repair service. In either case the instrument must be resealed with the symbol or trade mark of the repair service and a certificate of calibration supplied therewith.

F. Since it is usually impractical to measure the actual antenna current of a shunt excited antenna system, the current measured at the input of the excitation circuit feed line is accepted as the antenna current.

G. Recording instruments may be employed in addition to the indicating instruments to record the antenna current and the direct plate current and direct plate voltage of the last radio stage provided that they do not affect the operation of the circuits or accuracy of the indicating instruments. If the records are to be used in any proceedings before the Commission as representation of operation with respect to plate or antenna current and plate voltage only, the accuracy must be the equivalent of the indicating instruments and the calibration shall be checked at such intervals as to insure the retention of the accuracy.

H. The function of each instrument shall be clearly and permanently shown on the instrument itself or on the panel immediately adjacent thereto.

14. REQUIREMENTS FOR TYPE APPROVAL OF BROADCAST TRANSMITTERS AND AUTOMATIC FREQUENCY CONTROL EQUIPMENTS

Sections 3.41 to 3.64 govern the design, construction, and technical operation of standard broadcast equipment. In order to facilitate

filing of and action on applications for construction permits specifying equipment of standard manufacture, the Commission will approve, as complying with the technical requirements, such equipment by type, subject to the following conditions and in accordance with the following procedure:

(a) Approval of equipment by the Commission is only to the effect that insofar as can be determined from the data supplied the equipment complies with the current requirements of good engineering practice and the technical Rules and Regulations of the Commission. The approval may be withdrawn upon subsequent inspection or operation showing the equipment is not as represented or does not comply with the technical Rules and Regulations of the Commission and the requirements of good engineering practice.

(b) Such approval shall not be construed to mean that the equipment will be satisfactory as the state of the art progresses and/or as the Rules and Regulations of the Commission may be changed as deemed advisable.

(c) Applicants specifying equipment of approved manufacture need not submit detailed descriptions and diagrams where the correct type number is specified, provided the equipment, including the antenna tuning unit, is identical with that approved.

(d) In passing on equipment, no consideration is given by the Commission to patent rights.

(e) For approval of standard broadcast transmitters, manufacturers shall submit F. C. C. Form 301, completed with respect to all pertinent sections and the data set forth below, both of which shall be verified before a notary public.

1. Photograph or drawings or any other evidence that construction is in accordance with the requirements of good engineering practice.

2. Data and curves showing over-all audio frequency response from 30 to 7500 cycles for approximately 25-, 50-, 85-, and 100- (if obtainable) percent modulation (reference frequency, 1000 cycles).

3. Data on audio frequency harmonics for 25-, 50-, 85-, and 100-percent modulation for the fundamental frequencies of 50, 100, 400, 1000, 5000, and 7500 cycles (either arithmetical

sum or root-sum-square values up to tenth harmonic or 16,000 cycles).

4. Percentage carrier shift (current) for 25-, 50-, 85-, and 100-percent modulation.

5. Carrier hum and extraneous noise generated within the equipment and measured as the level below 100-percent modulation throughout audio spectrum or by bands.

6. Percentage of each measurable radio frequency harmonic generated under expected normal operating conditions or in the first installation.

7. How output power is varied to compensate for power supply voltage variations.

8. Data and curves on frequency stability for variations in ambient temperatures over the range encountered in practice.

9. Data and curves on frequency stability for variations in power supply voltage from 85 to 115 percent normal values.

10. Net sale price.

(f) For approval of automatic frequency control equipment or automatic temperature control chambers, manufacturers shall complete F. C. C. Form 305 with respect to all pertinent sections and the data set forth below, both of which shall be verified before a notary public.

1. Photograph or drawings or any other evidence.

2. Data and curves on frequency stability for variations in ambient temperatures over maximum range encountered in practice.

3. Data and curves on frequency stability for variations in power supply voltage from 85 to 115 percent normal values.

4. Net sale price.

15. REQUIREMENTS FOR APPROVAL OF FREQUENCY MONITORS

Section 3.60 requires that the licensee of each standard broadcast station have in operation at the transmitter a frequency monitor independent of the frequency control of the transmitter. The frequency monitor shall be approved by the Commission and shall have a stability and accuracy at least five parts per million.

A. GENERAL REQUIREMENTS AND APPROVAL

There are several ways or means by which it can be determined whether the frequency

of the emitted carrier wave is within the required limits of the assigned frequency. However, one of the commonest ways is by means of a local piezo oscillator of known frequency producing a beat with the emitted wave used in conjunction with an instrument to indicate the resultant beat frequency. The visual indicator³⁷ is the only method now in common use by which it is considered that the frequency of the beat may be determined with the required degree of accuracy. Approval of a frequency monitor will be given based upon data taken by the Laboratory Division of the F. C. C. Any manufacturer desiring to submit a monitor for approval shall supply the Commission with full details. If the specifications appear to meet the requirements, the Commission will authorize the Laboratory Division to issue shipping instructions. The shipping charges to and from the Laboratory at Laurel, Md., shall be paid by the manufacturer.

In approving a frequency monitor, based upon the tests by the Laboratory, the Commission merely recognizes that the type of monitor has the inherent capability of functioning in compliance with section 3.60, if properly constructed, maintained, and operated. The Commission accepts no responsibility beyond this and further realizes that these monitors may have a limited range over which the visual indicator will determine deviations. Accordingly, it is necessary that adjunct equipment be used to determine major deviations.³⁷

No change whatsoever will be permitted in the monitors sold under approval number issued by the Commission except when the licensee or the manufacturer is specifically authorized to make such changes.

When it is desired to make any change, either mechanical or electrical, the details shall be submitted to the Commission for its consideration.

Approval is given subject to withdrawal if the unit proves defective in service and cannot be relied upon under usual conditions of maintenance.

³⁷ In addition to the visual indicator, the range of which is necessarily limited in order to obtain the required accuracy, an aural indicator should also be employed to indicate frequency deviations beyond the range of the visual indicator, particularly where the visual indicator is so designed that the indication becomes zero when the deviations become considerably greater than the range of the instrument. When it is desired to make any change, either mechanical or electrical, the details shall be submitted to the Commission for its consideration.

nance and operation encountered in the average standard broadcast station. Withdrawal of approval means that no further units may be installed by standard broadcast stations for the purpose of complying with section 3.60, but will not affect units already sold, unless it is found that there has been an unauthorized change in design or construction, or the material or workmanship is defective. All manufacturers of approved frequency monitors shall keep a list of sale numbers of the monitors sold to licensees of standard broadcast stations under the assigned approval number, and shall advise the Commission upon shipment of the monitor to the standard broadcast station.

B. GENERAL SPECIFICATIONS

The general specifications that frequency monitors shall meet before they will be approved by the Commission are as follows:

(1) The unit shall have an accuracy of at least five parts per million under ordinary conditions (temperature, humidity, power supply, and other conditions which may affect its accuracy) encountered in standard broadcast stations throughout the United States.

(2) The range of the indicating device shall be at least from 50 cycles below to 50 cycles above the assigned frequency. (When used by stations required by section 3.59 to maintain an operating frequency within 20 cycles of the assigned frequency, the range may be less than from 50 cycles above to 50 cycles below zero deviation but in no event shall the scale be less than from 20 cycles above to 20 cycles below zero deviation.)

(3) The scale of the indicating device shall be so calibrated as to be read accurately within at least 1 cycle.

(4) The unit shall be equipped with an automatic temperature control chamber (preferably enclosing the tank circuits of the oscillator) such that the maximum temperature variation at the crystal from the normal operating temperature shall not be greater than,

(a) Plus or minus 0.05° C. when *X* or *Y* cut crystal is employed, or

(b) Plus or minus 0.5° C. when low temperature coefficient crystal is employed.

(5) Unless otherwise specifically authorized, the instrument shall be equipped with a ther-

mometer such that the temperature can be accurately measured within 0.025° C. for *X* or *Y* cut crystal or 0.25° C. for low temperature coefficient crystal.

(6) The monitor circuit shall be such that it may be continuously operated and the emitted carrier of the station is not heterodyned thereby.

(7) Means shall be provided for adjustment of the temperature or other means for correction of the indications of the monitor to agree with the external standard.

C. TESTS TO BE MADE BY THE LABORATORY DIVISION OF THE F. C. C.

The tests to be made by the Laboratory will include the determination of the following:

(1) *Accuracy.*—(a) Oscillator frequency, as received.

(b) Constancy of oscillator frequency, as measured several times in 1 month.

(c) Accuracy of readings of frequency-difference instrument.

(d) Functioning of frequency adjustment device.

(e) Effects on frequency of changing tubes and of voltage variations.

(2) *Temperature control stability.*—(a) Effect on frequency of variation of room temperature through a range not to exceed 10° to 35° C.

(3) *Sensitivity.*—(a) Response of indicating instrument to small changes of frequency.

(4) *General construction.*—(a) Inspection to determine ability to stand shipment and service.

(b) Special tests to determine quality of construction, such as effect of tilting or tipping on frequency.

(5) *Miscellaneous performance.*—(a) Various, depending on character of apparatus (e. g., changes after stopping and starting, effect of varying coupling with transmitter, etc.).

The equipment will be operated in a test in the same way and the same conditions under which it will be used in service as specified by the manufacturer. The manufacturer shall supply to the Laboratory Division all instructions or services which will be supplied to the purchaser of the equipment. The equipment, as submitted, shall be adjusted for operation in connection with broadcast stations operating on 1600 kc.

16. REQUIREMENTS FOR APPROVAL OF MODULATION MONITORS

Section 3.55 (b) requires all broadcast stations to have in operation a modulation monitor approved by the Commission and section 3.55 (d) states that the Commission will from time to time publish the specifications, requirements, and list of approved modulation monitors. The specifications and requirements for approval are set out below. For a list of approved modulation monitors, attention is invited to Commission release "List of Approved Modulation Monitors."

Approval will be given based on the test data taken by the Laboratory Division of the F. C. C. Any manufacturer desiring to submit a monitor for approval shall supply the Commission with full details and if the specifications appear to meet the requirements, the Commission will authorize the Laboratory Division to issue shipping instructions. The shipping charges to and from the Laboratory at Laurel, Md., shall be paid by the manufacturer.

The specifications that the modulation monitor shall meet before it will be approved by the Commission are as follows:

(1) A DC meter for setting the average rectified carrier at a specific value and to indicate changes in carrier intensity during modulation.

(2) A peak indicating light or similar device that can be set at any predetermined value from 50 to 120 percent modulation to indicate on positive peaks, and/or from 50 to 100 percent negative modulation.

(3) A semi-peak indicator with a meter having the characteristics given below shall be used with a circuit such that peaks of modulation of duration between 40 and 90 milliseconds are indicated to 90 percent of full value and the discharge rate adjusted so that the pointer returns from full reading to 10 percent of zero within 500 to 800 milliseconds. A switch shall be provided so that this meter will read either positive or negative modulation and, if desired, in the center position it may read both in a full-wave circuit.

The characteristics of the indicating meter are as follows:

Speed.—The time for one complete oscillation of the pointer shall be 290 to 350 milliseconds.

The damping factor shall be between 16 and 200. The useful scale length shall be at least 2.3 inches. The meter shall be calibrated for modulation from 0 to 110 percent and in decibels below 100 percent with 100 percent being 0 DB.

The accuracy of the reading on percentage of modulation shall be ± 2 percent for 100 percent modulation, and ± 4 percent of full scale reading at any other percentage of modulation.

(4) The frequency characteristics curve shall not depart from a straight line more than $\pm \frac{1}{2}$ DB from 30 to 10,000 cycles. The amplitude distortion or generation of audio harmonics shall be kept to a minimum.

(5) The modulation meter shall be equipped with appropriate terminals so that an external peak counter can be readily connected.

(6) Modulation will be tested at 115 volts ± 5 percent and 60 cycles, and the above accuracies shall be applicable under these conditions.

(7) All specifications not already covered above, and the general design, construction, and operation of these units must be in accordance with good engineering practice.

17. USE OF LOW TEMPERATURE COEFFICIENT CRYSTALS BY BROADCAST STATIONS

Section 3.62 requires that authority from the Commission shall be obtained before installing new automatic frequency control equipment or making changes in existing automatic frequency control equipment that may affect the precision of the frequency control. Therefore, licensees of standard broadcast stations desiring to install crystals of the low temperature coefficient type must obtain authorization therefor from the Commission. Requests for such authority may be made by letter specifying the manufacturer's name (see list of manufacturers of approved crystals below) and the guaranteed temperature coefficient and accuracy of calibration.

Use of a properly ground low temperature coefficient crystal normally materially increases the frequency stability, particularly where the equipment is subject to wide variations in ambient temperature. Where a crystal of this type is installed in the automatic frequency control unit but not in the approved frequency monitor, the stability of the control unit be-

comes considerably better than that of the monitor and unless care is exercised in making frequency adjustments, off frequency operation may occur. Therefore, it is recommended that when the crystal in the frequency control unit is changed to one of the low temperature coefficient type, a crystal of equal or better temperature coefficient and accuracy be installed in the monitor, authority for which may be requested by letter in the same manner as for installation in the automatic frequency control unit.

Manufacturers desiring approval of crystals of the low temperature coefficient type must submit under oath data on several such typical crystals manufactured by them showing that the temperature coefficient is not in excess of three parts per million per degree centigrade, and further affirming that no crystal of this type having a temperature coefficient in excess of this value will be supplied to any broadcast station and that all crystals so supplied will be ground to within five parts per million of the assigned frequency of the station for the normal operating temperature specified.

MANUFACTURERS OF LOW TEMPERATURE COEFFICIENT CRYSTALS WHICH HAVE BEEN ACCEPTED BY THE COMMISSION

American Piezo Supply Co., Kansas City, Mo.

Bellefonte Eng. Labs., Bellefonte, Pa.

Bliley Electric Co., Union Station Bldg., Erie, Pa.

Cambridge Thermonic Corp., Cambridge, Mass.

Collins Radio Co., Cedar Rapids, Iowa.

Commercial Radio Equipment Co., 216 East Seventy-fourth Street, Kansas City, Mo.

Electrical Products Corp., Oakland, Calif.

Hipower Crystal Co., 2035 West Charleston Street, Chicago, Ill.

Hollister Crystal Co., Merriam, Kans.

James Knights Co., Sandwich, Ill.

Piezo Electric Laboratories, New Dorp, N. Y.

Precision Crystal Laboratories, P. O. Box 326, Springfield, Mass.

Precision Piezo Service, Baton Rouge, La.

Premier Crystal Labs., Inc., 53-63 Park Row, New York, N. Y.

R. C. A. Mfg. Co., Camden, N. J.

Scientific Research Laboratories, Hyattsville, Md.

Silver City Crystal Co., Meriden, Conn.

Theodore S. Valpey, Holliston, Mass.

Western Electric Co., New York, N. Y.

William W. L. Burnett, San Diego, Calif.

18. MONEY REQUIRED TO CONSTRUCT AND COMPLETE ELECTRICAL TESTS OF STATIONS OF DIFFERENT CLASSES AND POWERS

Section 3.24 (c) requires that an applicant for standard broadcast station show that it is financially qualified to construct and operate the proposed station.

It is considered that the money specified below is required to construct and complete electrical tests of a new standard broadcast station of the class and power indicated, in accordance with the requirements of the Rules and Regulations of the Commission and good engineering practice.

Power and class of station:	Money required
100 watts, Class IV.....	\$6, 500
250 watts, Class IV.....	8, 500
250 watts, Class II.....	10, 000
500 watts, Class II and III.....	22, 500
1,000 watts, Class II and III.....	25, 000
5 kw, Class II or III.....	40, 000
10 kw, Class I or II.....	65, 000
25 kw, Class I or II.....	175, 000
50 kw, Class I or II.....	200, 000

Attention is invited to the fact that the above figures are considered the minimum required for satisfactory installation, including the transmitter, antenna system, monitoring equipment and equipment for one large and one small studio of average dimensions, and equipment including microphones, speech input equipment, and usual acoustical treatment, but exclusive of the cost of land and buildings and organization and development costs in more elaborate installations including directional antenna would increase the cost accordingly.

19. USE OF COMMON ANTENNA BY STANDARD BROADCAST STATIONS OR ANOTHER RADIO STATION

Section 3.45(e), under certain conditions, permits the simultaneous use of the same antenna or antenna structure by more than one standard broadcast station or by one or more standard broadcast stations and one or more stations of any other class or service.

Prerequisites to an authorization for simultaneous use are:

(1) Submission of complete verified engineering data showing that satisfactory operation of each station will be obtained without adversely affecting the operation of the other station.

(2) Compliance with Section 3.45(a) and (b) with respect to the minimum antenna height or field intensity for each standard broadcast station concerned.

20. USE OF FREQUENCY AND MODULATION MONITORS AT AUXILIARY BROADCAST TRANSMITTERS

Sections 3.60 and 3.55 (b) require that each standard broadcast station have approved frequency and modulation monitors in operation at the transmitter.

The following shall govern the installation of approved *frequency* and *modulation* monitors at auxiliary transmitters of standard broadcast stations in compliance with these rules:

In case the auxiliary transmitter location is at a site different from that of the main transmitter, an approved *frequency* monitor shall be installed at the auxiliary transmitter except when the frequency of the auxiliary transmitter can be monitored by means of the frequency monitor at the main transmitter.

The licensee will be held strictly responsible for any frequency deviation of the auxiliary transmitter in excess of 20 cycles from the assigned frequency, even though exempted by the above from installing an approved frequency monitor. Furthermore, whenever the auxiliary transmitter is operated without a frequency monitor under this exemption, it shall be monitored by means of the frequency monitor at the main transmitter.

Installation of an approved *modulation* monitor at the location of the auxiliary transmitter, when different from that of the main transmitter, is optional with the licensee. However, when it is necessary to operate the auxiliary transmitter beyond 2 calendar days, a modulation monitor shall be installed and operated at the auxiliary transmitter. The monitor (if taken from the main transmitter) shall be reinstalled at the main transmitter immediately upon resumption of operation of the *main transmitter*.

In all cases where the auxiliary transmitter and the main transmitter have the same location, the same frequency and modulation monitors may be used for monitoring both transmitters, provided they are so arranged as to be switched readily from one transmitter to the other.

Standard broadcast stations not complying with these requirements cannot be considered as operating in compliance with the rules governing such operation.

21. APPROVED FREQUENCY MONITORS

Section 3.60 requires that each standard broadcast station shall have in operation at the transmitter an approved frequency monitor³⁸ independent of the frequency control of the transmitter.

The following frequency monitors have been approved as in compliance with the specifications issued pursuant to section 3.60:

Manufacturer's name	Type	Approval No.
General Radio Co.....	25-A.....	1461
RCA Victor Co.....	311-A, 311-AB.....	1462
General Radio Co.....	25-AB.....	1463
Western Electric Co.....	1-C.....	1464
Doolittle Radio, Inc.....	FD-1A.....	1465
General Electric Co.....	98X402.....	1466
General Radio Co.....	1181-A.....	1467
RCA Manufacturing Co.....	WF-48A.....	1468

22. APPROVED MODULATION MONITORS

Section 3.55 (b) requires that each standard broadcast station shall have an approved modulation monitor in operation at the transmitter.

The following modulation monitors have been approved as in compliance with the specifications issued pursuant to section 3.55 (d):

Manufacturer's name	Type	Approval No.
General Radio Co.....	731-A or B.....	1551
RCA Manufacturing Co.....	66A.....	1552
Do.....	66B.....	1553
Do.....	66D.....	1554
General Radio Co.....	1931-A.....	1555
Gates Radio Co.....	MO-2639.....	1556
RCA Manufacturing Co.....	WM-43A.....	1557

³⁸ These monitors have a limited range over which the visual indicator will operate and accordingly it is necessary that auxiliary aural means be provided in conjunction with the monitor to indicate deviations beyond the range of the visual indicator such as may occur because of defective transmitting apparatus or other causes. In approving the monitors the Commission expects that this auxiliary equipment will be used by all broadcast licensees and will not accept as satisfactory explanations of any frequency deviation which may occur simply on the basis that it was not indicated by the monitor.

23. APPROVED EQUIPMENT

Sections 3.41 to 3.64 govern the design, construction, and technical operation of standard broadcast equipment. There is listed below the equipment which has been approved as in compliance with these rules in accordance with the provisions of "Requirements for Type Approval of Broadcast Transmitters and Automatic Frequency Control Equipment."

American Piezo Supply Co., P. O. Box 8112, Plaza Station, Kansas City, Mo.:

Type No. C-X-7-C, automatic frequency control unit.

Biley Electric Co., 203 Union Station Building, Erie, Pa.:

Type No. BC46T, automatic temperature control unit.

Type No. TC92, automatic temperature control unit.

Type No. TC93, automatic temperature control unit.

Collins Radio Co., Cedar Rapids, Iowa.:

Type No. 10S-2, automatic frequency control unit.

Type No. 20H, 1000-watt, broadcast transmitter.

Type No. 20HA, 1000-watt, broadcast transmitter.

Type No. 20J, 1000-watt, broadcast transmitter.

Type No. 20K, 1000-watt, broadcast transmitter.

Type No. 20T, 500-1000-watt, broadcast transmitter.

Type No. 21A, 5000-watt, broadcast transmitter.

Type No. 21D, 5000-watt, broadcast transmitter.

Type No. 21DA, 5000-watt, broadcast transmitter.

Type No. 21DX, 5000-watt, broadcast transmitter.

Type No. 40DA, automatic frequency control unit.

Type No. 40E, automatic frequency control unit.

Type No. 300C, 250-watt, broadcast transmitter.

Type No. 300C-1, 250-watt, broadcast transmitter.

Type No. 300E, 100-watt, broadcast transmitter.

Type No. 300FA, 250-watt, broadcast transmitter.

Type No. 300G, 100-250-watt, broadcast transmitter.

Doolittle Radio Inc., 7421 South Loomis Boulevard, Chicago, Ill.:

Type No. OB-5, automatic frequency control unit (includes Type TC-1 ATCU).

Type No. OB-6, automatic frequency control unit.

Type No. TC-1, automatic temperature control unit (includes Type 2-A ATCC).

Type No. 100-B, 100-watt, broadcast transmitter (includes Type OB-2 or OB-5 AFCU).

Type No. 250-B, 250-watt, broadcast transmitter (includes Type OB-2 or OB-5 AFCU).

Type No. 1000-B, 1000-watt, broadcast transmitter.

Federal Telegraph Co., Newark, N. J.:

Type No. 162-A, 50,000-watt, broadcast transmitter.

Type No. 163-A, 5,000-watt, broadcast transmitter.

Type No. 165-A, 5,000-watt, broadcast transmitter.

Type No. 196-A, 5,000-watt, broadcast transmitter.
Type No. 197-A, 50,000-watt, broadcast transmitter.

Gates Radio Co., Quincy, Ill.:

Type No. 25-A, automatic frequency control unit.
Type No. 100-A, 100-watt, broadcast transmitter.
Type No. 250-A, 250-watt, broadcast transmitter.
Type No. 500-A, 500-watt, broadcast transmitter.
Type No. BC-1E, 1000-watt, broadcast transmitter.
Type No. BC-250D, 250-watt, broadcast transmitter.
Type No. 250-C, 250-watt, broadcast transmitter.
Type No. 250-C-1, 250-watt, broadcast transmitter.
Type No. 1000-C, 1000-watt, broadcast transmitter.
Type No. 1-D, 1000-watt, broadcast transmitter.
Type No. S-101, 100-watt, broadcast transmitter.
Type No. S-251, 250-watt, broadcast transmitter.
Type No. BC-5A, 5000-watt, broadcast transmitter.

General Electric Co., Schenectady, N. Y.:

Type No. 32C401-G30, automatic temperature control unit.
Type No. BT-20-A, 250-watt, broadcast transmitter.
Type No. BT-21-A, 1000-watt, broadcast transmitter.
Type No. BT-22-A, 5000-watt, broadcast transmitter.
Type No. BT-23-A, 10,000-watt, broadcast transmitter.
Type No. BT-25-A, 50,000-watt, broadcast transmitter.
Type No. XT-1-A, 1000 watt, broadcast transmitter.

Piezo Electric Laboratories, 612 Rockland Avenue, New Dorp, N. Y.:

Type No. TC-210, automatic temperature control oven and relay unit.
Type No. TC-350, automatic temperature control oven and relay unit.
Type No. OB-10, oscillator and amplifier unit (oscillator and first buffer. No ATCU or crystal).

Precision Piezo Service, 427 Asia Street, Baton Rouge, La.:

Type No. 50M, automatic temperature control unit.

Premier Crystal Laboratories, Inc., 53-63 Park Row, New York, N. Y.:

Type No. 350-A, automatic frequency control unit.

R. C. A. Victor, Inc., Camden, N. J.:

Type No. UL-4292, automatic frequency control unit.

Type No. UL-4392, automatic frequency control unit.

Type No. 100-E, 100-watt, broadcast transmitter.

Type No. 100-G, 100-watt, broadcast transmitter.

Type No. 100-H, 100-watt, broadcast transmitter.

Type No. BTA-250L, 250-watt, broadcast transmitter.

Type No. 250-D, 250-watt, broadcast transmitter.
Type No. 250-E, 250-watt, broadcast transmitter.
Type No. 250-F, 250-watt, broadcast transmitter.
Type No. 250-G, 250-watt, broadcast transmitter.
Type No. 250-K, 250-watt, broadcast transmitter.
Type No. BTA-1L, 1,000-watt, broadcast transmitter.

Type No. BTA-1LA, 1,000-watt, broadcast transmitter.

Type No. 1-E, 1,000-watt, broadcast transmitter.

Type No. 1-E-A, 1,000-watt, broadcast transmitter.

Type No. 1-G, 1,000-watt, broadcast transmitter.

Type No. 1-K, 1,000-watt, broadcast transmitter.

Type No. ET-4300, 1,000-watt, broadcast transmitter.

Type No. BTA-5F, 5,000-watt, broadcast transmitter.

Type No. 5-D, 5,000-watt, broadcast transmitter.

Type No. 5-D-1, 5,000-watt, broadcast transmitter.

Type No. 5-D-2, 5,000-watt, broadcast transmitter.

Type No. 5-DX, 5,000-watt, broadcast transmitter.

Type No. 5-E, 5,000-watt, broadcast transmitter.

Type No. BTA-10F, 10,000-watt, broadcast transmitter.

Type No. 10-C-A, 10,000-watt, broadcast transmitter.

Type No. 10-C-B, 10,000-watt, broadcast transmitter.

Type No. 10-D, 10,000-watt, broadcast transmitter.

Type No. 10-DX, 10,000-watt, broadcast transmitter.

Type No. 10-E, 10,000-watt, broadcast transmitter.

Type No. BTA-50F, 50,000-watt, broadcast transmitter.

Type No. 50-D, 50,000-watt, broadcast transmitter.

Type No. 50-D, 50,000-watt, power amplifier.

Type No. 50-E, 50,000-watt power amplifier.

Raytheon Manufacturing Co., Chicago, Ill.:

Type No. RA-250, 250-watt, broadcast transmitter.

Type No. RA-1000, 1,000-watt, broadcast transmitter.

Type No. RA-5, 5,000-watt, broadcast transmitter.

Transmitter Equipment Mfg. Co., Inc., 345 Hudson Street, New York 14, N. Y.:

Type No. 250 BCA, 250-watt, broadcast transmitter.

Theodore S. Valpey, Holliston, Mass.:

Type No. CBC-0, automatic temperature control unit.

Western Electric Co., 195 Broadway, New York, N. Y.:

Type No. 700-B, automatic frequency control unit.

Type No. 700-C, automatic frequency control unit.

Type No. 702-A, automatic frequency control unit.

Type No. 310-A, 100-watt, broadcast transmitter.

Type No. 310-B, 250-watt, broadcast transmitter.

Type No. 310-C, 500-watt, broadcast transmitter.

Type No. 310-D, 1,000-watt, broadcast transmitter.

Type No. 350C-1, 100-watt, broadcast transmitter.

Type No. 351E-1, 250-watt, broadcast transmitter.
 Type No. 451A-1, 250-watt, broadcast transmitter.
 Type No. 352E-1 500-watt, broadcast transmitter.
 Type No. 353E-1, 1 000-watt, broadcast transmitter.
 Type No. 403A-1, 1,000-watt, broadcast transmitter.
 Type No. 405A-1, 5,000-watt, broadcast transmitter.
 Type No. 405A-2, 5,000-watt, broadcast transmitter.
 Type No. 405B-1, 5,000-watt, broadcast transmitter.
 Type No. 405B-2, 5,000-watt, broadcast transmitter.
 Type No. 406A-1, 10,000-watt, broadcast transmitter.
 Type No. 406A-2, 10,000 watt, broadcast transmitter.
 Type No. 406A-3, 10,000-watt, broadcast transmitter.
 Type No. 406B-1, 10,000-watt, broadcast transmitter.
 Type No. 407A-1, 50,000-watt, broadcast transmitter.
 Type No. 407A-2, 50,000-watt, broadcast transmitter.
 Type No. 407A-3, 50,000-watt, broadcast transmitter.
 Type No. 407A-4, 50,000-watt, broadcast transmitter.
 Type No. 442A-1, 500-watt, broadcast transmitter.
 Type No. 443A-1, 1000-watt, broadcast transmitter.

Westinghouse Electric and Mfg. Co., 2519
 Wilkins Avenue, Baltimore, Md.:

Type No. LK-1, automatic frequency control unit.
 Type No. LK-2, automatic frequency control unit.
 Type No. 50-HG, 50,000-watt, broadcast transmitter.
 Type No. 50-HG-1, 50,000-watt, broadcast transmitter.
 Type No. 5-HV, 5,000-watt, broadcast transmitter.
 Type No. 5-HV-1, 5,000-watt, broadcast transmitter.
 Type No. 10-HV, 10,000-watt, broadcast transmitter.
 Type No. 10-HV-1, 10,000-watt, broadcast transmitter.

24. STANDARD BROADCAST APPLICATION FORMS

The Communications Act of 1934, as amended, and the Rules and Regulations of the Commission require that application be made to the Commission for various authorizations. In order to be of aid to applicants, there are set out below the correct forms to be submitted in making application for various authorizations applicable to Standard Broadcast Stations.

F. C. C. Form 301, Application for Authority to Construct a New Broadcast Station or Make Changes in an Existing Broadcast Station.

F. C. C. Form 302, Application for New Broadcast Station License.

F. C. C. Form 303, Application for Renewal of Broadcast Station License.

F. C. C. Form 308, Application for Permit to Locate, Maintain, or Use Studio Apparatus for Production of Programs to be Transmitted or Delivered to Foreign Radio Stations.

F. C. C. Form 314, Application for Consent to Assignment of Radio Broadcast Station Construction Permit or License.

F. C. C. Form 315, Application for Consent to Transfer of Control of Corporation Holding Radio Broadcast Station Construction Permit or License.

F. C. C. Form 317, Application for Standard Broadcast Station Special Service Authorization or Extension Thereof (See Sec. 1.325).

F. C. C. Form 321, Application for Construction Permit to Replace Expired Permit.

F. C. C. Form 701, Application for Additional Time to Construct a Radio Station.

Informal requests (letters or telegrams) may be filed for requests:

- (a) To operate additional time.
- (b) To discontinue operation or services not covered by section 3.71.
- (c) To operate with additional power.
- (d) To operate with reduced power not covered by section 3.57.
- (e) To operate for test purposes (to determine site, etc.).
- (f) To rebroadcast programs of stations of other classes.
- (g) Other special temporary operation beyond terms of existing license.
- (h) Temporary operation without specified items of equipment, or with temporary, substitute, or auxiliary equipment.
 - (1) Operation without an approved frequency monitor.
 - (2) Operation without an approved modulation monitor.
 - (3) Operation without thermometer in automatic temperature control chamber.
 - (4) Operation without antenna ammeter, plate voltmeter, or plate ammeter.
 - (5) Operation with substitute ammeter, plate voltmeter, or plate ammeter.
 - (6) Operation with temporary antenna system.
 - (7) Operation with auxiliary transmitter as main transmitter.
 - (i) Operation with new or modified equipment pending repair of existing equipment, or pending receipt and action upon a formal application.
 - (j) Where formal application is not required, application for new or modified equipment or antenna system.

(k) Change of specifications for painting and lighting antenna towers where formal application is not required.

(l) Operation to determine power by direct method during program test period.

(m) Relocation of transmitter in same building.

(n) Operation with reduced power or time under sections 3.57 and 3.71.

(o) Approval of types of equipment as to compliance with outstanding rules or standards.

(p) All authorizations for equipment and program tests, or extensions thereof, where it appears that compliance has been had with the terms of the construction permit.

(q) Extensions of time within which to comply with technical requirements specified in authorizations, orders, and rules or releases of the Commission.

(r) Representations of compliance with technical requirements specified in authorizations, orders, rules, or releases (except formal applications).

(s) Operation with licensed, new or modified equipment at a temporary location with a temporary antenna system in case of an emergency when, due to causes beyond the control of the licensee, it becomes impossible to continue operating at the licensed location.

25. FIELD OFFICES OF THE COMMISSION

Section 3.57 and other rules of the Commission require that in certain instances, the inspector in charge of the district in which the station is located be advised of the conditions existing at the station. The following is a list of the radio districts, giving the address of each field office of the Commission and the territory embraced in each district:

Radio district	Address of the Engineer in charge	Territory within district	
		States	Counties
1	1600 Customhouse, Boston 9, Mass.....	Connecticut..... Maine..... Massachusetts..... New Hampshire..... Rhode Island..... Vermont.....	All counties. Do. Do. Do. Do. Do.
2	748 Federal Bldg., 641 Washington St., New York 14, N. Y.	New Jersey..... New York.....	Bergen, Essex, Hudson, Hunterdon, Mercer, Middlesex, Monmouth, Morris, Passaic, Somerset, Sussex, Union, and Warren. Albany, Bronx, Columbia, Delaware, Dutchess, Green, Kings, Nassau, New York, Orange, Putnam, Queens, Rensselaer, Richmond, Rockland, Schenectady, Suffolk, Sullivan, Ulster, and Westchester.
3	1005 U. S. Customhouse, Philadelphia, 6, Pa.	Delaware..... New Jersey..... Pennsylvania.....	Newcastle. Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Ocean and Salem. Adams, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Perry, Philadelphia, Schuylkill, and York.
4	508 Old Town Bank Bldg., Gay St. and Fallsway, Baltimore 2, Md.	Delaware..... District of Columbia..... Maryland..... Virginia..... West Virginia.....	Kent and Sussex. All. All counties. Arlington, Clark, Fairfax, Fauquier, Frederick, Loudoun, Page, Prince William, Rappahannock, Shenandoah, and Warren. Barbour, Berkeley, Grant, Hampshire, Hardy, Harrison, Jefferson, Lewis, Marion, Mineral, Monongalia, Morgan, Pendleton, Preston, Randolph, Taylor, Tucker, and Upshur.
5	Room 402, New Post Office Bldg., Nor- folk 10, Va.	North Carolina..... Virginia.....	All except district 6. All except district 4.
6	411 Federal Annex, Atlanta 3, Ga..... Suboffice, P. O. Box 77 (214-218 Post Of- fice Bldg.), Savannah, Ga.	Alabama..... Georgia..... North Carolina..... South Carolina.....	All except district 8. All counties. Ashe, Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Cleveland, Graham, Haywood, Henderson, Jackson, McDowell, Macon, Madison, Mitchell, Polk, Rutherford, Swain, Transylvania, Watauga, and Yancey. All counties.
7	P. O. Box 150 (312 Federal Bldg.), Miami 1, Fla. Suboffice, 409-410 Post Office Bldg., Tampa 2, Fla.	Tennessee..... Florida.....	Do. All except district 8.
8	400 Audubon Bldg., New Orleans 16, La.	Alabama..... Arkansas..... Florida..... Louisiana..... Mississippi..... Texas.....	Mobile and Baldwin. All counties. Escambia. All counties. Do. City of Texarkana only.

Radio district	Address of the Engineer in charge	Territory within district	
		States	Counties
9	324 U. S. Appraisers Bldg., 7300 Wingate St., Houston 11, Tex. Suboffice, P. O. Box 1527 (329 Post Office Bldg.), Beaumont, Tex.	Texas.....	Angelina, Aransas, Atascosa, Austin, Bandera, Bexar, Blanco, Brazoria, Brazos, Burleson, Caldwell, Calhoun, Cameron, Chambers, Colorado, Comal, De Witt, Duval, Dimmit, Edwards, Fayette, Fort Bend, Frio, Galveston, Gillespie, Goliad, Gonzales, Grimes, Guadalupe, Hardin, Hays, Harris, Hidalgo, Jackson, Jasper, Jefferson, Jim Hogg, Jim Wells, Karnes, Kenedy, Kendall, Kerr, Kinney, Kleberg, La Salle, Lavaca, Lee, Liberty, Live Oak, Matagorda, Madison, Maverick, McMullen, Medina, Montgomery, Nacadoches, Newton, Nueces, Orange, Polk, Real, Refugio, San Augustine, San Jacinto, San Patricio, Sabine, Starr, Travis, Trinity, Uvalde, Val Verde, Victoria, Walker, Waller, Washington, Webb, Wharton, Willacy, Williamson, Wilson, Zapata, Zavala, and Tyler.
10	P. O. Box 5238 (U. S. Terminal Annex Bldg.), Dallas 2, Tex.	New Mexico.....	All counties.
11	530 U. S. Post Office and Courthouse Bldg., Temple and Spring Sts., Los Angeles 12, Calif. Suboffice, 230 U. S. Customhouse, San Diego 1, Calif.	Oklahoma.....	Do.
		Texas.....	All except district 9 and the city of Texarkana.
12	323-A Customhouse, San Francisco 26, Calif.	Arizona.....	All counties.
		California.....	Imperial, Inyo, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura.
13	406 Central Bldg., Portland 5, Oreg.....	Nevada.....	Clarke.
		California.....	All except district 11.
14	801 Federal Office Bldg., Seattle 4, Wash.	Nevada.....	All except Clarke.
		Idaho.....	All except district 14.
15	521 Customhouse, Denver 2, Colo....	Oregon.....	All counties.
		Washington.....	Wahkiakum, Cowlitz, Clark, Skamania, and Klickitat.
16	208 Uptown Post Office and Federal Courts Bldg., 5th and Washington Sts., St. Paul 2, Minn.	Idaho.....	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, Nez Perce, and Shoshone.
		Montana.....	All counties.
17	838 U. S. Courthouse, Kansas City 6, Mo.	Washington.....	All except district 13.
		Colorado.....	All counties.
18	246 U. S. Courthouse, Chicago 4, Ill....	Utah.....	Do.
		Wyoming.....	Do.
19	1029 New Federal Bldg., Detroit 26, Mich.	Nebraska.....	Banner, Box Butte, Cheyenne, Dawes, Deuel, Garden, Kimball, Morrill, Scottsbluff, Sheridan, Stoux.
		South Dakota.....	Butte, Custer, Fall River, Lawrence, Meade, Pennington, Shannon, Washington.
20	Suboffice, 541 Old Post Office Bldg., Cleveland 14, Ohio. 328 Federal Bldg., Buffalo 3, N. Y.....	Minnesota.....	All counties.
		Michigan.....	Alger, Baraga, Chippewa, Delta, Dickinson, Gogebic, Houghton, Iron, Keweenaw, Luce, Mackinac, Marquette, Menominee, Ontonagon, and Schoolcraft.
21	609 Stangenwald Bldg., Honolulu 1, T. H.	North Dakota.....	All counties.
		South Dakota.....	All except district 15.
22	P. O. Box 2987, (322-323 Federal Bldg.), San Juan 13, P. R. P. O. Box 1421, (7-8 Shattuck Bldg.), Juneau, Alaska. Suboffice, P. O. Box 644, (Room 39, Federal Bldg.), Anchorage, Alaska.	Wisconsin.....	All except district 18.
		Iowa.....	All except district 18.
23		Kansas.....	All counties.
		Missouri.....	Do.
24		Nebraska.....	All except district 15.
		Illinois.....	All counties.
25		Indiana.....	Do.
		Iowa.....	Allamakee, Buchanan, Cedar, Clayton, Clinton, Delaware, Des Moines, Dubuque, Fayette, Henry, Jackson, Johnson, Jones, Lee, Linn, Louisa, Muscatine, Scott, Washington, and Winnebago.
26		Wisconsin.....	Brown, Columbia, Calmet, Crawford, Dane, Dodge, Door, Fond du Lac, Grant, Green, Iowa, Jefferson, Keewanee, Kenosha, Lafayette, Manitowoc, Marinette, Milwaukee, Ozaukee, Oconto, Outagamie, Racine, Richland, Rock Sauk, Sheboygan, Walworth, Washington, Waukesha, and Winnebago.
		Kentucky.....	All except district 19.
27		Kentucky.....	Bath, Bell, Boone, Bourbon, Boyd, Bracken, Breathitt, Campbell, Carter, Clark, Clay, Elliott, Estill, Fayette, Fleming, Floyd, Franklin, Gallatin, Garrard, Grant, Greenup, Kenton, Harlan, Harrison, Jackson, Jessamine, Johnson, Knott, Knox, Laurel, Lawrence, Lee, Leslie, Letcher, Lewis, Lincoln, Madison, Magoffin, Martin, Mason, McCreary, Menifee, Montgomery, Morgan, Nicholas, Owen, Owsley, Pendleton, Perry, Pike, Powell, Pulaski, Robertson, Rockcastle, Rowan, Scott, Wayne, Whitely, Wolfe, and Woodford.
		Ohio.....	All counties.
28		Michigan.....	All except district 16.
		West Virginia.....	All except district 4.
29		New York.....	All except district 2.
		Pennsylvania.....	All except district 3.
30		Territory of Hawaii and outlying Pacific possessions, except Alaska and adjacent islands.	
		Puerto Rico.....	
31		Virgin Islands.....	
		Alaska.....	

26. AVERAGE SUNRISE AND SUNSET TIMES

[Effective September 30, 1945; Revised to April 20, 1948]

Section 3.8 states that the terms "sunrise" and "sunset" mean for each particular station during any particular month, the average times of sunrise and sunset as specified in the license of a broadcast station. The following is a tabulation of the average times of sunrise and sunset for each month at various points:

[Average sunrise time (SR); average sunset time (SS); (TZ) time zone i. e. (E) Eastern; latitude and longitude (lat./long.); (*) metropolitan district; (A) Atlantic; (E) eastern; (C) central; (M) mountain; (P) Pacific; standard time]

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Alabama</i>														
Albertville, *34-16/86-12	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:45	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:00 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Alexander City 32-56/85-59	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:45	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:00 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Birmingham*	C	SR SS	7:00 5:00	6:30 5:30	6:00 5:00	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:15 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Clanton, 32-50/86-40	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:00	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:00 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Decatur	C	SR SS	7:00 5:00	6:30 5:30	6:00 5:00	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:15 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Dothan	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:45	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:00 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Gadsden, 34-02/85-56	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:45	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:00 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Mobile	C	SR SS	6:45 5:15	6:30 5:45	6:00 5:00	5:30 5:45	5:00 5:45	4:45 5:00	4:45 5:00	5:15 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Montgomery	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:00	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:15 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Opelika	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:45	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:15 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Sylacauga, * 33-10/86-14	C	SR SS	6:45 5:00	6:30 5:30	6:00 5:00	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:00 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
Tuscaloosa	C	SR SS	7:00 5:00	6:30 5:30	6:00 5:00	5:15 5:45	4:45 5:00	4:30 5:00	4:45 5:00	5:15 5:30	5:30 6:00	5:45 6:15	6:15 6:45	6:45 7:00
<i>Arizona</i>														
Coolidge, 33-00/111-34	M	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:15	5:15 7:30	5:30 7:45	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:30 5:15
Phoenix	M	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:15	5:15 7:45	5:30 7:45	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:30 5:15
Tucson	M	SR SS	7:15 5:45	7:15 6:15	6:30 6:30	6:00 7:00	5:30 7:15	5:15 7:30	5:30 7:30	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:30 5:15
Yuma	M	SR SS	7:45 6:00	7:30 6:30	6:45 6:45	6:15 7:15	5:45 7:30	5:30 7:45	5:45 7:45	6:00 7:30	6:15 6:45	6:45 6:00	7:15 5:45	7:30 5:30
<i>Arkansas</i>														
Blytheville	C	SR SS	7:15 5:15	6:45 5:45	6:15 6:00	5:30 6:30	5:00 7:00	4:45 7:15	5:00 7:15	5:15 6:45	5:45 6:15	6:00 5:30	6:30 4:45	7:00 4:45
Fort Smith	C	SR SS	7:30 5:30	7:00 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:30	5:15 7:30	5:30 7:15	6:00 6:30	6:15 5:45	6:45 5:15	7:15 4:30
Helena, 34-31/90-37	C	SR SS	7:00 5:15	6:45 5:45	6:15 6:00	5:30 6:30	5:00 7:00	4:45 7:15	5:00 7:15	5:15 6:45	5:45 6:15	6:00 5:30	6:30 4:45	7:00 4:45
Hot Springs	C	SR SS	7:15 5:30	7:00 6:00	6:30 6:15	5:45 6:45	5:15 7:00	5:00 7:30	5:15 7:30	5:30 7:00	6:00 6:15	6:15 5:45	6:45 5:15	7:15 5:00
Jonesboro	C	SR SS	7:15 5:15	6:45 5:45	6:15 6:15	5:30 6:30	5:00 7:00	4:45 7:15	5:00 7:15	5:15 6:45	5:45 6:15	6:15 5:30	6:45 4:45	7:00 4:45
Little Rock*	C	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:45 6:45	5:00 7:00	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 5:00
Magnolia, * 33-15/93-14	C	SR SS	7:15 5:30	7:00 6:00	6:30 6:15	5:45 6:45	5:15 7:00	5:00 7:30	5:15 7:30	5:30 7:00	6:00 6:15	6:15 5:45	6:45 5:15	7:00 5:00
Siloam Springs	C	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:30	5:15 7:30	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:15 5:00
<i>California</i>														
Beverly Hills*	P	SR SS	7:00 5:00	6:45 5:30	6:00 6:00	5:30 6:30	4:45 5:00	4:45 5:00	4:45 5:00	5:15 6:45	5:30 6:00	6:00 6:00	6:30 4:45	6:45 4:45
Chico	P	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:15	4:45 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 5:00	7:15 4:45
Dinuba, 36-32/119-24	P	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 5:00	4:30 5:00	4:45 5:15	5:15 6:45	5:45 6:00	6:00 5:15	6:30 4:45	7:00 4:45
Eureka	P	SR SS	7:45 5:15	7:15 6:45	6:30 6:15	5:45 7:00	5:00 7:30	4:45 7:45	5:00 7:15	5:30 7:15	6:00 6:30	6:30 5:45	7:00 4:45	7:30 4:45
Fresno, * 36-44/119-47	P	SR SS	7:15 5:30	6:45 5:45	6:00 6:00	5:30 6:30	4:45 5:00	4:45 5:00	4:45 5:15	5:15 6:45	5:45 6:15	6:00 5:30	6:30 4:45	7:00 4:45
Glendale*	P	SR SS	7:00 5:00	6:45 5:30	6:00 6:00	5:30 6:30	4:45 5:00	4:45 5:00	4:45 5:15	5:15 6:45	5:30 6:00	6:00 5:15	6:30 4:45	7:00 4:45
Hanford, 36-19/119-35	P	SR SS	7:15 5:00	6:45 5:45	6:00 6:00	5:30 6:30	4:45 5:00	4:45 5:00	4:45 5:15	5:15 6:45	5:45 6:15	6:00 5:30	6:30 4:45	7:00 4:45
Kentfield, 37-57/122-32	P	SR SS	7:30 5:15	7:00 6:45	6:30 6:15	5:30 6:45	5:00 7:15	4:45 7:30	4:45 7:30	5:00 7:00	5:30 6:15	6:00 5:30	6:30 4:45	7:00 4:45
Long Beach	P	SR SS	7:00 5:00	6:45 5:30	6:00 6:00	5:30 6:30	5:00 7:00	4:45 5:00	4:45 5:15	5:15 6:45	5:45 6:15	6:00 5:30	6:30 4:45	7:00 4:45
Los Angeles*	P	SR SS	7:00 5:00	6:45 5:30	6:00 6:00	5:30 6:30	4:45 5:00	4:45 5:00	4:45 5:15	5:15 6:45	5:30 6:00	6:00 5:15	6:30 4:45	7:00 4:45
Merced	P	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:30	5:00 7:00	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 5:00	7:15 4:45
Modesto	P	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:00	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Oakland*	P	SR SS	7:00 5:15	7:00 5:45	6:30 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Ontario, 34-04/117-39	P	SR SS	7:00 5:00	6:30 5:30	6:00 6:00	5:15 6:15	4:45 5:00	4:30 5:00	4:45 5:15	5:15 6:45	5:30 6:00	6:00 5:15	6:30 4:45	7:00 4:45
Oroville, 39-31/121-33	P	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Sacramento*	P	SR SS	7:00 5:15	6:45 5:45	6:00 6:00	5:30 6:45	5:00 7:15	4:45 7:30	4:45 7:30	5:00 7:00	5:15 6:15	5:45 5:30	6:15 4:45	6:45 4:45
San Bernardino, 34-04/117-17	P	SR SS	7:00 6:45	6:30 5:30	6:00 6:00	5:15 6:15	4:45 5:00	4:30 5:00	4:45 5:15	5:15 6:45	5:30 6:00	6:00 5:15	6:30 4:45	7:00 4:45
San Diego*	P	SR SS	6:45 5:00	6:30 5:30	6:00 6:00	5:15 6:15	4:45 5:00	4:45 5:00	4:45 5:15	5:15 6:45	5:30 6:00	6:00 5:15	6:30 4:45	7:00 4:45
San Fernando, 34-14/118-27	P	SR SS	7:00 5:00	6:45 5:30	6:00 6:00	5:30 6:45	5:00 7:00	4:45 7:00	4:45 5:15	5:15 6:45	5:30 6:00	6:00 5:15	6:30 4:45	7:00 4:45
San Francisco*	P	SR SS	7:30 5:15	7:00 5:45	6:30 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Sanger, 36-44/110-29	P	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 5:00	4:45 5:00	4:45 5:15	5:15 6:45	5:45 6:15	6:00 5:30	6:30 4:45	7:00 4:45
San Jose*	P	SR SS	7:30 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Santa Barbara	P	SR SS	7:00 5:15	6:45 5:45	6:15 6:00	5:30 6:30	5:00 7:00	4:45 7:15	5:00 7:15	5:15 6:45	5:45 6:15	6:00 5:30	6:30 4:45	7:00 4:45

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>California—Continued</i>														
Santa Cruz, 36-57/121-58	P	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:00	5:30 7:00	5:45 6:15	6:15 5:30	6:45 5:00	7:15 4:45
Santa Monica, 34-01/118-25	P	SR SS	7:00 5:00	6:45 5:30	6:00 6:00	5:15 6:30	4:45 6:45	4:45 7:15	4:45 7:00	5:15 6:45	5:30 6:00	6:00 5:15	6:30 4:45	6:45 4:45
Stockton	P	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:00	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 5:00	7:15 4:45
Taft, * 35-08/119-27	P	SR SS	7:00 5:15	6:45 5:45	6:15 6:00	5:30 6:30	5:00 7:00	4:45 7:15	5:00 7:15	5:15 6:45	5:45 6:00	6:00 5:30	6:30 5:00	7:00 4:45
Tulare, 36-13/119-17	P	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:00	4:45 7:15	5:15 6:45	5:45 6:00	6:00 5:15	6:30 4:45	7:00 4:45
Vallejo, 38-07/122-15	P	SR SS	7:30 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:15	4:45 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:00 5:30	6:30 5:00	7:00 4:45
Vasalia, *36-20/119-17	P	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:15	4:45 7:15	5:15 6:45	5:45 6:00	6:00 5:15	6:30 4:45	7:00 4:45
<i>Colorado</i>														
Cannon City, 38-27/105-13	M	SR SS	7:15 5:00	7:00 5:45	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Denver*	M	SR SS	7:15 5:00	7:00 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:15	6:45 4:45	7:15 4:30
Grand Junction	M	SR SS	7:30 4:45	7:15 5:45	6:30 6:15	5:45 6:45	5:00 7:15	4:45 7:45	5:00 7:45	5:30 7:15	6:00 6:30	6:30 5:30	7:00 5:00	7:30 5:00
Greeley	M	SR SS	7:15 5:00	7:00 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:30	4:45 7:00	5:15 7:00	5:45 6:15	6:15 5:15	6:45 4:45	7:15 4:30
Pueblo	M	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:30	4:45 7:15	5:15 7:00	5:45 6:15	6:00 5:15	6:30 4:45	7:00 4:45
<i>Connecticut</i>														
Bridgeport *	E	SR SS	7:15 4:45	6:45 5:30	6:15 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:30
Danbury, 41-22/73-26	E	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:30
Hartford *	E	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
Meriden, 41-33/72-47	E	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
New Britain *	E	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:30
New Haven *	E	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:30
Norwalk, * 41-06/73-25	E	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:30
Torrington, 41-48/73-09	E	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
<i>Delaware</i>														
Wilmington*	E	SR SS	7:30 5:00	7:00 5:30	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
<i>District of Columbia</i>														
Washington*	E	SR SS	7:30 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 5:00	7:15 4:45
<i>Florida</i>														
Belle Glade, 26-40/80-41	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:15 7:15	5:30 7:00	6:00 7:15	6:15 6:30	6:15 6:00	6:45 5:30	7:00 5:30
Clearwater, 27-53/82-48	E	SR SS	7:30 6:00	7:15 6:15	6:45 6:45	6:00 7:00	5:45 7:15	5:30 7:30	5:45 7:30	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:45	7:15 5:30
Coral Gables, 25-43/80-18	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:15	6:00 7:00	6:00 6:30	6:15 6:00	6:45 5:30	7:00 5:30
Crestview, * 30-45/86-35	C	SR SS	6:45 5:15	6:30 5:30	6:00 6:00	5:15 6:15	4:45 6:30	4:45 6:45	4:45 6:30	5:15 6:00	5:30 6:00	5:45 5:15	6:15 4:45	6:45 4:45
Daytona Beach, 29-13/81-03	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:30	5:30 7:00	6:00 7:00	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Gainesville	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 6:45	5:30 7:00	5:30 7:30	5:45 7:00	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:00 5:30
Hollywood, 25-55/80-08	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:15	6:00 7:00	6:15 6:30	6:00 6:00	6:45 5:30	7:00 5:30
Jacksonville *	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:30	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Jacksonville Beach, 30-17/81-24	E	SR SS	7:30 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:15 7:30	5:30 7:30	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Melbourne, * 28-04/80-36	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:00	6:00 7:00	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Miami, * 24-48/80-14	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:00	6:00 7:00	6:15 6:30	6:00 6:00	6:45 5:30	7:00 5:30
Ocala, 29-12/82-10	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:30	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Orlando	E	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:30	5:30 7:00	6:00 7:00	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Palatka, 29-38/81-38	E	SR SS	7:30 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:30	6:00 7:00	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Panama City	E	SR SS	7:45 6:00	7:30 6:30	7:00 6:45	6:15 7:15	5:45 7:30	5:45 7:45	5:45 7:45	6:15 7:30	6:30 7:45	6:45 6:15	7:15 6:45	7:30 6:45
Pensacola	C	SR SS	6:45 5:15	6:30 5:30	6:00 6:00	6:15 6:45	6:30 7:30	6:45 7:45	6:45 7:45	7:00 8:00	6:00 6:00	5:15 5:45	6:45 5:45	7:00 6:45
St. Petersburg*	E	SR SS	7:30 6:00	7:15 6:15	6:45 6:45	6:00 7:00	5:45 7:15	5:30 7:30	5:45 7:30	6:30 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
Sarasota	E	SR SS	7:30 6:00	7:15 6:15	6:45 6:45	6:00 7:00	5:45 7:15	5:30 7:30	5:45 7:30	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:45	7:15 5:45
Tallahassee	E	SR SS	7:30 6:00	7:15 6:30	6:45 6:45	6:00 7:00	5:45 7:30	5:30 7:45	5:45 7:45	6:00 7:15	6:15 6:45	6:00 6:00	6:45 5:45	7:00 6:45
Tampa*	E	SR SS	7:30 6:00	7:15 6:15	6:45 6:45	6:00 7:00	5:45 7:15	5:30 7:30	5:45 7:30	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:15 5:30
West Palm Beach, 26-38/80-06	E	SR SS	7:45 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:30 7:15	5:30 7:15	6:00 7:00	6:15 6:30	6:00 5:45	6:45 5:30	7:00 5:30
<i>Georgia</i>														
Athens, * 33-57/83-23	E	SR SS	7:45 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:15	6:15 6:45	6:45 6:00	7:00 5:30	7:30 5:30
Atlanta, * 33-46/84-22	E	SR SS	7:45 5:45	7:30 6:15	6:45 6:45	6:15 7:15	5:30 7:30	5:30 7:45	5:30 7:45	6:00 7:00	6:15 6:45	6:45 6:00	7:15 5:30	7:30 5:30
Albany	E	SR SS	7:45 6:00	7:15 6:30	6:45 6:45	6:15 7:00	5:45 7:30	5:30 7:45	5:45 7:45	6:00 7:15	6:15 6:45	6:45 6:00	7:00 5:45	7:30 5:30
Brunswick	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:15	5:15 7:30	5:30 7:30	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:00 5:30
Buckhead, * 33-34/83-21	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:00	5:15 7:45	5:30 7:45	6:00 7:15	6:15 6:30	6:00 6:00	6:45 5:30	7:00 5:15
Carrollton, 33-35/85-03	E	SR SS	7:45 6:00	7:30 6:30	6:45 6:45	6:15 7:15	5:45 7:30	5:30 7:45	5:45 8:00	6:00 7:30	6:15 6:45	6:00 6:00	6:45 5:30	7:15 5:30
Columbus, 32-29/85-02	E	SR SS	7:45 6:00	7:30 6:30	6:45 6:45	6:15 7:15	5:45 7:30	5:30 7:45	5:45 8:00	6:00 7:30	6:15 6:45	6:00 6:00	6:45 5:30	7:15 5:30
Cordele	E	SR SS	7:30 6:00	7:15 6:15	6:45 6:45	6:15 7:00	5:45 7:30	5:30 7:45	5:45 7:45	6:00 7:15	6:15 6:45	6:00 6:00	6:45 5:30	7:00 5:30

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Georgia—Continued</i>														
Dawson,* 31-46/84-26	E	SR SS	7:45 6:00	7:15 6:30	6:45 6:45	6:15 7:00	5:45 7:30	5:30 7:45	5:45 7:45	6:00 7:30	6:15 6:45	6:45 6:00	7:00 5:45	7:30 5:30
Decatur, 33-48/84-16	E	SR SS	7:45 5:45	7:30 6:15	6:45 6:45	6:00 7:15	5:30 7:30	5:30 7:45	5:30 7:45	6:00 7:30	6:15 6:45	6:45 6:00	7:15 5:30	7:30 5:30
Douglas, 31-30/82-48	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:15	5:30 7:45	5:30 7:45	6:00 7:15	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:30
Griffin	E	SR SS	7:45 5:45	7:30 6:15	6:45 6:45	6:15 7:00	5:45 7:15	5:30 7:45	5:45 7:45	6:00 7:30	6:15 6:45	6:45 6:00	7:15 5:30	7:30 5:30
Hartwell, 34-21/82-57	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:45	5:15 7:45	5:15 7:15	6:00 6:45	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:30
Macon, 32-43/83-37	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:15 7:45	5:15 7:45	6:00 7:15	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:30
Martinez	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:15	5:30 7:30	5:15 7:15	6:00 7:15	6:15 6:45	6:30 6:00	7:00 5:30	7:15 5:30
Rome, 34-14/85-10	E	SR SS	7:45 6:00	7:30 6:30	7:00 6:45	6:15 7:15	5:45 7:30	5:30 8:00	5:45 8:00	6:00 7:30	6:30 6:45	6:45 6:00	7:15 5:30	7:45 5:30
Savannah*	E	SR SS	7:30 5:45	7:15 6:15	6:30 6:30	6:00 7:00	5:30 7:15	5:15 7:30	5:30 7:30	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:15 5:15
Thomaston, 32-53/84-20	E	SR SS	7:45 5:45	7:15 6:15	6:45 6:45	6:15 7:15	5:45 7:30	5:30 7:45	5:30 7:45	6:00 7:30	6:15 6:45	6:45 6:00	7:15 5:30	7:30 5:30
Thomasville, 30-50/83-57	E	SR SS	7:30 6:00	7:15 6:30	6:45 6:45	6:15 7:00	5:45 7:15	5:30 7:45	5:45 7:45	6:00 7:15	6:15 6:45	6:30 6:00	7:00 5:45	7:30 5:30
Valdosta	E	SR SS	7:30 6:00	7:15 6:15	6:45 6:45	6:00 7:00	5:45 7:15	5:30 7:30	5:45 7:45	6:00 7:15	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:30
<i>Idaho</i>														
Boise	M	SR SS	8:15 5:30	7:45 6:15	7:00 6:45	6:00 7:30	5:15 8:00	5:00 8:30	5:15 8:30	5:45 7:45	6:30 7:00	7:00 6:00	7:15 5:15	8:15 5:15
Idaho Falls	M	SR SS	8:00 5:15	7:30 6:00	6:45 6:30	5:45 7:15	5:00 7:45	4:45 8:15	5:00 8:15	5:30 7:30	6:00 6:45	6:45 5:45	7:15 5:00	8:00 4:45
Lewiston 46-23/116-59	P	SR SS	7:45 4:45	7:00 5:15	6:00 6:00	5:30 6:30	4:15 7:15	3:45 7:45	4:15 7:45	5:00 7:00	6:00 6:45	6:15 5:00	7:15 4:15	7:30 4:00
Pocatello	M	SR SS	8:00 5:15	7:30 6:00	6:45 6:30	5:45 7:15	5:15 7:45	4:45 8:15	5:00 8:00	5:30 7:30	6:15 6:45	6:45 5:45	7:15 5:15	8:00 5:00
Twin Falls	M	SR SS	8:00 5:30	7:30 6:15	7:00 6:45	6:00 7:15	5:15 7:45	5:00 8:15	5:15 8:15	5:45 7:45	6:15 6:45	6:45 6:00	7:30 5:15	8:00 5:00
Wallace	P	SR SS	7:30 4:15	6:45 5:00	6:00 5:45	5:00 6:30	4:15 7:15	3:45 7:45	4:00 7:45	4:45 7:00	5:15 6:00	6:00 5:00	6:45 4:15	7:30 4:00
<i>Illinois</i>														
Aiton, 38-55/90-13	C	SR SS	7:15 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:00	4:30 7:30	4:45 7:30	5:15 6:00	5:45 6:15	6:15 6:00	6:45 5:45	7:15 4:45
Aurora	C	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	6:00 6:00	6:15 5:15	7:15 4:30	7:30 4:30
Belleville, 38-31/90-00	C	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:30	4:45 7:00	5:15 6:15	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Canton, 40-32/90-01	C	SR SS	7:30 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:00	5:15 6:15	5:45 6:15	6:15 5:15	6:45 4:45	7:15 4:30
Carbondale, 37-43/89-16	C	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:15	4:45 7:15	5:15 6:45	5:45 6:00	6:00 5:15	6:30 4:45	7:00 4:45
Carthage	C	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:00	5:15 6:15	5:45 6:15	6:15 6:00	6:45 5:45	7:15 4:45
Centralia, 39-34/89-06	C	SR SS	7:15 5:00	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:30	6:45 4:45	7:15 4:30
Chicago*	C	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
Clinton, 40-05/88-57	C	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:45	7:15 4:30
Decatur	C	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:45	7:15 4:30
De Kalb, 41-56/88-44	C	SR SS	7:30 4:45	7:00 5:30	6:15 6:00	5:15 6:30	4:30 7:15	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:30
Effingham, 39-06/88-34	C	SR SS	7:15 5:00	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:15	5:00 6:45	6:00 6:00	6:15 5:15	7:15 4:45	7:30 4:30
Evanson, 42-01/87-42	D	SR SS	7:15 4:45	6:45 5:15	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
Freeport, 42-18/80-35	C	SR SS	7:15 4:30	6:45 5:15	6:15 6:45	5:00 6:30	4:15 7:00	4:00 7:30	4:15 7:15	4:45 6:45	5:15 6:00	6:00 5:00	6:30 4:15	7:00 4:15
Herrin	C	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:30	4:45 7:00	4:30 7:15	4:45 7:15	5:15 6:45	6:00 6:00	6:15 5:15	7:15 4:45	7:30 4:45
Jacksonville	C	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:30 6:45	4:45 7:00	4:30 7:30	4:45 7:00	5:15 6:15	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Joliet	C	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:30	6:45 4:30	7:15 4:30
La Salle, 41-18/89-05	C	SR SS	7:30 4:45	7:00 5:30	6:15 6:00	5:30 6:30	4:45 7:15	4:30 7:30	4:45 7:00	5:15 6:00	5:45 6:15	6:15 5:15	7:15 4:30	7:30 4:30
Macomb, 40-27/90-38	C	SR SS	7:30 5:00	7:00 5:30	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:00	5:15 6:15	5:45 6:15	6:00 5:30	6:45 4:45	7:15 4:45
Mount Vernon, 38-22/88-55	C	SR SS	7:15 5:00	6:45 5:30	6:15 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:15	5:15 6:45	6:00 6:00	6:15 5:30	7:15 4:45	7:30 4:45
Olny, 38-42/88-04	C	SR SS	7:15 5:00	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:45	7:15 4:30
Peoria*	C	SR SS	7:15 5:00	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:45	7:15 4:30
Quincy	C	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:00	5:15 6:15	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Rockford*	C	SR SS	7:30 4:45	7:00 5:30	6:15 6:00	5:15 6:30	4:30 7:15	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:15	6:15 5:15	7:15 4:30	7:30 4:30
Rock Island	C	SR SS	7:30 5:00	7:00 5:30	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:45	4:45 7:30	5:15 6:15	5:45 6:15	6:15 5:15	7:15 4:45	7:30 4:30
Tuscola	C	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:15	4:30 7:15	5:00 6:45	6:00 6:00	6:15 5:15	7:15 4:45	7:30 4:30
Urbana	C	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:15	5:00 6:45	6:00 6:00	6:15 5:15	7:15 4:45	7:30 4:30
<i>Indiana</i>														
Anderson	C	SR SS	7:00 4:45	6:45 5:15	6:00 5:45	5:00 6:15	4:30 6:45	4:15 7:15	4:30 7:15	5:00 6:45	5:30 6:00	6:00 5:00	6:30 4:30	7:00 4:15
Bloomington, 39-06/86-31	C	SR SS	7:00 4:45	6:45 5:15	6:00 5:45	5:15 6:30	4:30 7:00	4:15 7:15	4:30 7:15	5:00 6:45	5:30 6:00	6:00 5:15	6:30 4:30	7:00 4:30
Connersville, 39-38/85-08	C	SR SS	7:00 4:45	6:30 5:15	6:00 5:45	5:00 6:15	4:30 6:45	4:15 7:15	4:30 7:15	5:45 6:45	5:15 5:45	6:00 5:30	6:30 4:30	7:00 4:15
Evansville	C	SR SS	7:00 5:00	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:15	4:30 7:15	5:45 6:45	6:00 6:00	6:15 5:15	7:15 4:45	7:30 4:30
Fort Wayne*	C	SR SS	7:30 4:30	6:30 5:15	6:00 5:45	5:00 6:15	4:30 6:45	4:00 7:15	4:15 7:15	5:45 6:45	6:00 6:00	6:15 5:15	7:15 4:45	7:30 4:30
Gary*	C	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
Hammond*	C	SR SS	7:15 4:45	6:45 5:30	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:30 7:00	5:00 6:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
Indianapolis*	C	SR SS	7:00 4:45	6:45 5:15	6:00 5:45	5:15 6:15	4:30 6:45	4:15 7:15	4:30 7:15	5:00 6:45	5:30 6:00	6:00 5:00</		

	TZ	SR	SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Indiana—Continued</i>															
Kokomo,* 40-29/86-08	C	SR	SS	7:15	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:00
		SR	SS	4:45	5:30	6:00	6:30	7:00	7:15	7:15	6:45	6:00	5:15	4:30	4:15
La Porte,* 41-36/86-43	C	SR	SS	7:15	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:15
		SR	SS	4:45	5:15	6:00	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:30	4:15
Marion, 40-31/85-43	C	SR	SS	7:00	6:45	6:00	5:00	4:30	4:15	4:15	4:45	5:15	6:00	6:30	7:00
		SR	SS	4:45	5:15	5:45	6:15	7:00	7:15	7:15	6:45	6:00	5:00	4:30	4:15
Michigan City, 41-10/86-53	C	SR	SS	7:15	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:15
		SR	SS	4:45	5:15	6:00	6:30	7:00	7:30	7:30	6:45	6:00	5:15	4:30	4:15
South Bend*	C	SR	SS	7:15	6:45	6:00	5:00	4:30	4:15	4:15	4:45	5:30	6:00	6:30	7:00
		SR	SS	4:45	5:15	5:45	6:30	7:00	7:15	7:15	6:45	6:00	5:00	4:30	4:15
West Lafayette	C	SR	SS	7:15	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:00
		SR	SS	4:45	5:15	6:00	6:30	7:00	7:15	7:15	6:45	6:00	5:15	4:30	4:30
<i>Iowa</i>															
Ames	C	SR	SS	7:45	7:15	6:30	5:30	5:00	4:50	4:45	5:15	6:00	6:30	7:00	7:30
		SR	SS	5:00	5:45	6:15	7:00	7:30	7:45	7:45	7:15	6:30	5:30	5:00	4:45
Boone	C	SR	SS	7:45	7:15	6:30	5:30	5:00	4:45	4:45	5:15	6:00	6:30	7:00	7:30
		SR	SS	5:15	5:45	6:15	7:00	7:30	8:00	7:45	7:15	6:30	5:30	5:00	4:45
Cedar Rapids	C	SR	SS	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:45	6:15	6:45	7:15	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Council Bluffs, 41-12/95-53	C	SR	SS	7:45	7:15	6:30	5:45	5:00	4:45	4:45	5:30	6:00	6:30	7:15	7:45
		SR	SS	5:15	6:00	6:30	7:00	7:30	8:00	8:00	7:30	6:00	5:45	5:00	5:00
Creston, 41-02/95-36	C	SR	SS	7:45	7:15	6:30	5:45	5:00	4:45	4:45	5:30	6:00	6:30	7:15	7:45
		SR	SS	5:15	6:00	6:30	7:00	7:30	8:00	8:00	7:30	6:00	5:45	5:00	4:45
Davenport*	C	SR	SS	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SR	SS	5:00	5:30	6:15	6:45	7:15	7:45	7:30	7:00	6:15	5:15	4:45	4:30
Decorah	C	SR	SS	7:45	7:15	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:30	6:15	6:45	7:30	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Des Moines*	C	SR	SS	7:45	7:15	6:30	5:30	5:00	4:45	4:45	5:15	6:00	6:30	7:00	7:30
		SR	SS	5:00	5:45	6:15	7:00	7:30	7:45	7:45	7:15	6:30	5:30	5:00	4:45
Dubuque	C	SR	SS	7:30	7:00	6:15	5:30	4:45	4:30	4:30	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:30	6:15	6:45	7:15	7:45	7:45	7:00	6:15	5:30	4:45	4:30
Fort Madison,* 40-37/91-20	C	SR	SS	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:45	6:15	6:45	7:15	7:45	7:45	7:00	6:15	5:30	4:45	4:45
Iowa City	C	SR	SS	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:45	6:15	6:45	7:15	7:45	7:45	7:00	6:15	5:30	4:45	4:30
Kokuk, 40-26/91-24	C	SR	SS	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:45	6:15	6:45	7:15	7:45	7:45	7:00	6:15	5:30	4:45	4:45
Mason City	C	SR	SS	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:45	6:15	7:00	7:30	8:00	7:45	7:15	6:30	5:30	4:45	4:45
Muscatine, 41-26/91-04	C	SR	SS	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:30	6:15	6:45	7:15	7:45	7:45	7:00	6:15	5:30	4:45	4:30
Shenandoah	C	SR	SS	7:45	7:15	6:30	5:45	5:00	4:45	4:45	5:30	6:00	6:30	7:15	7:45
		SR	SS	5:15	6:00	6:30	7:00	7:30	8:00	7:45	7:15	6:30	5:45	5:00	5:00
Sioux City	C	SR	SS	8:00	7:30	6:45	5:45	5:00	4:45	4:45	5:30	6:00	6:30	7:15	7:45
		SR	SS	5:15	6:00	6:30	7:00	7:45	8:00	8:00	7:30	6:45	5:45	5:00	5:00
Waterloo, 42-26/92-17	C	SR	SS	7:45	7:00	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SR	SS	5:00	5:45	6:15	6:45	7:30	7:45	7:45	7:15	6:15	5:30	4:45	4:30
<i>Kansas</i>															
Abilene	C	SR	SS	7:45	7:15	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:15	7:45
		SR	SS	5:30	6:00	6:30	7:00	7:30	8:00	8:00	7:30	6:45	5:45	5:15	5:15
Arkansas City, 37-05/97-01	C	SR	SS	7:45	7:15	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:30	7:00	7:30
		SR	SS	5:30	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:15	5:30	5:15	5:15
Coffeyville	C	SR	SS	7:30	7:15	6:30	5:45	5:15	5:00	5:15	5:45	6:00	6:30	7:00	7:30
		SR	SS	5:30	6:00	6:30	7:00	7:30	7:30	7:45	7:45	7:15	6:30	5:45	5:15
Colby, 36-23/101-00	M	SR	SS	7:00	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:00
		SR	SS	4:45	5:15	5:45	6:15	6:45	7:15	7:15	6:45	6:00	5:00	4:30	4:15
Concordia, 39-26/97-39	C	SR	SS	7:45	7:30	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:15	7:45
		SR	SS	5:30	6:00	6:30	7:15	7:30	8:00	8:00	7:30	6:45	6:00	5:15	5:15
Dodge City	C	SR	SS	8:00	7:30	7:00	6:00	5:30	5:15	5:30	6:00	6:00	6:15	7:15	7:45
		SR	SS	5:45	6:15	6:45	7:15	7:45	8:00	8:00	7:30	6:45	6:00	5:30	5:30
Garden City, 37-69/100-53	M	SR	SS	7:00	6:30	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:00
		SR	SS	4:45	5:15	5:45	6:15	6:45	7:15	7:15	6:45	6:00	5:30	4:30	4:30
Goodland, 39-20/101-44	M	SR	SS	7:00	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:00
		SR	SS	4:45	5:30	6:00	6:30	7:00	7:00	7:15	7:15	6:45	6:00	5:30	5:30
Great Bend, 38-18/98-47	C	SR	SS	7:45	7:30	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:15	7:45
		SR	SS	5:30	6:15	6:45	7:15	7:30	8:00	8:00	7:30	6:45	6:00	5:15	5:15
Hutchinson, 38-06/97-56	C	SR	SS	7:45	7:30	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:15	7:30
		SR	SS	5:30	6:15	6:45	7:15	7:30	8:00	8:00	7:30	6:45	6:00	5:15	5:15
Independence, 37-14/95-43	C	SR	SS	7:45	7:15	6:30	5:45	5:15	5:00	5:15	5:45	6:00	6:30	7:00	7:30
		SR	SS	5:30	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:15	5:00
Lawrence	C	SR	SS	7:45	7:15	6:30	5:45	5:15	5:00	5:00	5:30	6:00	6:30	7:00	7:30
		SR	SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:15	5:00
Leavenworth,* 39-18/94-55	C	SR	SS	7:45	7:15	6:30	5:45	5:15	5:00	5:15	5:45	6:00	6:30	7:00	7:30
		SR	SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:00	5:00
Manhattan	C	SR	SS	7:45	7:15	6:30	5:45	5:15	5:00	5:15	5:45	6:00	6:30	7:00	7:30
		SR	SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:00	5:00
Pittsburg	C	SR	SS	7:30	7:15	6:30	5:45	5:15	5:00	5:15	5:30	6:00	6:30	7:00	7:30
		SR	SS	5:30	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:15	5:00
Salina	C	SR	SS	7:45	7:30	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:15	7:45
		SR	SS	5:30	6:00	6:30	7:00	7:30	8:00	8:0					

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Louisiana</i>														
Abbeville, 30-00/92-07	C	SR	7:00	6:45	6:15	5:45	5:15	5:00	5:15	5:30	6:00	6:15	6:30	7:00
		SS	5:30	6:00	6:15	6:30	7:00	7:15	7:15	6:45	6:15	5:45	5:15	5:30
Bastrop, * 32-47/91-55	C	SR	7:15	7:00	6:15	5:45	5:15	5:00	5:15	5:30	6:00	6:15	6:45	7:00
		SS	5:30	5:45	6:15	6:45	7:00	7:15	7:15	6:30	6:15	5:30	5:00	5:00
Baton Rouge	C	SR	7:00	6:45	6:15	5:45	5:15	5:00	5:15	5:30	6:00	6:30	7:00	7:00
		SS	5:30	5:45	6:15	6:30	6:45	7:15	7:15	6:45	6:15	5:30	5:15	5:00
Hammond, 30-29/90-27	C	SR	7:00	6:45	6:15	5:30	5:00	5:00	5:00	5:30	6:00	6:30	6:45	6:45
		SS	5:15	5:45	6:15	6:30	6:45	7:00	7:00	6:45	6:15	5:30	5:00	5:00
New Orleans*	C	SR	7:00	6:45	6:15	5:30	5:15	5:00	5:15	5:30	6:00	6:30	6:45	6:45
		SS	5:15	5:45	6:15	6:30	6:45	7:00	7:00	6:45	6:00	5:30	5:00	5:00
Opelousas, 30-32/92-07	C	SR	7:00	6:45	6:15	5:30	5:15	5:00	5:15	5:30	6:00	6:15	6:30	7:00
		SS	5:30	6:00	6:15	6:30	7:00	7:15	7:15	6:45	6:15	5:45	5:15	5:15
Shreveport	C	SR	7:15	7:00	6:30	5:45	5:15	5:00	5:15	5:45	6:00	6:15	6:45	7:15
		SS	5:30	6:00	6:15	6:45	7:00	7:30	7:30	7:00	6:30	5:45	5:15	5:15
<i>Maine</i>														
Bangor	E	SR	7:15	6:45	5:45	5:00	4:15	3:45	4:00	4:30	5:15	5:45	6:30	7:00
		SS	4:15	5:00	5:45	6:15	7:00	7:15	7:15	6:45	6:15	5:45	4:15	4:00
Portland	E	SR	7:15	6:45	6:00	5:00	4:15	4:00	4:15	4:45	5:15	6:00	6:30	7:15
		SS	4:30	5:15	5:45	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:15	4:00
<i>Maryland</i>														
Annapolis, 38-58/76-30	E	SR	7:30	7:00	6:15	5:30	5:00	4:45	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	5:00	4:45
Baltimore*	E	SR	7:30	7:00	6:15	5:30	5:00	4:45	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:30	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Cumberland	E	SR	7:30	7:15	6:30	5:45	5:00	4:45	4:45	5:00	5:30	6:00	7:00	7:30
		SS	5:15	5:45	6:15	6:45	7:15	7:45	7:45	7:15	6:30	5:30	5:00	4:45
Easton, * 38-46/76-04	E	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Essex *	E	SR	7:30	7:00	6:15	5:30	5:00	4:45	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Frederick	E	SR	7:30	7:00	6:30	5:30	5:00	4:45	4:45	5:15	5:45	6:15	7:00	7:30
		SS	5:15	5:45	6:15	6:45	7:15	7:45	7:30	7:00	6:15	5:30	5:00	4:45
Havre de Grace, * 39-32/76-05	E	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Preston, 38-44/75-55	E	SR	7:15	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Salisbury, 38-23/75-24	E	SR	7:15	6:45	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:00	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Silver Spring, 39-02/77-02	E	SR	7:30	7:00	6:15	5:30	5:00	4:45	4:45	5:00	5:15	6:15	6:45	7:15
		SS	5:15	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	5:00	4:45
<i>Massachusetts</i>														
Boston *	E	SR	7:15	6:45	6:00	5:00	4:30	4:00	4:15	4:45	5:30	6:00	6:30	7:00
		SS	4:30	5:15	5:45	6:30	7:00	7:15	7:15	6:45	6:00	5:30	4:30	4:15
Brockton, 42-04/71-62	E	SR	7:15	6:45	6:00	5:00	4:30	4:00	4:15	4:45	5:30	6:00	6:30	7:15
		SS	4:30	5:15	5:45	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:15	4:15
Fall River*	E	SR	7:15	6:45	6:00	5:00	4:30	4:15	4:15	4:45	5:30	6:00	6:30	7:00
		SS	4:45	5:15	5:45	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:30	4:15
Frammingham, 42-17/71-25	E	SR	7:15	6:45	6:00	5:00	4:30	4:00	4:15	4:45	5:30	6:00	6:30	7:15
		SS	4:30	5:15	5:45	6:30	7:00	7:30	7:30	7:00	6:00	5:00	4:30	4:15
Lawrence*	E	SR	7:15	6:45	6:00	5:00	4:30	4:00	4:15	4:45	5:30	6:00	6:30	7:15
		SS	4:30	5:15	5:45	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:30	4:15
Lynn, 42-27/70-58	E	SR	7:15	6:45	6:00	5:00	4:15	4:00	4:15	4:45	5:15	6:00	6:30	7:15
		SS	4:30	5:15	5:45	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:30	4:15
North Adams, 42-41/73-06	E	SR	7:30	6:45	6:00	5:15	4:30	4:00	4:15	4:45	5:30	6:00	6:30	7:15
		SS	4:45	5:45	6:00	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:30	4:15
Quincy, 42-15/70-57	E	SR	7:15	6:45	6:00	5:00	4:15	4:00	4:15	4:45	5:15	6:00	6:30	7:15
		SS	4:30	5:15	5:45	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:15	4:15
Springfield*	E	SR	7:15	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:15	6:00	6:30	7:00	7:30	7:30	7:00	6:45	6:00	5:15	4:30
Waltham, 42-21/71-15	E	SR	7:15	6:45	6:00	5:00	4:30	4:00	4:15	4:45	5:30	6:00	6:30	7:15
		SS	4:30	5:15	5:45	6:30	7:00	7:30	7:15	6:45	6:00	5:00	4:30	4:15
Ware, 42-14/72-12	E	SR	7:15	6:45	6:00	5:15	4:30	4:15	4:15	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:15	6:00	6:30	7:00	7:30	7:30	7:00	6:45	6:15	5:30	4:15
Worcester *	E	SR	7:45	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:30	7:15
		SS	4:45	5:15	6:00	6:30	7:00	7:30	7:30	7:00	6:45	6:00	5:00	4:30
<i>Michigan</i>														
Adrian, 41-50/84-01	E	SR	8:00	7:30	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:30	8:00
		SS	5:30	6:15	6:45	7:15	7:45	8:15	8:15	7:45	6:45	6:00	5:15	5:00
Battle Creek, * 42-19/85-11	E	SR	8:15	7:45	7:00	6:00	5:15	5:00	5:15	5:45	6:15	7:00	7:30	8:00
		SS	5:30	6:15	6:45	7:15	8:00	8:15	8:15	7:45	6:45	6:00	5:15	5:00
Bay City, * 43-35/83-53	E	SR	8:15	7:30	6:45	6:00	5:15	4:45	5:00	5:45	6:15	6:45	7:30	8:00
		SS	5:30	6:00	6:45	7:15	8:00	8:15	8:15	7:45	6:45	6:00	5:15	5:00
Benton Harbor, 42-04/86-28	E	SR	8:15	7:45	7:00	6:00	5:30	5:00	5:15	5:45	6:30	7:00	7:30	8:15
		SS	5:30	6:15	6:45	7:30	8:00	8:30	8:15	7:45	7:00	6:00	5:30	5:15
Dearborn, 42-20/83-14	E	SR	8:00	7:30	6:45	6:00	5:15	4:45	5:00	5:30	6:15	6:45	7:30	8:00
		SS	5:30	6:00	6:45	7:15	7:45	8:15	8:15	7:30	6:45	6:15	5:15	5:00
Detroit*	E	SR	8:00	7:30	6:45	6:00	5:15	5:00	5:00	5:45	6:15	6:45	7:15	8:00
		SS	5:30	6:00	6:45	7:15	7:45	8:15	8:15	7:30	6:45	6:45	5:15	5:00
East Lansing	E	SR	8:00	7:30	7:00	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:30	8:00
		SS	5:30	6:15	6:45	7:15	8:00	8:15	8:15	7:45	6:45	6:00	5:15	5:00
Flint*	E	SR	8:00	7:30	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:30	8:00
		SS	5:30	6:00	6:45	7:15	7:45	8:15	8:15	7:45	6:45	6:15	5:15	5:00
Grand Rapids*	E	SR	8:15	7:45	7:00	6:00	5:15	5:00	5:15	5:45	6:15	7:00	7:30	8:15
		SS	5:30	6:15	6:45	7:30	8:00	8:30	8:15	7:45	7:00	6:00	5:15	5:15
Kalamazoo, 42-19/85-31	E	SR	8:15	7:45	7:00	6:00	5:15	5:00	5:15					

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Minnesota-- Continued</i>														
Minneapolis*	C	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	4:45	4:30
Northfield	C	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	4:45	4:30
St. Paul*	C	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	4:45	4:30
Wadena, 46-22/95-08	C	SR	8:00	7:30	6:30	5:30	4:45	4:30	4:45	5:15	6:00	6:30	7:30	8:00
		SS	5:00	5:45	6:30	7:00	7:45	8:15	8:15	7:30	6:30	5:30	4:45	4:30
Worthington, 43-37/95-40	C	SR	8:00	7:30	6:30	5:45	5:00	4:45	5:00	5:30	6:00	6:30	7:15	7:45
		SS	5:15	5:45	6:30	7:00	7:45	8:00	8:00	7:30	6:30	5:45	5:00	4:45
<i>Mississippi</i>														
Gulfport	C	SR	7:00	6:45	6:15	5:30	5:00	5:00	5:00	5:30	5:45	6:00	6:15	6:45
		SS	5:15	5:45	6:00	6:15	6:45	7:00	7:00	6:45	6:00	5:30	5:00	5:00
Hattiesburg	C	SR	7:00	6:45	6:15	5:30	5:00	4:45	5:00	5:15	5:45	6:00	6:30	6:45
		SS	5:15	5:45	6:00	6:30	6:45	7:00	7:00	6:45	6:00	5:30	5:00	5:00
Jackson	C	SR	7:00	6:45	6:15	5:30	5:00	5:00	5:00	5:30	5:45	6:00	6:30	7:00
		SS	5:30	6:00	6:15	6:30	7:00	7:15	7:15	6:45	6:15	5:30	5:15	5:00
McComb, * 31-14/90-27	C	SR	7:00	6:45	6:15	5:30	5:00	5:00	5:00	5:30	5:45	6:00	6:30	7:00
		SS	5:15	5:45	6:15	6:30	6:45	7:00	7:15	6:45	6:00	5:30	5:00	5:00
Meridian	C	SR	7:00	6:45	6:00	5:30	5:00	4:45	5:00	5:15	5:45	6:00	6:30	6:45
		SS	5:15	5:45	6:00	6:30	6:45	7:00	7:00	6:45	6:00	5:30	5:00	4:45
Vicksburg	C	SR	7:00	6:45	6:15	5:30	5:00	5:00	5:00	5:30	5:45	6:00	6:30	7:00
		SS	5:15	5:45	6:15	6:30	7:00	7:15	7:15	6:45	6:15	5:30	5:00	5:00
<i>Missouri</i>														
Cape Girardeau, 37-19/89-28	C	SR	7:15	6:45	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:00	6:30	7:00
		SS	5:00	5:30	6:00	6:30	7:00	7:15	7:15	6:45	6:00	5:15	4:45	4:15
Clayton*	C	SR	7:15	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:00	6:30	7:00	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Columbia	C	SR	7:30	7:00	6:30	5:30	5:00	4:45	5:00	5:15	5:45	6:15	6:45	7:15
		SS	5:15	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	5:00	4:45
Farmington, * 37-47/90-26	C	SR	7:15	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:00	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Hannibal, 39-38/91-20	C	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	4:45	4:45
Independence, 39-04/94-27	C	SR	7:30	7:15	6:30	5:45	5:00	4:45	5:00	5:30	6:00	6:30	7:15	7:30
		SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:00	5:00
Joplin, * 37-05/94-31	C	SR	7:30	7:15	6:30	5:45	5:15	5:00	5:00	5:30	6:00	6:30	7:00	7:30
		SS	5:30	6:00	6:30	7:00	7:15	7:45	7:45	7:15	6:30	5:45	5:15	5:00
Kansas City, * 39-05/94-33	C	SR	7:30	7:15	6:30	5:45	5:00	4:45	5:00	5:30	6:00	6:30	7:00	7:30
		SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:00	5:00
Kennett, 36-13/90-04	C	SR	7:15	6:45	6:15	5:30	5:00	4:45	4:45	5:15	5:45	6:00	6:45	7:00
		SS	5:00	5:45	6:00	6:30	7:00	7:15	7:15	6:45	6:15	5:30	4:45	4:45
Springfield	C	SR	7:30	7:00	6:30	5:45	5:00	4:45	5:00	5:30	6:00	6:15	6:45	7:15
		SS	5:15	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:30	5:45	5:00	5:00
St. Joseph	C	SR	7:45	7:15	6:30	5:45	5:00	4:45	5:00	5:30	6:00	6:30	7:00	7:30
		SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:00	5:00
St. Louis*	C	SR	7:15	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:45	6:00	6:30	7:00	7:30	7:30	7:00	6:15	5:30	4:45	4:45
<i>Montana</i>														
Billings	M	SR	8:00	7:15	6:30	5:30	4:45	4:30	4:30	5:15	5:45	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:30	6:30	5:30	4:45	4:30
Butte	M	SR	8:15	7:30	6:45	5:45	5:00	4:45	5:00	5:30	6:00	6:45	7:30	8:00
		SS	5:15	6:00	6:30	7:15	8:00	8:15	8:15	7:45	6:45	5:45	5:00	4:45
Great Falls, 47-25/111-16	M	SR	8:15	7:30	6:45	5:45	4:45	4:15	4:45	5:15	6:00	6:45	7:30	8:15
		SS	5:00	5:45	6:30	7:15	8:00	8:30	8:30	7:45	6:45	5:45	4:45	4:30
Havre, 48-34/109-39	M	SR	8:15	7:30	6:30	5:30	4:30	4:15	4:30	5:15	6:00	6:30	7:30	8:00
		SS	4:45	5:45	6:30	7:15	8:00	8:30	8:15	7:30	6:30	5:30	4:45	4:15
Kalispell	M	SR	8:30	7:45	7:00	6:45	5:00	4:30	4:45	5:30	6:15	7:00	7:45	8:15
		SS	5:15	6:00	6:45	7:30	8:15	8:45	8:30	8:00	6:45	5:45	5:00	4:45
Missoula	M	SR	8:15	7:45	6:45	5:45	5:00	4:45	5:00	5:30	6:15	7:00	7:45	8:15
		SS	5:15	6:00	6:45	7:30	8:00	8:30	8:30	7:45	6:45	5:45	5:00	4:45
Wolf Point	M	SR	7:45	7:15	6:15	5:15	4:30	4:00	4:15	5:00	5:45	6:15	7:15	7:45
		SS	4:30	5:30	6:00	6:45	7:30	8:00	8:00	7:15	6:15	5:15	4:30	4:15
<i>Nebraska</i>														
Columbus, 41-26/97-23	C	SR	8:00	7:30	6:45	5:45	5:15	4:45	5:00	5:30	6:15	6:45	7:15	7:45
		SS	5:30	6:00	6:30	7:15	7:45	8:00	8:00	7:30	6:45	5:45	5:15	5:00
Freemont	C	SR	7:45	7:30	6:45	5:45	5:15	4:45	5:00	5:30	6:00	6:30	7:15	7:45
		SS	5:15	6:00	6:30	7:00	7:30	8:00	8:00	7:30	6:45	5:45	5:15	5:00
Grand Island	C	SR	8:00	7:30	6:45	5:45	5:00	4:45	5:00	5:15	5:45	6:15	6:45	7:15
		SS	5:30	6:15	6:45	7:15	7:45	8:00	8:00	7:30	6:45	6:00	5:15	5:00
Lincoln	C	SR	7:45	7:30	6:45	5:45	5:15	5:00	5:00	5:30	6:00	6:30	7:15	7:45
		SS	5:30	6:00	6:30	7:00	7:30	8:00	8:00	7:30	6:45	5:45	5:15	5:00
Norfolk	C	SR	8:00	7:30	6:45	5:45	5:15	4:45	5:00	5:30	6:15	6:45	7:15	7:45
		SS	5:15	6:00	6:30	7:15	7:45	8:00	8:00	7:30	6:45	5:45	5:15	5:00
North Platte	C	SR	8:15	7:45	7:00	6:00	5:30	5:15	5:30	5:45	6:30	7:00	7:30	8:00
		SS	5:45	6:15	6:45	7:15	8:00	8:15	8:15	7:45	6:30	6:00	5:30	5:15
Omaha*	C	SR	7:45	7:15	6:45	5:45	5:00	4:45	5:00	5:30	6:00	6:30	7:15	7:45
		SS	5:15	6:00	6:30	7:00	7:30	8:00	8:00	7:30	6:30	5:45	5:00	5:00
Scotts Bluff	M	SR	7:15	6:45	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:00	7:30	7:30	7:00	6:00	5:15	4:30	4:30
<i>Nevada</i>														
Las Vegas, 36-11/115-07	P	SR	7:00	6:30	6:00	5:15	4:30	4:15	4:30	5:00	5:15	5:45	6:15	6:45
		SS	4:45	5:15	5:45	6:15	6:45	7:00	7:00	6:30	5:45	5:00	4:30	4:30
Reno	P	SR	7:15	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	6:45	7:15
		SS	5:00	5:30	6:00	6:30	7:00	7:30	7:30	7:00	6:15	5:15	4:45	4:30
<i>New Hampshire</i>														
Manchester	E	SR	7:15	6:45	6:00	5:00	4:30	4:00	4:15	4:45	5:30	6:00	6:45	7:15

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>New Mexico</i>														
Albuquerque	M	SR	7:15	7:00	6:15	5:30	5:00	4:45	5:00	5:30	5:45	6:15	6:45	7:15
		SS	5:15	5:45	6:15	6:45	7:00	7:15	7:15	7:00	6:15	5:30	5:00	5:00
Gallup	M	SR	7:30	7:00	6:30	5:45	5:15	5:00	5:15	5:30	6:00	6:15	6:45	7:15
		SS	5:30	6:00	6:15	6:45	7:15	7:30	7:30	7:00	6:30	5:45	5:15	5:00
<i>New York</i>														
Albany*	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:15	7:30	7:30	7:00	6:15	5:15	4:30	4:15
Binghamton	F	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SS	5:00	5:30	6:15	6:45	7:15	7:45	7:45	7:00	6:15	5:30	4:45	4:30
Brooklyn*	E	SR	7:15	6:45	6:15	5:15	4:45	4:30	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:00	7:30	7:30	7:00	6:00	5:15	4:45	4:30
Buffalo*	E	SR	7:45	7:15	6:30	5:30	5:00	4:30	4:45	5:15	6:00	6:30	7:00	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	5:00	4:45
Canton	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:45	6:15	7:00	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:15
Cobleskill, 42-40/74-27	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	6:45	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:30
Cortland, 42-33/76-09	E	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:30	5:15	5:45	6:15	7:00	7:30
		SS	5:00	5:30	6:15	6:45	7:30	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Elmira	E	SR	7:30	7:00	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SS	5:00	5:45	6:15	6:45	7:15	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Hempstead, 40-41/73-36	E	SR	7:15	6:45	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:00	7:30	7:30	7:00	6:00	5:15	4:30	4:30
Ithaca	E	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	5:45	6:15	7:00	7:30
		SS	5:00	5:30	6:15	6:45	7:15	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Jamestown, 42-03/79-14	E	SR	7:45	7:15	6:30	5:45	5:00	4:30	4:45	5:15	6:00	6:30	7:00	7:45
		SS	5:15	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	5:00	4:45
Kenmore, 42-59/78-49	E	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	6:00	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	4:45	4:45
Lackawanna, 42-49/78-47	E	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	6:00	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	4:45	4:45
Newburgh	E	SR	7:15	7:00	6:15	5:15	4:45	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:15	7:30	7:30	7:00	6:15	5:15	4:45	4:30
New York*	E	SR	7:15	6:45	6:15	5:15	4:45	4:30	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:00	7:30	7:30	7:00	6:00	5:15	4:45	4:30
Niagara Falls, 43-07/78-59	E	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:30	5:15	6:00	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	4:45	4:45
Olean	E	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:45	5:15	6:00	6:30	7:00	7:30
		SS	5:00	5:45	6:15	7:00	7:30	7:45	7:45	7:15	6:30	5:30	5:00	4:45
Oneonta, 42-26/75-05	E	SR	7:30	7:00	6:15	5:15	4:45	4:15	4:30	5:00	5:45	6:15	6:45	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:30
Plattsburg, 44-39/73-26	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:15	5:00	5:30	6:15	6:45	7:30
		SS	4:45	5:15	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:15
Rochester*	E	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:30	7:00	7:30
		SS	5:00	5:45	6:15	6:45	7:30	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Saranac Lake	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	6:45	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:15
Schenectady*	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:15	7:30	7:30	7:00	6:15	5:15	4:30	4:15
Syracuse*	E	SR	7:30	7:00	6:15	5:30	4:45	4:30	4:30	5:15	5:45	6:15	7:00	7:30
		SS	5:00	5:30	6:15	6:45	7:15	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Troy*	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:15	7:30	7:30	7:00	6:15	5:15	4:30	4:15
Utica, 43-07/75-14	E	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:45	6:15	7:00	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:30
Watertown	E	SR	7:30	7:00	6:15	5:30	4:45	4:15	4:30	5:00	5:45	6:15	7:00	7:30
		SS	4:45	5:30	6:15	6:45	7:15	7:45	7:45	7:15	6:15	5:15	4:45	4:30
<i>North Carolina</i>														
Ahoskie, 36-16/77-01	E	SR	7:15	7:00	6:15	5:30	5:00	4:45	5:00	5:30	5:45	6:15	6:45	7:15
		SS	5:15	5:45	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:30	5:00	5:00
Albemarle, 35-22/80-11	E	SR	7:30	7:15	6:30	5:45	5:15	5:00	5:15	5:45	6:00	6:30	7:00	7:15
		SS	5:30	6:00	6:30	7:00	7:15	7:30	7:30	7:15	6:30	5:45	5:15	5:15
Asheboro, 35-43/79-48	E	SR	7:30	7:15	6:30	5:45	5:15	5:00	5:15	5:30	6:00	6:30	7:00	7:30
		SS	5:30	6:00	6:30	6:45	7:15	7:45	7:30	7:15	6:30	5:45	5:15	5:00
Asheville	E	SR	7:45	7:15	6:45	6:00	5:30	5:15	5:30	5:45	6:15	6:30	7:00	7:30
		SS	5:45	6:15	6:30	7:00	7:30	7:45	7:45	7:15	6:45	6:00	5:30	5:15
Burlington, 36-05/79-20	E	SR	7:30	7:00	6:30	5:45	5:15	5:00	5:15	5:30	6:00	6:30	7:00	7:15
		SS	5:30	6:00	6:30	6:45	7:15	7:30	7:30	7:15	6:30	5:45	5:15	5:00
Charlotte	E	SR	7:30	7:15	6:30	5:30	5:15	5:15	5:15	5:45	6:00	6:30	7:00	7:30
		SS	6:00	6:30	6:30	7:00	7:15	7:45	7:45	7:15	6:30	5:45	5:15	5:15
Clinton, 35-00/78-17	E	SR	7:15	7:00	6:30	5:45	5:15	5:00	5:00	5:30	6:00	6:15	6:45	7:15
		SS	5:30	6:00	6:15	6:45	7:15	7:30	7:30	7:00	6:15	5:45	5:15	5:00
Dunn, 35-17/78-35	E	SR	7:30	7:00	6:30	5:45	5:15	5:00	5:15	5:30	6:00	6:15	6:45	7:15
		SS	5:30	6:00	6:15	6:45	7:15	7:30	7:30	7:00	6:30	5:45	5:15	5:00
Elizabeth City, 36-20/76-14	E	SR	7:15	7:00	6:15	5:30	5:00	4:45	5:00	5:15	5:45	6:15	6:45	7:15
		SS	5:15	5:45	6:15	6:45	7:00	7:30	7:30	7:00	6:15	5:30	5:00	4:45
Fayetteville	E	SR	7:30	7:00	6:30	5:45	5:15	5:00	5:15	5:30	6:00	6:15	6:45	7:15
		SS	5:30	6:00	6:15	6:45	7:15	7:30	7:30	7:00	6:30	5:45	5:15	5:00
Forest City, 35-20/81-53	E	SR	7:30	7:15	6:45	6:00	5:30	5:15	5:15	5:45	6:15	6:30	7:00	7:30
		SS	5:30	6:15	6:30	7:00	7:30	7:45	7:45	7:15	6:30	6:00	5:15	5:15
Gastonia, 35-15/81-08	E	SR	7:30	7:15	6:30	6:00	5:15	5:15	5:15	5:45	6:00	6:30	7:00	7:30
		SS	5:30	6:00	6:30	7:00	7:15	7:45	7:45	7:15	6:30	5:45	5:15	5:15
Greensboro, 36-02/79-45	E	SR	7:30	7:15	6:30	5:45	5:15	5:00	5:15	5:30	6:00	6:30	7:00	7:30
		SS	5:30	6:00	6:30</									

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>North Carolina—Continued</i>														
Rocky Mount, 35-54/77-50.....	E	SR SS	7:15 5:15	6:45 6:00	6:30 6:15	5:45 6:45	5:15 7:00	5:00 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 5:00	7:15 5:00
Salisbury, 35-40/80-30.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:45 7:00	5:15 7:15	5:00 7:45	5:15 7:45	5:45 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 5:15
Sanford, 35-26/79-12.....	E	SR SS	7:30 5:30	7:00 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:30	5:15 7:30	5:30 7:00	6:00 6:30	6:15 5:45	6:45 5:15	7:15 5:00
Shelby,* 35-17/81-32.....	E	SR SS	7:30 5:30	7:15 6:00	6:45 6:30	6:00 7:00	5:15 7:30	5:15 7:45	5:15 7:45	5:45 7:15	6:15 6:30	6:15 5:45	6:30 5:15	7:00 5:15
Southern Pines, 35-11/79-24.....	E	SR SS	7:30 5:30	7:00 6:00	6:30 6:45	5:45 7:15	5:15 7:30	5:00 7:30	5:15 7:00	5:30 7:00	6:00 6:30	6:30 5:45	6:45 5:15	7:15 5:00
Tarboro, 35-55/77-34.....	E	SR SS	7:15 5:15	7:00 5:45	6:15 6:45	5:45 7:15	5:00 7:30	4:45 7:30	5:00 7:00	5:30 7:00	6:15 6:00	6:15 5:30	6:45 5:00	7:15 5:00
Thomasville, 35-53/80-05.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:45 7:00	5:15 7:15	5:00 7:45	5:15 7:45	5:45 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 5:00
Wadesboro, 34-57/80-03.....	E	SR SS	7:30 5:30	7:00 6:00	6:30 6:45	5:45 7:15	5:15 7:30	5:00 7:30	5:15 7:30	5:45 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:15 5:00
Washington.....	E	SR SS	7:15 5:15	7:00 6:00	6:15 6:15	5:30 6:45	5:00 7:00	4:45 7:15	5:00 7:00	5:30 7:00	6:00 6:15	6:15 5:30	6:45 5:00	7:15 5:00
Wilmington.....	E	SR SS	7:15 5:30	7:00 6:00	6:30 6:15	5:45 6:45	5:15 7:00	5:00 7:30	5:15 7:30	5:30 7:00	6:00 6:15	6:15 5:45	6:45 5:15	7:15 5:00
Wilson,* 35-43/77-54.....	E	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:00	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 5:00	7:15 5:00
Winston-Salem.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:45 7:00	5:15 7:15	5:00 7:45	5:15 7:45	5:45 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 5:15
<i>North Dakota</i>														
Bismarck.....	C	SR SS	8:30 6:15	7:45 6:00	7:00 6:45	6:00 7:30	5:15 8:15	4:45 8:45	5:00 8:30	5:45 8:30	6:15 7:00	7:00 6:00	7:45 5:15	8:15 5:00
Fargo.....	C	SR SS	8:15 6:15	7:45 6:45	6:45 6:45	5:45 7:00	4:45 7:45	4:30 8:00	4:45 8:00	5:30 7:30	6:00 6:45	6:45 5:45	7:30 5:00	8:00 4:45
Grand Forks.....	C	SR SS	8:15 6:15	7:45 6:45	6:45 6:30	5:45 7:15	4:45 8:00	4:30 8:30	4:45 8:30	5:15 8:30	6:00 6:45	6:45 5:45	7:30 4:45	8:15 4:30
Mandan, 46-49/100-50.....	C	SR SS	8:30 6:15	7:45 6:00	7:00 6:45	6:00 7:30	5:15 8:15	4:45 8:45	5:00 8:45	5:45 8:00	6:15 7:00	7:00 6:00	7:45 5:15	8:30 4:45
Minot.....	C	SR SS	8:30 6:15	8:00 6:00	7:00 6:45	6:00 7:30	5:00 8:15	4:45 8:45	5:00 8:45	5:45 8:00	6:15 7:00	7:00 6:00	7:45 5:15	8:30 4:45
<i>Ohio</i>														
Akron*.....	E	SR SS	7:45 5:15	7:15 6:00	6:45 6:30	5:45 7:00	5:15 7:30	5:00 8:00	5:00 8:00	5:30 7:30	6:00 6:30	6:30 5:45	7:15 5:15	7:45 5:00
Ashtabula.....	E	SR SS	7:45 5:15	7:15 6:00	6:45 6:30	5:45 7:00	5:00 7:30	4:45 8:00	5:00 8:00	5:30 7:30	6:00 6:30	6:30 5:45	7:15 5:00	7:45 5:00
Bellaire, 40-02/80-46.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:15 7:30	5:00 8:00	5:00 8:00	5:30 7:45	6:00 7:15	6:30 5:45	7:00 5:00	7:45 5:00
Cambridge,* 40-01/81-35.....	E	SR SS	7:45 5:30	7:15 6:00	6:45 6:30	5:45 7:00	5:15 7:30	5:00 8:00	5:15 8:00	5:30 7:30	6:00 6:30	6:30 5:45	7:15 5:15	7:45 5:00
Canton*.....	E	SR SS	7:45 5:15	7:15 6:00	6:45 6:30	5:45 7:00	5:15 7:30	5:00 8:00	5:00 8:00	5:30 7:30	6:00 6:30	6:30 5:45	7:15 5:15	7:45 5:00
Cincinnati*.....	E	SR SS	8:00 5:45	7:30 6:15	6:45 6:45	6:00 7:15	5:30 7:45	5:15 8:00	5:30 8:00	6:00 7:30	6:15 6:45	6:45 6:00	7:15 5:30	7:45 5:15
Cleveland*.....	E	SR SS	8:00 5:45	7:30 6:15	6:45 6:45	5:45 7:15	5:15 7:45	4:45 8:00	5:00 8:00	5:30 7:30	6:00 6:45	6:45 6:15	7:15 5:15	7:45 5:00
Columbus*.....	E	SR SS	8:00 5:30	7:30 6:00	6:45 6:45	6:00 7:15	5:15 7:45	5:00 8:00	5:15 8:00	5:45 7:30	6:15 6:45	6:45 6:00	7:15 5:15	7:45 5:15
Dayton*.....	E	SR SS	8:00 5:30	7:30 6:15	6:45 6:45	6:00 7:15	5:30 7:45	5:15 8:00	5:15 8:00	5:45 7:30	6:15 6:45	6:45 6:00	7:15 5:15	7:45 5:15
Findlay,* 41-02/83-39.....	E	SR SS	8:00 5:30	7:30 6:00	6:45 6:45	6:00 7:15	5:15 7:45	5:00 8:15	5:15 8:00	5:45 7:30	6:15 6:45	6:45 6:00	7:15 5:15	8:00 5:00
Mansfield.....	E	SR SS	8:00 5:30	7:30 6:00	6:45 6:30	6:00 7:15	5:15 7:45	5:00 8:00	5:15 8:00	5:45 7:30	6:15 6:45	6:45 6:15	7:15 5:15	7:45 5:00
Middleton, 39-30/84-21.....	E	SR SS	8:00 5:30	7:30 6:15	6:45 6:45	6:00 7:15	5:30 7:45	5:15 8:00	5:15 8:00	5:45 7:30	6:15 6:45	6:45 6:15	7:15 5:15	7:45 5:00
Piqua, 40-08/84-16.....	E	SR SS	8:00 5:30	7:30 6:15	6:45 6:45	6:00 7:15	5:15 7:45	5:00 8:15	5:15 8:00	5:45 7:45	6:15 6:45	6:45 6:00	7:15 5:15	7:45 5:15
Roscoe, 40-16/81-53.....	E	SR SS	7:45 5:30	7:15 6:00	6:45 6:30	5:45 7:00	5:15 7:30	5:00 8:00	5:15 8:00	5:30 7:30	6:00 6:45	6:30 5:45	7:15 5:15	7:45 5:00
Springfield, 39-56/83-50.....	E	SR SS	8:00 5:30	7:30 6:15	6:45 6:45	6:00 7:15	5:15 7:45	5:00 8:00	5:15 8:00	5:45 7:30	6:15 6:45	6:45 6:00	7:15 5:15	7:45 5:00
Toledo*.....	E	SR SS	8:00 5:30	7:30 6:00	6:45 6:45	6:00 7:15	5:15 7:45	5:00 8:15	5:15 8:15	5:45 7:45	6:15 6:45	6:45 6:00	7:30 5:15	8:00 5:00
Wooster, 40-47/81-54.....	E	SR SS	7:45 5:30	7:30 6:00	6:45 6:30	5:45 7:00	5:00 7:45	5:00 8:00	5:00 8:00	5:30 7:30	6:00 6:45	6:30 6:00	7:15 5:15	7:45 5:00
Youngstown*.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 8:00	4:45 8:00	5:30 7:30	6:00 6:30	6:30 5:45	7:15 5:00	7:45 5:00
<i>Oklahoma</i>														
Ardmore.....	C	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:30 5:15
Chickasha,* 35-02/97-56.....	C	SR SS	7:45 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	5:45 7:15	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:15
Duncan, 34-31/97-68.....	C	SR SS	7:45 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	5:45 7:15	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:15
Durant, 34-00/96-24.....	C	SR SS	7:30 5:45	7:15 6:15	6:30 6:30	6:00 7:00	5:30 7:15	5:15 7:45	5:30 7:45	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:15	7:30 5:15
Hobart, 35-01/99-05.....	C	SR SS	7:45 5:45	7:30 6:15	6:45 6:45	6:00 7:15	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:45	6:30 6:45	6:45 6:00	7:15 5:30	7:30 5:30
Lawton.....	C	SR SS	7:45 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:45 7:30	5:15 7:45	5:30 7:45	6:00 7:30	6:15 6:45	6:45 6:00	7:00 5:30	7:30 5:30
Norman.....	C	SR SS	7:45 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:30	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:15
Oklahoma City*.....	C	SR SS	7:45 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:30	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:15
Pauls Valley, 34-44/97-14.....	C	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:30 5:15
Seminole,* 35-14/96-40.....	C	SR SS	7:30 5:30	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:30	5:15 7:45	5:15 7:45	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:15	7:30 5:15
Stillwater, 36-05/97-03.....	C	SR SS	7:45 5:30	7:15 6:15	6:45 6:30	6:00 7:00	5:15 7:30	5:15 7:45	5:15 7:45	5:45 7:15	6:15 6:30	6:30 6:00	7:00 5:15	7:30 5:15
Tulsa*.....	C	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	6:00 7:00	5:15 7:30	5:00 7:45	5:15 7:45	5:45 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 5:15
<i>Oregon</i>														
Baker.....	P	SR SS	7:30 4:30	7:00 5:15	6:00 6:30	5:15 6:30	4:30 7:15	4:00 7:45	4:15 7:30	4:45 7:00	5:30 6:00	6:00 5:15	6:15 4:30	7:15 4:15
Corvallis.....	P	SR SS	7:45 5:00	7:15 5:45	6:30 6:15	5:30 7:00	4:45 8:00	4:30 8:00	4:45 8:00	5:15 8:00	6:00 6:30	6:30 5:30	7:15 4:45	7:45 4:30
Eugene, 44-03/123-03.....	P	SR SS	7:45 5:00	7:15 5:45	6:30 6:15	5:30 7:00	4:45 8:00	4:30 8:00	4:45 8:00	5:15 8:00	6:00 6:30	6:30 5:30	7:15 4:45	7:45 4:30
Medford, 42-21/122-54.....	P	SR SS	7:45 5:00	7:15 5:45	6:30 6:15	5:30 7:00	4:45 8:00	4:30 7:45	4:45 7:45	5:15 7:15	6:00 6:30	6:30 5:30	7:00 4:45	7:30 4:45
Portland*.....	P	SR SS	7:45 4:45	7:15 5:30	6:30 6:15	5:30 7:00	4:45 7:30	4:15 8:00	4:30 8:00	5:15 8:00	6:00 6:30	6:30 5:30	7:15 4:45	7:45 4:30

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Oregon—Continued</i>														
Roseburg.....	P	SR SS	7:45 5:00	7:15 5:45	6:30 6:15	5:30 7:00	4:45 7:30	4:30 8:00	4:45 7:45	5:15 7:15	5:45 6:30	6:30 5:30	7:00 4:45	7:45 4:45
Salem.....	P	SR SS	7:45 5:00	7:15 5:45	6:30 6:15	5:30 7:00	4:45 7:30	4:30 8:00	4:45 7:45	5:15 7:15	5:45 6:30	6:30 5:30	7:15 4:45	7:45 4:30
The Dalles.....	P	SR SS	7:15 4:45	7:15 5:30	6:15 6:15	5:15 6:45	4:30 7:30	4:15 8:00	4:30 7:45	5:00 7:15	5:45 6:15	6:15 5:15	4:30 4:30	7:45 4:15
<i>Pennsylvania</i>														
Allentown, 40-37/75-29.....	E	SR SS	7:30 5:00	7:00 5:30	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:30
Altoona*.....	E	SR SS	7:30 5:15	7:15 5:45	6:30 6:15	5:30 6:45	4:45 7:15	4:30 7:45	4:45 7:45	5:00 7:35	6:00 6:30	6:30 5:30	7:00 5:00	7:30 4:45
Apollo, 40-35/79-31.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	4:45 7:30	4:30 7:45	4:45 7:45	5:00 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 5:00
Bethlehem, 40-37/75-23.....	E	SR SS	7:30 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:30
Bloomsburg, 41-01/76-25.....	E	SR SS	7:30 4:45	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:45	4:45 7:45	5:15 7:00	5:45 6:15	6:15 5:30	7:00 4:45	7:30 4:30
Bradnock, 40-24/79-51.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 8:00	5:00 7:45	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 5:00
Butler.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 8:00	5:00 7:45	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 5:00
Chambersburg, 39-55/77-41.....	E	SR SS	7:30 5:15	7:00 5:45	6:30 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:45	5:00 7:15	5:45 6:15	6:15 5:30	7:00 5:00	7:30 4:45
Chester, 39-52/75-22.....	E	SR SS	7:15 5:00	7:00 5:45	6:15 6:15	5:15 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:00 7:00	5:30 6:15	6:00 5:30	6:45 4:45	7:15 4:30
Clearfield, 41-02/78-26.....	E	SR SS	7:45 5:15	7:15 5:45	6:30 6:15	5:30 7:00	4:45 7:30	4:30 7:45	4:45 7:45	5:00 7:15	6:00 6:30	6:30 5:30	7:00 5:00	7:30 4:45
Doylestown*, 40-18/75-08.....	E	SR SS	7:30 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:15	6:45 4:45	7:15 4:30
Erie*.....	F	SR SS	7:45 5:15	7:15 5:45	6:30 6:30	5:45 7:00	5:00 7:30	4:45 8:00	4:45 8:00	5:00 7:15	6:00 6:30	6:30 5:45	7:15 5:00	7:45 4:45
Glenside*.....	E	SR SS	7:15 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:30
Greensburg.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 7:45	5:00 7:45	6:00 7:15	6:30 6:45	7:00 6:15	7:30 5:00	8:00 4:45
Harrisburg*.....	E	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:45	5:15 7:00	6:00 6:15	6:30 5:30	7:00 4:45	7:30 4:45
Johnstown*.....	E	SR SS	7:45 5:15	7:15 5:45	6:30 6:15	5:45 7:15	5:00 7:30	4:45 7:30	5:00 7:45	6:00 7:15	6:30 6:30	7:00 5:30	7:30 4:45	8:00 4:45
Lebanon, 40-20/76-29.....	E	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:45	4:45 7:45	5:15 7:00	5:45 6:15	6:15 5:30	7:00 4:45	7:30 4:45
McKeesport, 40-18/79-50.....	F	SR SS	7:30 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 7:45	5:00 7:45	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 5:00
Nanticoke, 41-13/75-59.....	E	SR SS	7:30 5:00	7:00 5:30	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:45	4:45 7:45	5:15 7:00	5:45 6:15	6:15 5:30	7:00 4:45	7:30 4:30
New Castle.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 8:00	4:45 8:00	5:00 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 5:00
New Kensington*.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 7:45	4:45 7:45	5:00 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 4:45
Norristown, 40-08/75-18.....	E	SR SS	7:15 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:30
Philadelphia*.....	E	SR SS	7:15 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:30
Pittsburgh*.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 7:45	5:00 7:45	6:00 7:15	6:30 6:45	7:00 6:15	7:30 5:00	8:00 4:45
Reading*.....	E	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	6:00 6:15	6:30 5:30	7:00 4:45	7:30 4:45
Scranton*.....	E	SR SS	7:30 5:00	7:00 5:30	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:45	4:45 7:45	5:15 7:00	6:00 6:15	6:30 5:30	7:00 4:45	7:30 4:45
Shamokin 40-45/76-31.....	E	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:45	4:45 7:45	5:15 7:00	5:45 6:15	6:15 5:30	7:00 4:45	7:30 4:45
Sharon*.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 8:00	5:00 8:00	5:30 7:15	6:00 6:30	6:30 5:45	7:15 5:00	7:45 5:00
Stroudsburg, 40-58/75-11.....	E	SR SS	7:30 5:00	7:00 5:30	6:15 6:00	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:15	7:00 4:45	7:30 4:30
Uniontown.....	E	SR SS	7:45 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:00 7:30	4:45 7:45	5:00 7:45	6:00 7:15	6:30 6:45	7:00 6:30	7:30 5:00	8:00 4:45
Warren, 41-49/79-06.....	E	SR SS	7:45 5:15	7:15 5:45	6:30 6:15	5:45 7:00	5:00 7:30	4:45 8:00	4:45 7:45	5:15 7:15	6:00 6:30	6:30 5:30	7:00 5:00	7:45 4:45
York.....	E	SR SS	7:30 5:00	7:00 5:45	6:15 6:15	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
<i>Puerto Rico</i>														
San Juan.....	A	SR SS	7:00 6:15	7:00 6:30	6:30 6:30	6:15 6:45	5:45 6:45	5:45 7:00	6:00 7:00	6:00 6:15	6:15 6:30	6:15 6:00	6:30 5:45	6:45 5:45
Ponce.....	A	SR SS	7:00 6:15	7:00 6:30	6:30 6:30	6:15 6:45	5:45 6:45	5:45 7:00	6:00 7:00	6:15 6:30	6:15 6:00	6:15 6:30	6:30 5:45	6:45 5:00
Mayaguez.....	A	SR SS	7:00 6:15	7:00 6:30	6:30 6:45	6:15 6:45	5:45 7:00	5:45 7:00	6:00 7:15	6:15 7:00	6:30 6:30	6:00 6:00	6:30 5:45	6:00 6:00
<i>Rhode Island</i>														
Providence*.....	E	SR SS	7:15 4:45	6:45 5:15	6:00 5:45	5:00 6:30	4:30 7:00	4:15 7:30	4:15 7:15	4:45 6:45	5:30 6:00	6:00 5:00	6:30 4:30	7:00 4:15
<i>South Carolina</i>														
Charleston.....	E	SR SS	7:30 5:30	7:00 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:15 7:30	5:15 7:30	5:45 7:00	6:00 6:30	6:30 5:45	6:45 5:15	7:15 4:30
Columbia.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:30 6:30	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 4:45
Dillon, 34-22/79-24.....	E	SR SS	7:30 5:30	7:00 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:30	5:15 7:30	5:45 7:00	6:00 6:30	6:15 5:45	6:45 5:15	7:15 4:45
Florence, 34-13/70-47.....	E	SR SS	7:30 5:30	7:00 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:15 7:30	5:15 7:30	5:30 7:00	6:00 6:30	6:30 5:45	7:00 5:15	7:30 4:45
Gaffney, 35-02/81-38.....	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	5:30 7:00	4:45 7:30	4:30 7:45	4:45 7:45	5:15 7:15	6:00 6:30	6:30 6:00	7:00 5:15	7:30 4:45
Greenville.....	E	SR SS	7:45 5:45	7:15 6:15	6:45 6:30	5:30 7:00	4:45 7:30	4:30 7:45	4:45 7:45	5:15 7:15	6:00 6:45	6:30 6:00	7:00 5:15	7:30 4:45
Laurens, 34-30/82-01.....	F	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	5:30 7:00	4:45 7:30	4:30 7:45	4:45 7:45	5:15 7:15	6:00 6:45	6:30 6:00	7:00 5:15	7:30 4:45
Orangeburg* 33-29/80-51.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:30 7:00	4:45 7:15	4:30 7:30	4:45 7:45	5:15 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 4:45
Rock Hill* 35-56/81-01.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:30 7:00	4:45 7:15	4:30 7:45	4:45 7:45	5:15 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 4:45
Spartanburg.....	E	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	5:30 7:00	4:45 7:30	4:30 7:45	4:45 7:45	5:15 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 4:45
Sumter.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:30 6:45	4:45 7:15	4:30 7:30	4:45 7:30	5:15 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 4:45

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>South Dakota</i>														
Aberdeen	C	SR	8:15	7:45	6:45	5:45	5:00	4:45	5:00	5:30	6:15	6:45	7:30	8:00
		SS	5:15	6:00	6:45	7:15	8:00	8:30	8:15	7:45	6:45	5:45	5:00	4:45
Brookings	C	SR	8:00	7:30	6:45	5:45	5:00	4:45	5:00	5:30	6:00	6:45	7:15	8:00
		SS	5:15	6:00	6:30	7:15	7:45	8:15	8:15	7:30	6:45	5:45	5:00	4:45
Pierre	C	SR	8:15	7:45	7:00	6:00	5:15	5:00	5:15	5:45	6:15	7:00	7:30	8:15
		SS	5:30	6:15	6:45	7:30	8:00	8:30	8:30	7:45	7:00	6:00	5:15	5:00
Rapid City	M	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:15	6:00	6:30	7:15	7:45	7:30	7:00	6:00	5:15	4:30	4:15
Sioux Falls	C	SR	8:00	7:30	6:45	5:45	5:00	4:45	5:00	5:30	6:00	6:15	7:00	8:00
		SS	5:15	6:00	6:30	7:15	7:45	8:15	8:00	7:30	6:45	5:45	5:00	4:45
Vermillion	C	SR	8:00	7:30	6:45	5:45	5:00	4:45	5:00	5:30	6:00	6:45	7:15	7:45
		SS	5:15	6:00	6:30	7:15	7:45	8:15	8:00	7:30	6:45	5:45	5:00	5:00
Yankton	C	SR	8:00	7:30	6:45	5:45	5:15	4:45	5:00	5:30	6:15	6:45	7:15	8:00
		SS	5:15	6:00	6:30	7:15	7:45	8:15	8:00	7:30	6:45	5:45	5:15	5:00
<i>Tennessee</i>														
Chattanooga*	C	SR	6:45	6:30	6:00	5:15	4:45	4:30	4:30	5:00	5:30	5:45	6:15	6:45
		SS	4:45	5:30	5:45	6:15	6:30	7:00	7:00	6:30	5:45	5:15	4:30	4:30
Gnllatin,* 36-24/86-26	C	SR	7:00	6:30	6:00	5:15	4:45	4:30	4:30	5:00	5:30	6:00	6:30	6:45
		SS	5:00	5:30	6:00	6:15	6:45	7:00	7:00	6:45	6:00	5:15	4:45	4:30
Jackson	C	SR	7:00	6:45	6:15	5:30	4:45	4:45	4:45	5:15	5:30	6:00	6:30	7:00
		SS	5:00	5:30	6:00	6:30	6:45	7:15	7:15	6:45	6:00	5:15	4:45	4:45
Johnson City	C	SR	6:45	6:15	5:45	5:00	4:30	4:15	4:15	4:45	5:15	5:30	6:00	6:30
		SS	4:30	5:15	5:30	6:00	6:30	6:45	6:45	6:15	5:45	5:00	4:15	4:15
Knoxville*	C	SR	6:45	6:30	5:45	5:00	4:30	4:15	4:30	5:00	5:15	5:45	6:15	6:45
		SS	4:45	5:15	5:45	6:15	6:30	7:00	7:00	6:30	5:45	5:00	4:30	4:30
Memphis*	C	SR	7:15	6:45	6:15	5:30	5:00	4:45	5:00	5:15	5:45	6:00	6:30	7:00
		SS	5:15	5:45	6:00	6:30	7:00	7:15	7:15	6:45	6:15	5:30	5:00	4:45
Nashville*	C	SR	7:00	6:30	6:00	5:15	4:45	4:30	4:45	5:00	5:30	6:00	6:30	6:45
		SS	5:00	5:30	6:00	6:15	6:45	7:00	7:00	6:30	5:45	5:15	4:45	4:30
Paris, 36-16/88-17	C	SR	6:45	6:30	6:00	5:15	4:30	4:30	4:30	5:00	5:15	5:45	6:00	6:00
		SS	5:00	5:30	6:00	6:30	7:00	7:15	7:15	6:45	6:00	5:15	4:45	4:45
Pnlaski, 35-12/87-03	C	SR	7:00	6:30	6:00	5:15	4:45	4:30	4:45	5:00	5:30	6:00	6:30	6:45
		SS	4:45	5:30	6:00	6:15	6:45	7:00	7:00	6:30	6:00	5:15	4:45	4:30
Tullahoma, 35-21/86-13	C	SR	7:00	6:30	6:00	5:15	4:45	4:30	4:45	5:00	5:30	5:45	6:15	6:45
		SS	5:00	5:30	5:45	6:15	6:45	7:00	7:00	6:30	6:00	6:15	4:45	4:30
<i>Texas</i>														
Alice, 27-47/98-04	C	SR	7:30	7:15	6:45	6:00	5:45	5:30	5:45	6:00	6:15	6:30	7:00	7:15
		SS	6:00	6:15	6:45	7:00	7:15	7:30	7:30	7:15	6:45	6:00	5:45	5:30
Amarillo	C	SR	8:00	7:30	7:00	6:15	5:45	5:30	5:45	6:00	6:30	7:00	7:15	7:45
		SS	5:00	5:30	6:00	7:15	7:30	8:00	8:00	7:30	6:45	6:00	5:15	5:00
Athens,* 32-12/95-51	C	SR	7:30	7:00	6:30	6:00	5:30	5:15	5:30	5:45	6:00	6:30	7:00	7:15
		SS	5:45	6:15	6:30	7:00	7:15	7:30	7:30	7:15	6:30	5:45	5:30	5:15
Austin,* 30-16/97-44	C	SR	7:30	7:15	6:45	6:00	5:30	5:30	5:45	6:00	6:15	6:30	7:00	7:15
		SS	5:45	6:15	6:45	7:00	7:15	7:30	7:30	7:15	6:45	6:00	5:30	5:30
Beaumont, 30-03/94-06	C	SR	7:15	7:00	6:30	5:45	5:30	5:15	5:30	5:45	6:00	6:15	6:45	7:00
		SS	5:45	6:00	6:30	6:45	7:00	7:15	7:15	7:00	6:15	5:45	5:15	5:15
Bonham,* 33-35/96-10	C	SR	7:30	7:15	6:30	6:00	5:30	5:15	5:30	5:45	6:00	6:30	7:00	7:15
		SS	5:45	6:15	6:30	7:00	7:15	7:30	7:30	7:15	6:30	5:45	5:15	5:15
Brady	C	SR	7:30	7:15	6:45	6:15	5:45	5:30	5:45	6:00	6:15	6:45	7:00	7:30
		SS	6:00	6:30	6:45	7:00	7:30	7:45	7:45	7:15	6:45	6:00	5:45	5:30
Breckenridge, 32-44/98-55	C	SR	7:45	7:15	6:45	6:00	5:30	5:30	5:30	6:00	6:15	6:45	7:00	7:30
		SS	5:45	6:15	6:45	7:00	7:30	7:45	7:45	7:15	6:45	6:00	5:30	5:30
Brenham, 30-10/96-24	C	SR	7:30	7:00	6:30	6:00	5:30	5:30	5:30	5:45	6:15	6:30	6:45	7:15
		SS	5:45	6:15	6:30	7:00	7:15	7:30	7:30	7:15	6:30	6:00	5:30	6:30
Brownsville	C	SR	7:15	7:00	6:45	6:15	5:45	5:30	5:45	6:00	6:15	6:30	6:45	7:15
		SS	6:00	6:30	6:45	7:00	7:15	7:30	7:30	7:00	6:30	6:00	5:45	5:45
Canyon, 34-59/101-58	C	SR	8:00	7:30	7:00	6:15	5:45	5:30	5:45	6:00	6:30	7:00	7:15	7:45
		SS	6:00	6:30	7:00	7:15	7:45	8:00	8:00	7:30	7:00	6:15	5:45	5:30
Childress, 35-25/100-13	C	SR	7:45	7:30	6:45	6:00	5:30	5:30	5:30	6:00	6:15	6:45	7:15	7:30
		SS	5:45	6:15	6:45	7:15	7:30	8:00	8:00	7:30	6:45	6:00	5:30	5:30
Cleburne, 32-23/97-24	C	SR	7:30	7:15	6:45	6:00	5:30	5:15	5:30	5:45	6:15	6:30	7:00	7:30
		SS	5:45	6:15	6:30	7:00	7:15	7:45	7:45	7:15	6:30	6:00	5:30	5:30
Coleman, 31-51/99-25	C	SR	7:30	7:15	6:45	6:15	5:45	5:30	5:45	6:00	6:15	6:45	7:00	7:30
		SS	6:00	6:30	6:45	7:00	7:30	7:45	7:45	7:15	6:45	6:00	5:45	5:30
College Station	C	SR	7:30	7:15	6:30	6:00	5:30	5:15	5:30	5:45	6:15	6:30	6:45	7:15
		SS	5:45	6:15	6:30	6:45	7:15	7:30	7:30	7:15	6:30	6:00	5:30	6:30
Corpus Christi	C	SR	7:30	7:15	6:45	6:00	5:45	5:30	5:45	6:00	6:15	6:30	6:45	7:15
		SS	6:00	6:15	6:45	7:00	7:15	7:30	7:30	7:15	6:30	6:00	5:45	5:30
Dalhart,* 30-04/102-31	C	SR	8:00	7:45	7:00	6:15	5:45	5:30	5:45	6:00	6:30	7:00	7:30	8:00
		SS	6:00	6:30	7:00	7:30	7:45	8:15	8:15	7:45	7:00	6:15	5:45	5:30
Dallas*	C	SR	7:30	7:15	6:45	6:00	5:30	5:15	5:30	5:45	6:15	6:30	7:00	7:30
		SS	5:45	6:15	6:30	7:00	7:15	7:30	7:30	7:15	6:30	6:00	5:30	5:15
Dublin	C	SR	7:30	7:15	6:45	6:00	5:30	5:30	5:30	6:00	6:15	6:30	7:00	7:30
		SS	5:45	6:15	6:45	7:00	7:30	7:45	7:45	7:15	6:45	6:00	5:30	5:30
Dumas,* 35-51/101-58	C	SR	8:00	7:30	7:00	6:15	5:45	5:30	5:45	6:00	6:30	7:00	7:30	7:45
		SS	6:00	6:30	7:00	7:15	7:45	8:00	8:00	7:45	7:00	6:15	5:45	5:30
Eastland 32-24/98-46	C	SR	7:30	7:15	6:45	6:00	5:30	5:15	5:30	6:00	6:15	6:30	7:00	7:30
		SS	5:45	6:15	6:45	7:00	7:30	7:45	7:45	7:15	6:45	6:00	5:30	5:30
Edinburg, 26-20/98-09	C	SR	7:30	7:15	6:45	6:15	5:45	5:30	5:45	6:00	6:15	6:30	7:00	7:15
		SS	6:00	6:30	6:45	7:00	7:15	7:30	7:30	7:15	6:45	6:00	5:45	5:45
El Campo 29-12/96-15	C	SR	7:15	7:00	6:30	6:00	5:30	5:30	5:30	6:00	6:15	6:30	6:45	7:15
		SS	5:45	6:15	6:30	7:00	7:15	7:30	7:30	7:15	6:30	6:00	5:30	5:30
El Paso*	C	SR	8:00	7:45	7:15	6:45	6:15	6:00	6:15	6:30	6:45	7:15	7:30	8:00
		SS	6:30	6:45	7:15									

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Texas—Continued</i>														
Lufkin.....	C	SR SS	7:15 5:45	7:00 6:00	6:30 6:45	6:00 6:45	5:30 7:15	5:15 7:30	5:30 7:30	5:45 7:00	6:00 6:30	6:15 6:45	6:45 5:15	7:15 5:15
McKinney, 33-11/66-39.....	C	SR SS	7:30 5:45	7:15 6:15	6:30 6:30	6:45 7:00	5:30 7:15	5:15 7:45	5:30 7:45	5:45 7:15	6:15 6:30	6:30 6:00	6:50 5:30	7:30 5:30
Midland, 31-58/102-06.....	C	SR SS	7:45 6:00	7:30 6:30	7:00 6:30	7:15 6:45	5:45 7:00	5:45 7:45	5:45 8:00	6:15 7:30	6:30 7:00	6:15 6:45	6:15 5:45	7:00 7:30
Mineral Wells, 32-47/98-06.....	C	SR SS	7:30 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:15	6:15 6:45	6:30 6:00	5:30 6:00	5:30 5:30
Nacogdoches, 31-36/94-37.....	C	SR SS	7:15 5:30	7:00 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:15 7:30	5:45 7:30	6:00 7:00	6:15 6:30	6:15 5:45	6:45 5:15	7:15 5:15
Oak Cliff, 32-43/96-47.....	C	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:15	5:15 7:30	5:45 7:15	6:15 7:30	6:30 6:00	7:00 6:00	7:00 5:30	7:15 5:15
Odessa, 31-46/102-21.....	C	SR SS	7:45 6:15	7:30 6:30	7:00 7:00	6:30 7:30	5:45 7:45	5:15 8:00	5:45 8:00	6:15 7:45	6:30 7:00	7:00 6:15	7:15 5:45	7:45 5:45
Orange, 30-08/93-45.....	C	SR SS	7:15 5:30	7:00 6:00	6:30 6:30	6:45 7:00	5:15 6:30	5:15 6:30	5:30 6:00	5:45 6:00	6:00 6:15	6:15 5:45	6:45 5:15	7:00 7:15
Palestine.....	C	SR SS	7:30 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:15	5:15 7:30	5:30 7:30	5:45 7:00	6:00 6:30	6:15 5:45	6:30 5:30	6:45 5:15
Plainview.....	C	SR SS	8:00 6:00	7:30 6:30	7:00 7:00	6:15 7:15	5:45 7:45	5:00 8:00	5:45 8:00	6:00 7:30	6:30 7:00	6:45 6:15	7:15 5:15	7:45 5:15
Port Arthur.....	C	SR SS	7:15 5:30	7:00 6:00	6:30 6:15	5:45 6:30	5:15 7:00	5:15 7:15	5:45 7:00	6:00 6:15	6:15 5:45	6:30 5:45	6:30 5:15	7:00 7:15
San Angelo, 31-29/100-28.....	C	SR SS	7:45 6:00	7:30 6:30	7:00 6:45	6:15 7:15	5:45 7:30	5:30 7:45	5:45 7:30	6:00 6:45	6:15 6:15	6:45 5:45	7:15 5:45	7:30 5:45
San Antonio*.....	C	SR SS	7:30 6:00	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:15 5:15
Sherman.....	C	SR SS	7:30 5:45	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:15	5:15 7:45	5:30 7:45	6:00 7:15	6:15 6:30	6:30 6:00	5:30 6:00	5:15 7:30
Stephenville, 32-13/98-13.....	C	SR SS	7:30 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:30 7:45	5:30 7:45	6:00 7:15	6:15 6:45	6:30 6:00	7:00 5:30	7:30 5:30
Taylor, * 30-34/97-24.....	C	SR SS	7:30 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:15	5:30 7:30	5:30 7:30	6:00 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:15 5:30
Texas City, 29-25/94-56.....	C	SR SS	7:15 5:45	7:00 6:15	6:30 6:30	6:00 6:45	5:30 7:00	5:15 7:15	5:30 7:15	5:45 7:00	6:00 6:30	6:15 5:45	7:00 5:30	7:00 5:15
Tyler, 32-19/95-17.....	C	SR SS	7:30 6:00	7:00 6:30	6:30 6:30	6:00 6:45	5:30 7:15	5:15 7:30	5:15 6:00	5:45 6:45	6:00 6:15	6:30 6:00	6:45 5:30	7:15 7:15
Victoria.....	C	SR SS	7:30 6:00	7:15 6:15	6:45 6:30	6:00 7:00	5:30 7:15	5:30 7:30	5:45 7:30	6:00 7:15	6:15 6:30	6:30 6:00	7:00 5:30	7:30 7:15
Wichita Falls.....	C	SR SS	7:45 5:45	7:15 6:15	6:45 6:45	6:00 7:00	5:30 7:30	5:15 7:45	5:30 7:45	6:00 7:15	6:15 6:45	6:45 6:00	7:00 5:30	7:30 5:30
<i>Territory of Hawaii</i>														
Honolulu (local).....	SR SS		6:45 5:45	6:30 6:00	6:15 6:15	5:45 6:15	5:30 6:30	5:15 6:45	5:30 6:45	5:45 6:30	5:45 6:00	6:00 5:30	6:15 5:15	6:30 5:15
<i>Utah</i>														
Blanding*, 37-37/109-29.....	M	SR SS	7:30 5:15	7:15 6:00	6:30 6:30	5:45 7:00	5:15 7:15	5:00 7:45	5:00 7:45	5:30 7:15	6:00 5:30	6:30 5:45	7:00 5:00	7:30 5:00
Brigham City, 41-31/112-02.....	P	SR SS	7:00 4:15	6:30 5:00	6:00 6:15	5:45 6:45	4:15 6:45	3:45 7:00	4:30 7:00	4:30 6:30	5:00 5:45	5:45 4:45	6:15 4:45	6:45 4:00
Ogden.....	M	SR SS	8:00 5:30	7:30 6:00	6:45 6:30	5:45 7:00	5:15 7:45	5:00 8:00	5:00 8:00	5:30 7:30	6:15 6:45	6:45 5:45	7:15 5:15	7:45 5:00
Provo, 40-12/111-40.....	M	SR SS	7:45 5:30	7:15 6:00	6:45 6:30	5:45 7:00	5:15 8:00	5:00 8:00	5:15 8:00	5:30 7:30	6:00 6:30	6:30 5:45	7:15 5:15	7:45 5:00
Richfield, 38-45/112-04.....	M	SR SS	7:45 5:30	7:15 6:00	6:45 6:30	5:45 7:00	5:15 8:00	5:00 8:00	5:15 8:00	5:30 7:30	6:15 6:45	6:45 5:45	7:15 5:15	7:45 5:00
Salt Lake City*.....	M	SR SS	7:45 5:30	7:30 6:00	6:45 6:30	5:45 7:00	5:15 8:00	5:00 8:00	5:15 8:00	5:30 7:30	6:15 6:45	6:45 5:45	7:15 5:15	7:45 5:00
<i>Vermont</i>														
Burlington, 44-31/73-12.....	E	SR SS	7:30 4:45	7:00 5:15	6:00 6:00	5:00 6:30	4:30 7:15	4:00 7:45	4:15 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:30 4:15
Rutland.....	E	SR SS	8:00 5:00	7:00 6:00	6:15 6:00	5:15 6:30	4:30 7:00	4:15 7:15	4:30 7:15	5:00 6:45	5:45 6:00	6:15 5:15	7:00 4:45	7:30 4:30
Springfield.....	E	SR SS	7:15 4:45	6:45 5:15	6:00 6:00	5:15 6:30	4:30 7:00	4:15 7:30	4:15 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
St. Albans.....	E	SR SS	7:30 4:30	7:00 5:15	6:15 6:00	5:15 6:30	4:30 7:15	4:00 7:45	4:15 7:30	5:00 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:30 4:15
Waterbury.....	E	SR SS	7:30 4:30	7:00 5:15	6:00 6:00	5:15 6:30	4:30 7:15	4:00 7:30	4:15 7:30	4:45 7:00	5:30 6:00	6:00 5:15	6:45 4:30	7:15 4:15
<i>Virginia</i>														
Bristol, 35-59/82-11.....	C	SR SS	6:45 4:30	6:15 5:15	5:45 5:30	5:00 6:30	4:15 6:45	4:00 6:45	4:15 6:45	4:45 6:15	5:15 5:45	5:30 5:00	6:00 4:15	6:30 4:15
Crewe, 37-11/78-10.....	E	SR SS	7:30 5:15	7:00 5:45	6:30 6:15	5:45 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 5:00	7:15 5:00
Danville.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:30	5:15 7:30	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 5:00
Farmville, 37-19/78-23.....	E	SR SS	7:30 5:15	7:00 6:45	6:30 6:15	5:45 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:30	6:15 5:45	6:45 5:00	7:15 5:00
Fredericksburg.....	E	SR SS	7:30 5:15	7:00 5:45	6:30 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 5:00	7:15 4:45
Harrisonburg.....	E	SR SS	7:30 5:15	7:15 6:30	6:30 6:15	5:45 6:45	5:00 7:15	4:45 7:45	5:00 7:45	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 5:00
Lynchburg, 37-24/79-09.....	E	SR SS	7:30 5:15	7:15 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:45	5:00 7:45	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:00	7:30 5:00
Martinsville.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:45	5:15 7:45	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 5:00
Norfolk*.....	E	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:00	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 4:45	7:15 4:45
Petersburg.....	E	SR SS	7:30 5:15	7:00 6:15	6:30 6:15	5:45 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:30 5:30	7:00 5:00	7:30 5:00
Portsmouth, 36-52/76-21.....	E	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:15 7:00	5:45 6:15	6:15 5:30	6:45 5:00	7:15 4:45
Richmond*.....	E	SR SS	7:30 5:15	7:00 5:45	6:30 6:15	5:30 6:45	5:00 7:15	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 5:00	7:15 5:00
Roanoke*.....	E	SR SS	7:30 5:30	7:15 6:00	6:30 6:30	5:45 6:45	5:15 7:15	5:00 7:45	5:15 7:45	5:30 7:15	6:00 6:30	6:30 5:45	7:00 5:15	7:30 5:00
Suffolk.....	E	SR SS	7:15 5:15	7:00 5:45	6:15 6:15	5:30 6:45	5:00 7:00	4:45 7:30	5:00 7:30	5:30 7:00	6:00 6:15	6:15 5:30	6:45 5:00	7:15 4:45
<i>Washington</i>														
Everett.....	P	SR SS	8:00 4:45	7:15 5:30	6:30 6:15	5:15 7:00	4:30 7:45	4:15 8:15	4:30 8:00	5:00 7:30	5:45 6:30	6:30 5:15	7:15 4:30	7:45 4:45
Kirkland, 47-40/122-12.....	P	SR SS	8:00 4:45	7:15 5:30	6:30 6:15	5:30 7:00	4:30 8:15	4:15 8:00	4:30 8:00	5:00 7:15	5:45 6:30	6:30 5:30	7:15 4:15	7:45 4:15
Mount Vernon.....	P	SR SS	8:00 4:45	7:15 5:30	6:30 6:15	5:15 7:00	4:30 7:45	4:00 8:15	4:15 8:00	5:00 7:30	5:45 6:30	6:30 5:30	7:15 4:30	7:45 4:15
Olympia.....	P	SR SS	8:00 4:45	7:15 5:30	6:30 6:15	5:30 7:00	4:30 7:45	4:15 8:15	4:30 8:00	5:00 7:30	5:45 6:30	6:30 5:30	7:15 4:45	7:45 4:15
Omak, 48-23/119-32.....	P	SR SS	7:45 4:30	7:15 5:15	6:15 6:00	5:15 6:45	4:15 7:30	3:45 8:00	4:15 8:00	4:45 7:15	5:30 6:15	6:15 5:15	7:00 4:00	7:45 4:00
Pullman.....	P	SR SS	7:30 4:30	7:00 5:15	6:00 6:30	5:00 7:15	4:15 7:45	4:00 8:00	4:15 7:45	4:45 7:00	5:30 6:00	6:15 5:00	6:45 4:15	7:30 4:00
Renton, 47-29/122-12.....	P	SR SS	8:00 4:45	7										

	TZ	SR SS	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Washington—Continued</i>														
Seattle*	P	SR	8:00	7:15	6:30	5:30	4:30	4:15	4:30	5:00	5:45	6:30	7:15	7:45
		SS	4:45	5:30	6:15	7:00	7:45	8:15	8:00	7:30	6:30	5:30	4:30	4:15
Spokane*	P	SR	7:30	7:00	6:00	5:00	4:15	3:45	4:00	4:45	5:30	6:15	7:00	7:30
		SS	4:30	5:15	6:00	6:45	7:15	7:45	7:45	7:00	6:00	5:00	4:15	4:00
Tacoma*	P	SR	8:00	7:15	6:30	5:30	4:30	4:15	4:30	5:00	5:45	6:30	7:15	7:45
		SS	4:45	5:30	6:15	7:00	7:45	8:15	8:00	7:30	6:30	5:30	4:30	4:15
Vancouver*	P	SR	7:45	7:15	6:30	5:30	4:45	4:15	4:30	5:15	5:45	6:30	7:15	7:45
		SS	4:45	5:30	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	4:45	4:30
Walla Walla, 46-04/118-24	P	SR	7:30	7:00	6:15	5:15	4:30	4:00	4:15	5:00	5:30	6:15	6:45	7:30
		SS	4:30	5:15	6:00	6:45	7:15	7:45	7:45	7:00	6:00	5:15	4:30	4:15
Wenatchee	P	SR	7:45	7:15	6:15	5:15	4:30	4:00	4:15	5:00	5:30	6:15	7:00	7:45
		SS	4:30	5:30	6:00	6:45	7:30	8:00	8:00	7:15	6:15	5:15	4:30	4:15
Yakima	P	SR	7:45	7:15	6:15	5:15	4:30	4:00	4:15	5:00	5:45	6:15	7:00	7:45
		SS	4:45	5:30	6:00	6:45	7:30	8:00	8:00	7:15	6:15	5:15	4:30	4:15
<i>West Virginia</i>														
Bluefield	E	SR	7:45	7:15	6:45	5:45	5:15	5:00	5:15	5:45	6:00	6:30	7:00	7:30
		SS	5:30	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:15	5:15
Charleston*	E	SR	7:45	7:15	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:30	7:15	7:30
		SS	5:30	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:15	5:15
Clarksburg, 39-14/80-23	E	SR	7:45	7:15	6:30	5:45	5:15	5:00	5:00	5:30	6:00	6:30	7:00	7:30
		SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:00	5:00
Fairmont	E	SR	7:45	7:15	6:30	5:45	5:15	4:45	5:00	5:30	6:00	6:30	7:00	7:30
		SS	5:15	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:00	5:00
Huntington*	E	SR	7:45	7:15	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:45	7:15	7:45
		SS	5:30	6:00	6:30	7:00	7:30	8:00	8:00	7:30	6:45	6:00	5:15	5:15
Logan	E	SR	7:45	7:15	6:45	6:00	5:15	5:00	5:15	5:45	6:15	6:30	7:15	7:30
		SS	5:30	6:00	6:30	7:00	7:30	7:45	7:45	7:30	6:45	6:00	5:15	5:15
Oak Hill, 37-57/81-08	E	SR	7:45	7:15	6:30	5:45	5:15	5:00	5:15	5:45	6:00	6:30	7:00	7:30
		SS	5:30	6:00	6:30	7:00	7:30	7:45	7:45	7:15	6:30	5:45	5:15	5:00
Wheeling*	E	SR	7:45	7:15	6:30	5:45	5:15	5:00	5:00	5:30	6:00	6:30	7:15	7:45
		SS	5:15	6:00	6:30	7:00	7:30	8:00	8:00	7:15	6:30	5:45	5:15	5:00
<i>Wisconsin</i>														
Beloit,* 42-30/89-02	C	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	6:45	7:15
		SS	4:45	5:30	6:00	6:45	7:15	7:30	7:30	7:00	6:15	5:15	4:30	4:15
Eu Claire	C	SR	7:45	7:15	6:15	5:30	4:45	4:15	4:30	5:00	5:45	6:15	7:00	7:30
		SS	4:45	5:30	6:15	6:45	7:30	8:00	8:00	7:15	6:15	5:30	4:45	4:30
Greenbay	C	SR	7:30	7:00	6:15	5:15	4:30	4:00	4:15	5:00	5:30	6:00	6:45	7:15
		SS	4:30	5:15	6:00	6:30	7:15	7:45	7:30	7:00	6:00	5:15	4:30	4:15
Kenosha, 42-35/87-49	C	SR	7:15	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:15	6:00	6:30	7:00	7:30	7:30	7:00	6:00	5:15	4:30	4:15
La Crosse	C	SR	7:45	7:00	6:15	5:30	4:45	4:15	4:30	5:15	5:45	6:15	7:00	7:30
		SS	4:45	5:30	6:15	6:45	7:30	7:45	7:45	7:15	6:15	5:30	4:45	4:30
Madison	C	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	6:45	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:30	7:00	6:15	5:15	4:30	4:30
Marinette	C	SR	7:30	7:00	6:00	5:15	4:15	4:00	4:15	4:45	5:30	6:00	6:45	7:30
		SS	4:30	5:15	6:00	6:30	7:15	7:45	7:30	7:00	6:00	5:15	4:30	4:15
Milwaukee*	C	SR	7:30	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:15	6:00	6:30	7:15	7:30	7:30	7:00	6:00	5:15	4:30	4:15
Neenah, 44-09/88-25	C	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:15	5:00	5:30	6:00	6:45	7:30
		SS	4:45	5:15	6:00	6:30	7:15	7:45	7:30	7:00	6:00	5:15	4:30	4:15
Racine*	C	SR	7:15	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:15	6:00	6:30	7:00	7:30	7:30	7:00	6:00	5:15	4:30	4:15
Rice Lake	C	SR	7:45	7:15	6:30	5:30	4:45	4:15	4:30	5:00	5:45	6:15	7:00	7:45
		SS	4:45	5:30	6:15	6:45	7:30	8:00	8:00	7:15	6:15	5:30	4:45	4:30
Rolling, 45-06/89-08	C	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:15	5:00	5:30	6:15	7:00	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:15
Sheboygan	C	SR	7:30	6:45	6:00	5:15	4:30	4:15	4:15	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:15	6:00	6:30	7:15	7:30	7:30	7:00	6:00	5:15	4:30	4:15
Stevens Point	C	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	7:00	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:15
Waukesha, 43-01/88-15	C	SR	7:30	6:45	6:00	5:15	4:30	4:15	4:30	5:00	5:30	6:00	6:45	7:15
		SS	4:45	5:30	6:00	6:30	7:15	7:30	7:30	7:00	6:00	5:15	4:30	4:15
Wisconsin Rapids	C	SR	7:30	7:00	6:15	5:15	4:30	4:15	4:30	5:00	5:30	6:15	7:00	7:30
		SS	4:45	5:30	6:00	6:45	7:15	7:45	7:45	7:00	6:15	5:15	4:30	4:15
<i>Wyoming</i>														
Cheyenne	M	SR	7:30	7:00	6:15	5:15	4:45	4:30	4:45	5:00	5:45	6:15	6:45	7:15
		SS	5:00	5:30	6:00	6:45	7:15	7:30	7:30	7:00	6:15	5:15	4:45	4:30
Powell, 44-47/108-47	M	SR	7:45	7:15	6:30	5:30	4:45	4:30	4:45	5:15	5:45	6:30	7:15	7:45
		SS	5:00	5:45	6:15	7:00	7:30	8:00	8:00	7:30	6:30	5:30	4:45	4:30
Rock Springs, 41-37/109-14	M	SR	7:45	7:15	6:30	5:45	5:00	4:45	5:00	5:30	6:00	6:30	7:00	7:45
		SS	5:15	5:45	6:15	7:00	7:30	8:00	8:00	7:15	6:30	5:30	5:00	4:45
Sheridan, 44-48/106-57	M	SR	7:45	7:15	6:15	5:30	4:45	4:15	4:30	5:15	5:45	6:15	7:00	7:45
		SS	4:45	5:30	6:15	6:45	7:30	8:00	8:00	7:15	6:15	5:30	4:45	4:30

[F. R. Doc. 48-5104; Filed, June 4, 1948; 12:24 p. m.]

APPENDIX I

GROUNDWAVE FIELD INTENSITY CHARTS

Graphs 1-20 show the computed values of groundwave field intensity as a function of the distance from the transmitting antenna. The groundwave field intensity is here considered to be that part of the vertical component of the electric field received on the ground which has not been reflected from the ionosphere nor the troposphere. These 20 charts were computed for 20 different frequencies, a dielectric constant of the ground equal to 15 for land and 80 for sea water (referred to air as unity) and for the ground conductivities (expressed in electromagnetic units $\times 10^{14}$ or expressed in mhos per meter $\times 10^3$) given on the curves. The curves show the variation of the groundwave field intensity with distance to be expected for transmission from a short vertical antenna at the surface of a uniformly conducting spherical earth with the ground constants shown on the curves; the curves are for an antenna power and efficiency such that the inverse distance field is 100 mv/m at 1 mile. The curves are valid at distances large compared to the dimensions of the antenna for other than short vertical antennas.

The inverse distance field (100 mv/m divided by the distance in miles) corresponds to the groundwave field intensity to be expected from an antenna with the same radiation efficiency when it is located over a perfectly conducting earth. To determine the value of the groundwave field intensity corresponding to a value of inverse distance field other than 100 mv/m at 1 mile, simply multiply the field intensity as given on these charts by the desired value of inverse distance field at 1 mile divided by 100; for example, to determine the groundwave field intensity for a station with an inverse distance field of 1700 mv/m at 1 mile, simply multiply the values given on the charts by 17. The value of the inverse distance field to be used for a particular antenna depends upon the power input to the antenna, the nature of the ground in the neighborhood of the antenna, and the geometry of the antenna. For methods of calculating the interrelations between

these variables and the inverse distance field, see "The Propagation of Radio Waves Over the Surface of the Earth and in the Upper Atmosphere," Part II, by Mr. K. A. Norton, Proc. I. R. E., Vol. 25, September 1937, pp. 1203-1236.

At sufficiently short distances (say less than 35 miles), such that the curvature of the earth does not introduce an additional attenuation of the waves, the graphs were computed by means of the plane earth formulas given in the paper, "The Propagation of Radio Waves Over the Surface of the Earth and in the Upper Atmosphere," Part I, by Mr. K. A. Norton, Proc. I. R. E., Vol. 24, October 1936, pp. 1367-1387. At larger distances the additional attenuation of the waves which is introduced by the effect of the curvature of the earth was introduced by the methods outlined in the papers, "The Diffraction of Electromagnetic Waves from an Electrical Point Source round a Finitely Conducting Sphere, with Applications to Radiotelegraphy and the Theory of the Rainbow," by Balth van der Pol and H. Bremmer, Part I, Phil. Mag., Vol. 24, p. 141, July 1937, Part II, Phil. Mag., Vol. 24, p. 825, Suppl., November 1937, "Ergebnisse einer Theorie über die Fortpflanzung elektromagnetischer Wellen über eine Kugel endlicher Leitfähigkeit," by Balth van der Pol and H. Bremmer, Hochfrequenztechnik und Elektroakustik, Band 51, Heft 6, June 1938, "Further Note on the Propagation of Radio Waves over a Finitely Conducting Spherical Earth," by Balth van der Pol and H. Bremmer, Phil. Mag., Vol. 27, p. 261, March 1939. In order to allow for the refraction of the radio waves in the lower atmosphere due to the variation of the dielectric constant of the air with height above the earth, a radius of the earth equal to $4/3$ the actual radius was used in the computations for the effect of the earth's curvature in the manner suggested by C. R. Burrows, "Radio Propagation over Spherical Earth," Proc. I. R. E., May 1935; i. e., the distance corresponding to a given value of attenuation due to the curvature of the earth in the absence of air refraction was multiplied by the factor $(4/3)^3 = 1.21$. The amount of this refraction varies from day to day and from season to season, depending on the air mass

conditions in the lower atmosphere. If k denotes the ratio between the equivalent radius of the earth and the true radius, the following table gives the values of k for several typical air masses encountered in the United States.

Air mass type	k	
	Summer	Winter
Tropical Gulf— T_1	1.53	1.43
Polar Continental— P_1	1.31	1.25
Superior— S_1	1.25	1.25
Average.....	1.33	

It is clear from this table that the use of the average value of $k=4/3$ is justified in obtaining a single correction for the systematic effects of atmospheric refraction.

Provided the value of the dielectric constant is near 15, the curves of Graphs 1-20 may be compared with experimental data to determine the appropriate values of the ground conductivity and of the inverse distance field intensity at 1 mile. This is accomplished simply by plotting the measured fields on transparent log-log graph paper similar to that used for Graphs 1-20 and superimposing this chart over the Graph corresponding to the frequency involved. The log-log graph sheet is then shifted vertically until the best fit is obtained with one of the curves on the Graph; the intersection of the inverse distance line on the graph with the 1-mile abscissa on the chart determines the inverse distance field intensity at 1 mile. For other values of dielectric constant, the following procedure may be used for a determination of the dielectric constant of the ground, conductivity of the ground and the inverse distance field intensity at 1 mile. Graph 21 gives the relative values of groundwave field intensity over a plane earth as a function of the numerical distance p and phase angle b . On graph paper with coordinates similar to those of Graph 21, plot the measured values of field intensity as ordinates versus the corresponding distances from the antenna expressed in miles as abscissae. The data should be plotted only for distances greater than one wavelength (or, when this is greater, five times the vertical height of the antenna in the case of a single element, i. e.,

nondirectional antenna or 10 times the spacing between the elements of a directional antenna) and for distances less than $50/f_{mc}^{\frac{1}{2}}$ miles (i. e., 50 miles at 1 mc). Then, using a light box, place the sheet with the data plotted on it over the sheet with the curves of Graph 21 and shift the data sheet vertically and horizontally (making sure that the vertical lines on both sheets are parallel) until the best fit with the data is obtained with one of the curves on Graph 21. When the two sheets are properly lined up, the value of the field intensity corresponding to the intersection of the inverse distance line of Graph 21 with the 1 mile abscissa on the data sheet is the inverse distance field intensity at 1 mile, and the values of the numerical distance at 1 mile, p_1 , and of b are also determined. Knowing the values of b and p_1 (the numerical distance at 1 mile), we may substitute in the following approximate formulas to determine the appropriate values of the ground conductivity and dielectric constant.

$$x \cong \frac{\pi}{p_1} (R/\lambda)_1 \cos b \quad (1)$$

$(R/\lambda)_1$ = Number of wavelengths in 1 mile.

$$\sigma_{e. m. u.} = \frac{x f_{mc}}{17.9731} \cdot 10^{-14} \quad (2)$$

$\sigma_{e. m. u.}$ = Conductivity of the ground expressed in electromagnetic units.

f_{mc} = frequency expressed in megacycles.

$$\epsilon \cong x \tan b - 1 \quad (3)$$

ϵ = dielectric constant of the ground referred to air as unity.

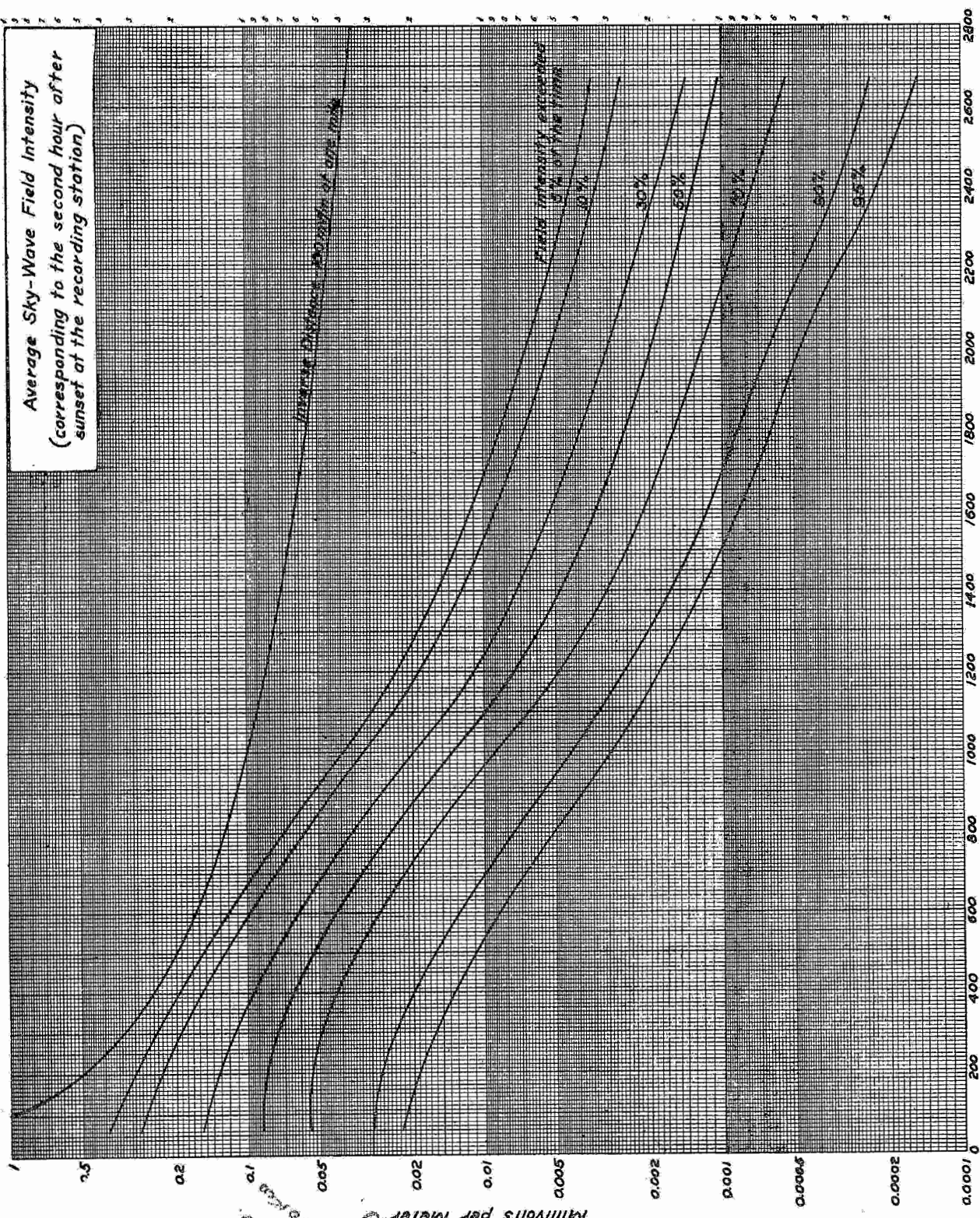
First solve for x by substituting the known values of p_1 , $(R/\lambda)_1$, and $\cos b$ in equation (1). Equation (2) may then be solved for σ and equation (3) for ϵ . At distances greater than $50/f_{mc}^{\frac{1}{2}}$ miles the curves of Graph 21 do not give the correct relative values of field intensity since the curvature of the earth weakens the field more rapidly than these plane earth curves would indicate. Thus, no attempt should be made to fit experimental data to these curves at the larger distances.

At sufficiently short distances (say less than 35 miles at broadcast frequencies), such that the curvature of the earth does not introduce an additional attenuation of the waves, the curves of Graph 21 may be used for determining

the ground wave field intensity for transmitting and receiving antennas at the surface of the earth for any radiated power, frequency, or set of ground constants in the following manner: First, lay off the straight inverse distance line corresponding to the power radiated on transparent log-log graph paper similar to that of Graph 21, labelling the ordinates of the chart in terms of field intensity and the abscissae in terms of distance. Next, by means of the formulas given on Graph 21, calculate the value

of the numerical distance, p , at 1 mile and the value of b . Then superimpose the log-log chart over Graph 21, shifting it vertically until the inverse distance lines on both charts coincide and shifting it horizontally until the numerical distance at 1 mile on Graph 21 coincides with 1 mile on the log-log graph paper. The curve of Graph 21 corresponding to the calculated value of b is then traced on the log-log graph paper giving the field intensity versus distance in miles.

Average Sky-Wave Field Intensity
 (corresponding to the second hour after
 sunset at the recording station)



These curves are not considered to be sufficiently accurate for practical use for distances less than approximately 250 miles.

Miles
 Figure 1

Handwritten notes:

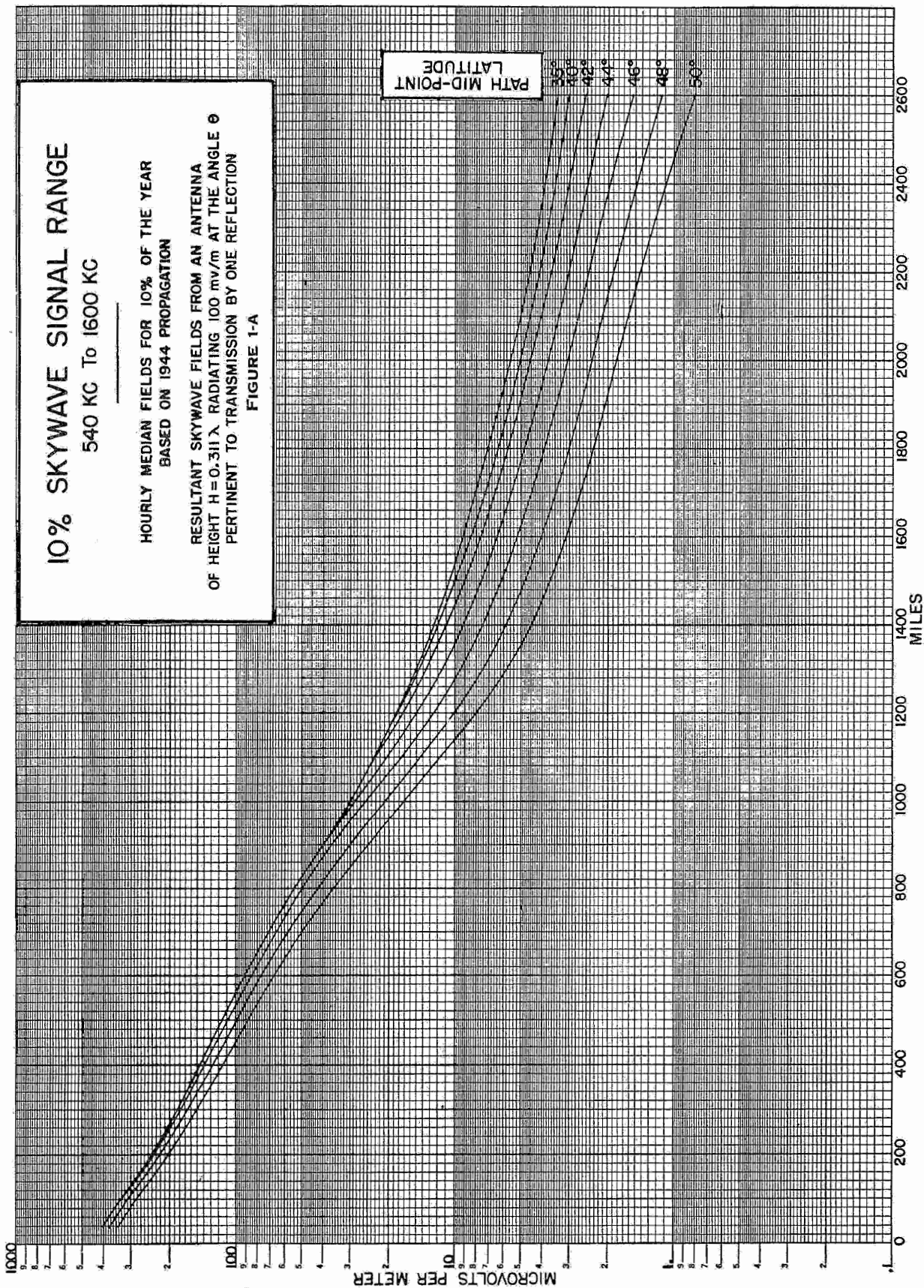
- 50% = 50.0 mV = 5 mV
- 80% = 80.0 mV = 8 mV
- 410 mV @ 5% (W)
- 100% = 100 mV
- 3/6

10% SKYWAVE SIGNAL RANGE

540 KC To 1600 KC

HOURLY MEDIAN FIELDS FOR 10% OF THE YEAR
 BASED ON 1944 PROPAGATION
 RESULTANT SKYWAVE FIELDS FROM AN ANTENNA
 OF HEIGHT $H = 0.311 \lambda$, RADIATING 100 mw/m AT THE ANGLE θ
 PERTINENT TO TRANSMISSION BY ONE REFLECTION

FIGURE 1-A



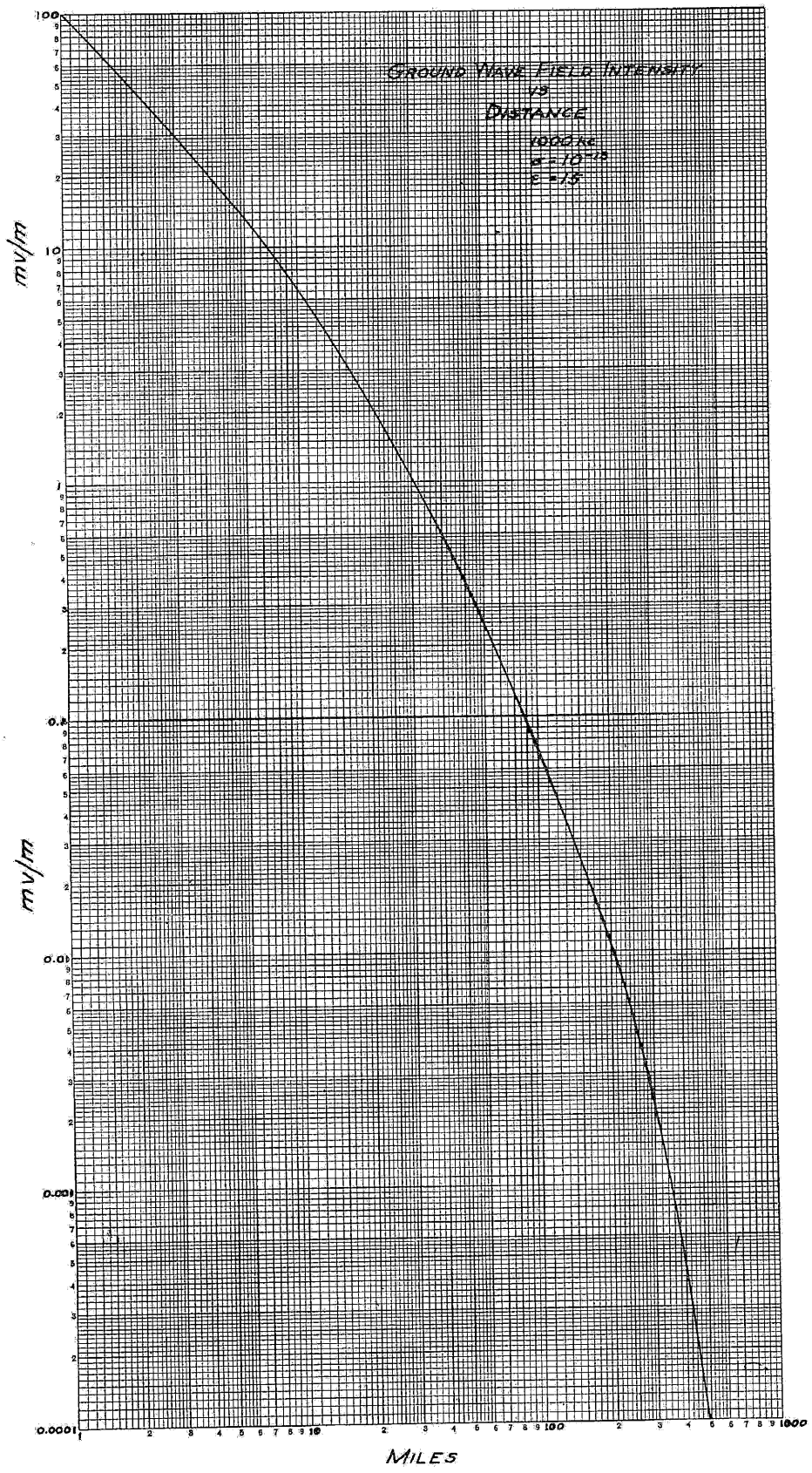
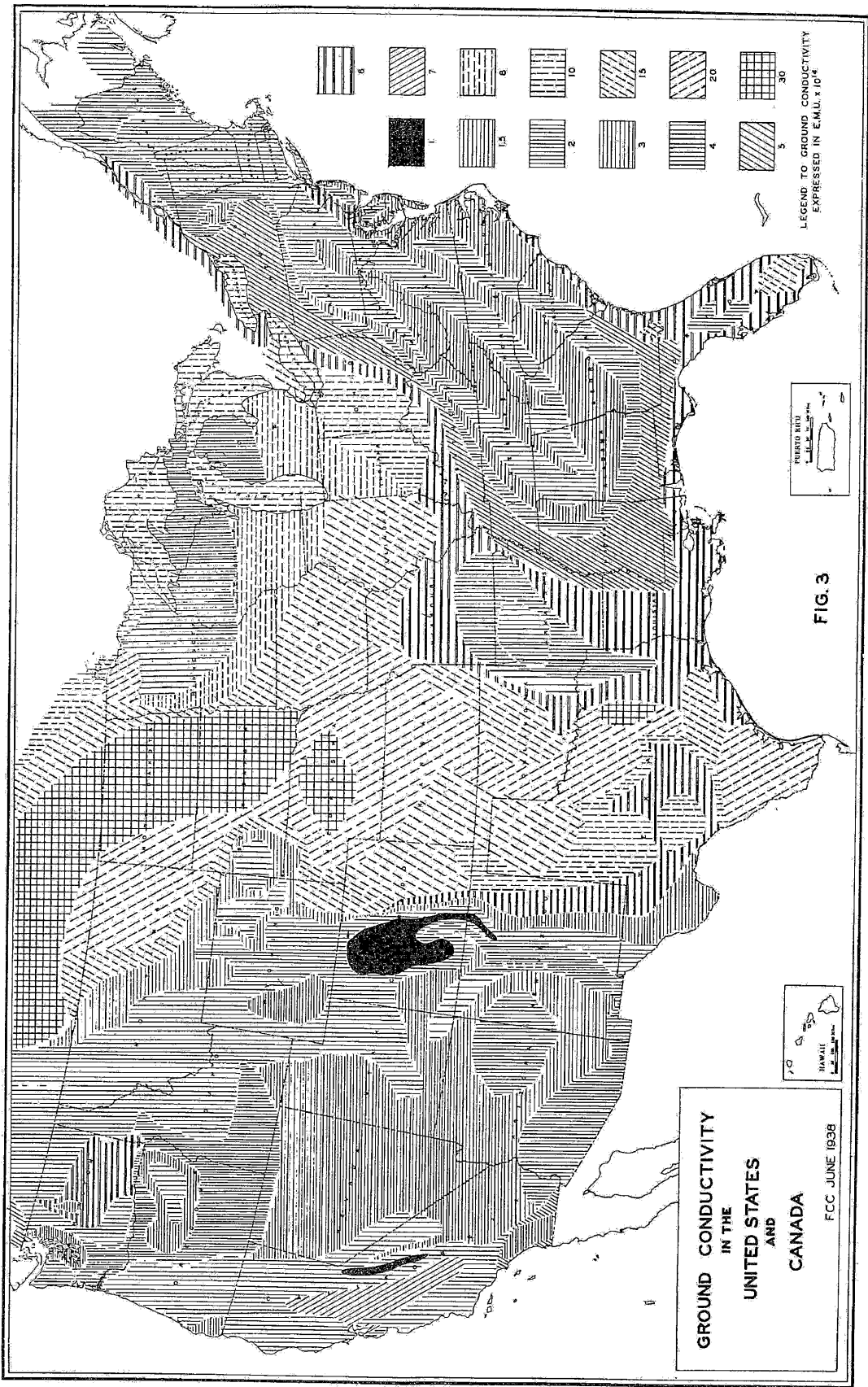
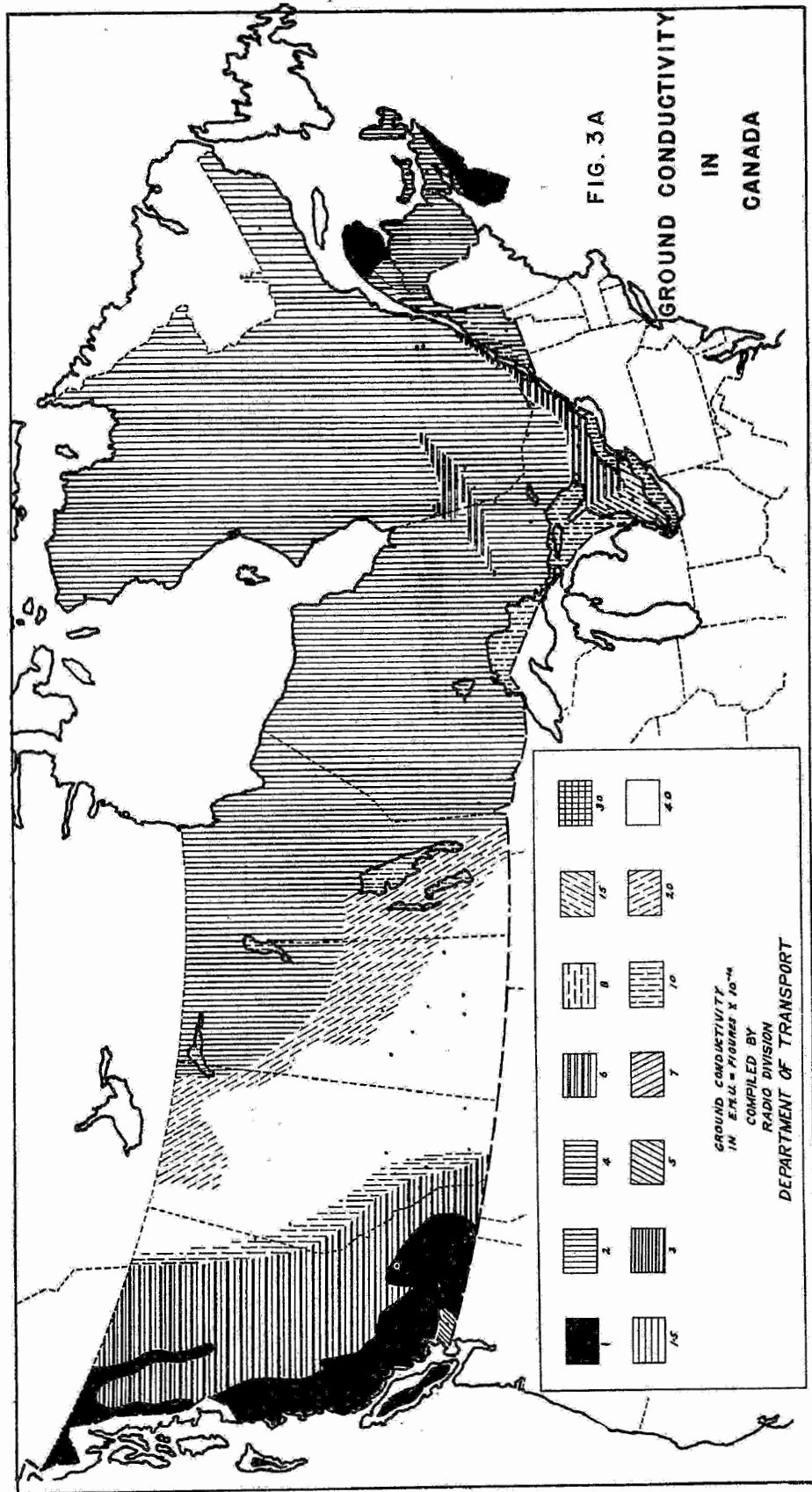
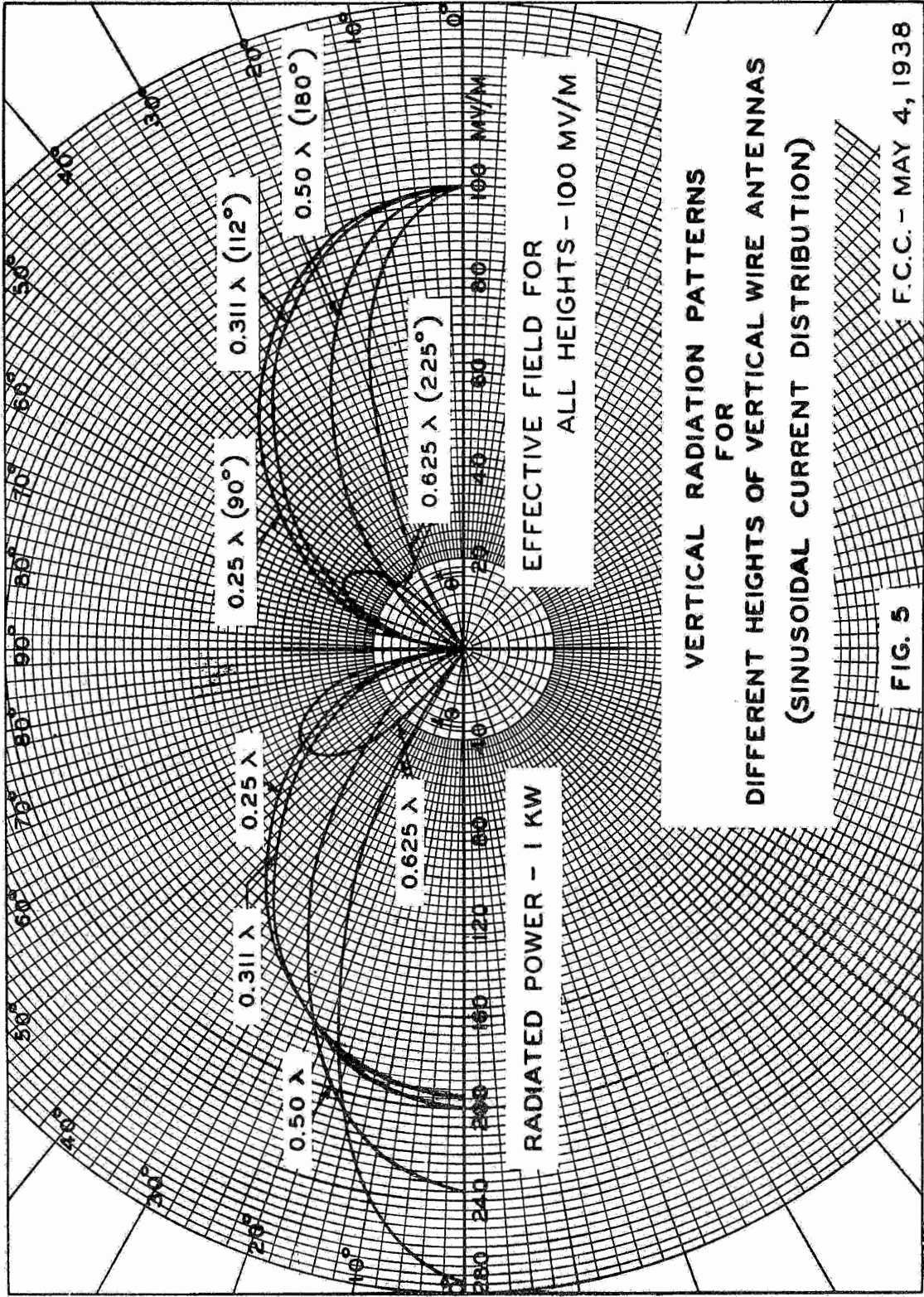


Fig. 2







F.C.C. - MAY 4, 1938

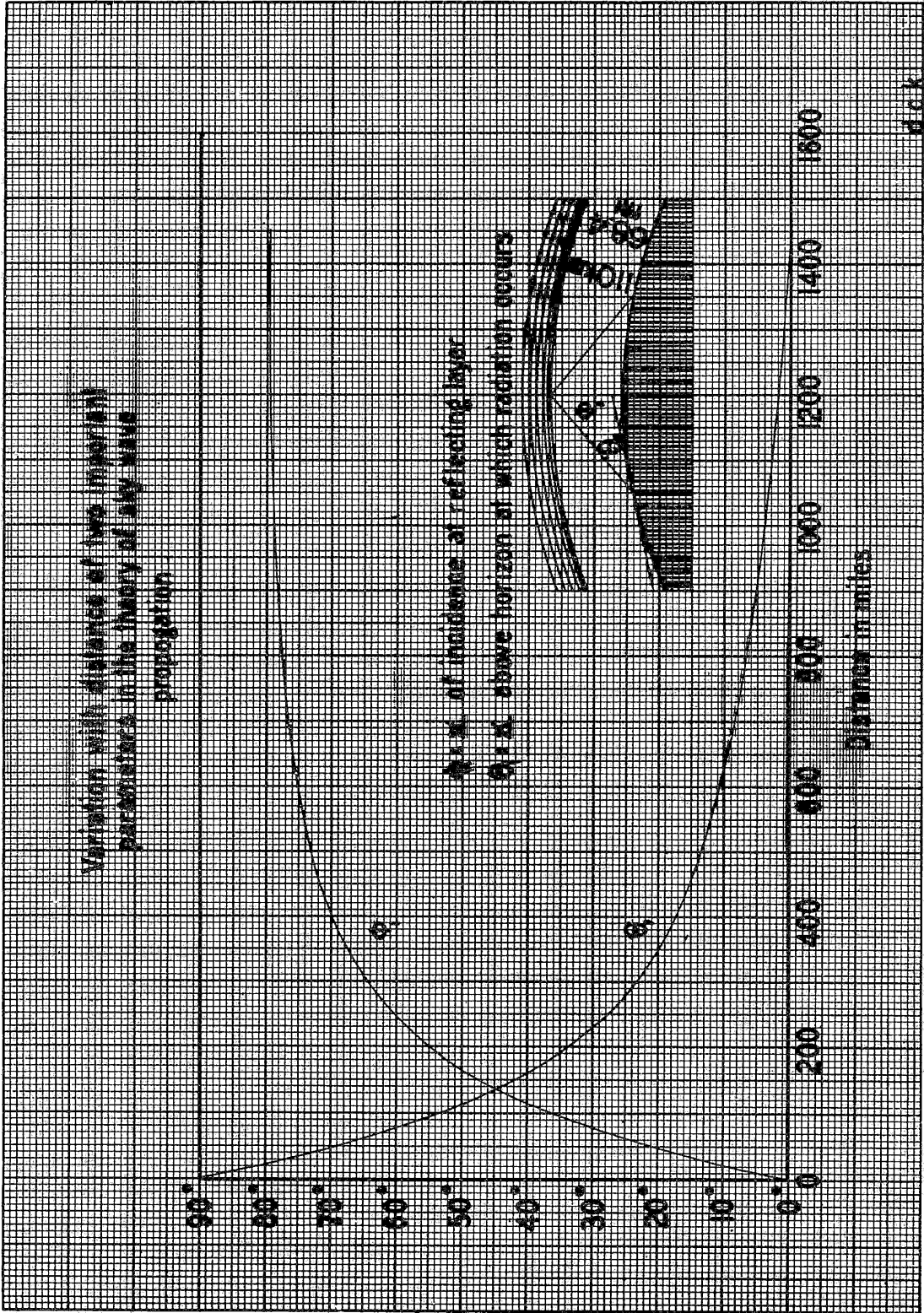
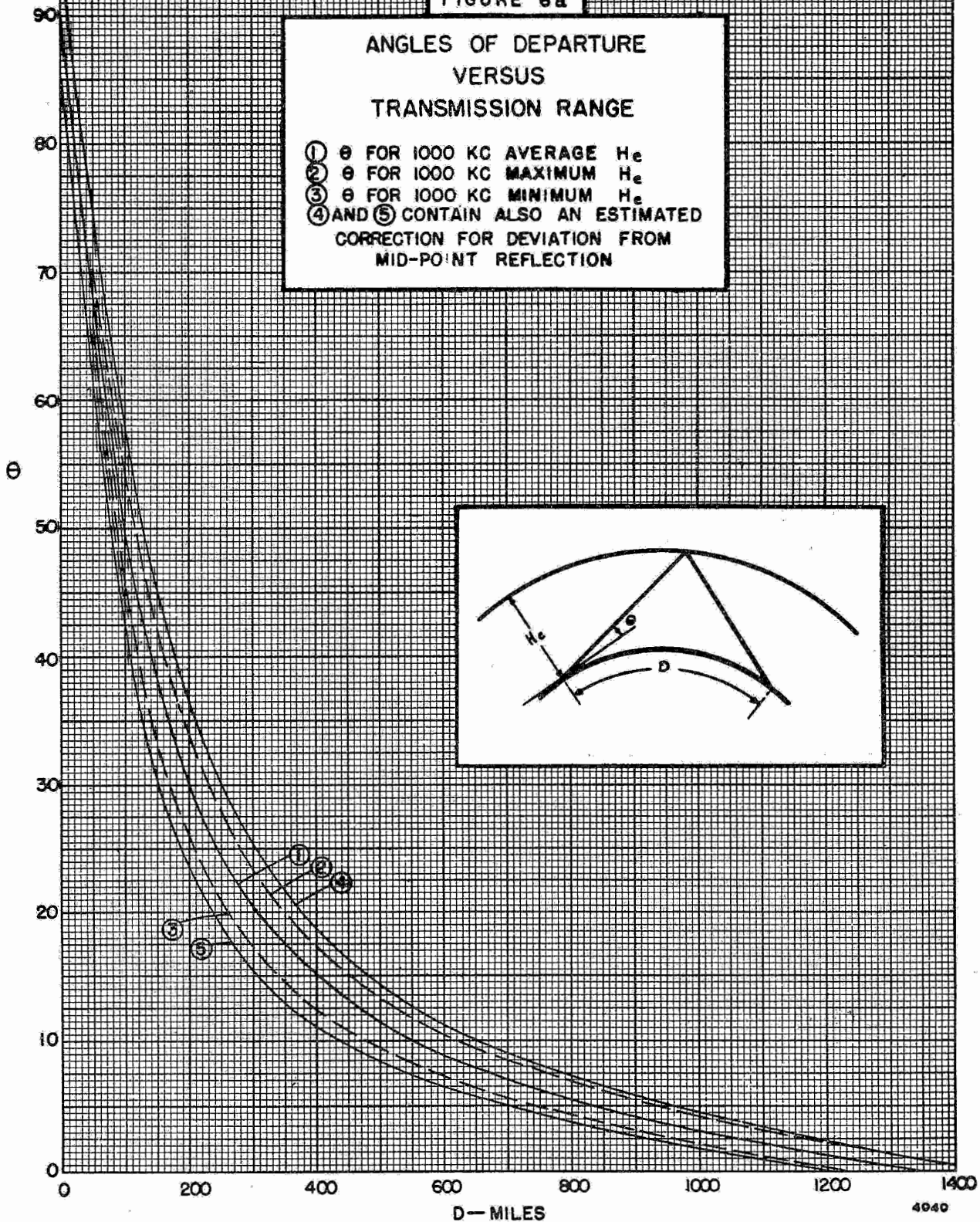


Fig. 6

FIGURE 6a

ANGLES OF DEPARTURE
VERSUS
TRANSMISSION RANGE

- ① θ FOR 1000 KC AVERAGE H_e
- ② θ FOR 1000 KC MAXIMUM H_e
- ③ θ FOR 1000 KC MINIMUM H_e
- ④ AND ⑤ CONTAIN ALSO AN ESTIMATED CORRECTION FOR DEVIATION FROM MID-POINT REFLECTION



ANTENNAS FOR STANDARD BROADCAST STATIONS

MINIMUM VERTICAL HEIGHT OF ANTENNAS
PERMITTED TO BE INSTALLED (A, B, & C)

- A. CLASS IV STATIONS, OR A MINIMUM EFFECTIVE
FIELD INTENSITY OF 150 mv/m. FOR 1 KW.
(100 WATTS, 47.5 mv/m & 250 WATTS, 75 mv/m)
- B. CLASS II & III STATIONS, OR A MINIMUM EFFECTIVE
FIELD INTENSITY OF 175 mv/m FOR 1 KW
- C. CLASS I STATIONS, OR A MINIMUM EFFECTIVE FIELD
INTENSITY OF 225 mv/m FOR 1 KW
- C' WHERE IT IS SHOWN THAT THE CIVIL AERONAUTICS
AUTHORITY WILL NOT APPROVE AN ANTENNA
HAVING HEIGHT IN EXCESS OF 500 FEET AT ANY
LOCATION WITHIN THE METROPOLITAN AREA
CONCERNED, A HEIGHT OF 500 FEET WILL BE
ACCEPTED.
- D. 0.25 WAVELENGTH
- E. 0.50 WAVELENGTH
- F. 0.625 WAVELENGTH

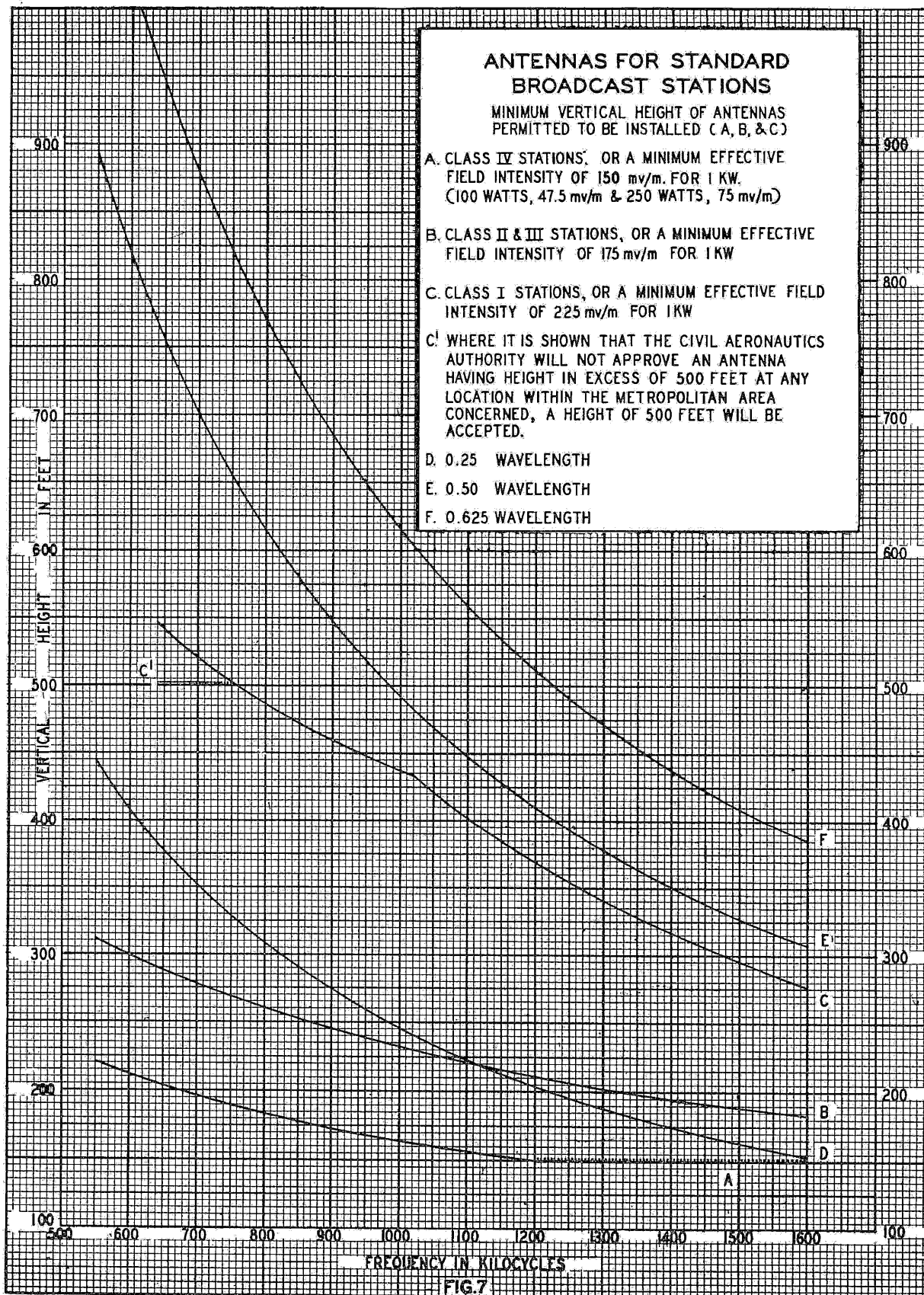


FIG. 7

FEDERAL COMMUNICATIONS COMMISSION
STANDARDS OF GOOD ENGINEERING PRACTICE CONCERNING FM BROADCAST STATIONS
EFFECTIVE SEPTEMBER 20, 1945*

INTRODUCTION

There are presented herein the Commission's engineering standards relating to the allocation and operation of FM broadcast stations. These standards also apply to noncommercial educational (FM) broadcast stations, except as noted herein. The Commission's Rules and Regulations contain references to these standards, which have been approved by the Commission and thus are considered as reflecting its opinion in all matters involved.

The standards set forth herein are those deemed necessary for the construction and operation of FM broadcast stations to meet the requirements of technical regulations and for operation in the public interest along technical lines not otherwise enunciated. These standards are based upon the best engineering data available, including evidence at hearings, conferences with radio engineers, and data supplied by manufacturers of radio equipment and by licensees of FM broadcast stations. These standards are complete in themselves and supersede previous engineering standards or policies of the Commission concerning FM broadcast stations. While these standards provide for flexibility and indicate the conditions under which they are applicable, it is not expected that material deviation from the fundamental principles will be recognized unless full information is submitted as to the need and reasons therefor.

These standards will necessarily be revised from time to time as progress is made in the art. The Commission will accumulate and analyze engineering data available as to the progress of the art so that these standards may be kept current with technical developments.

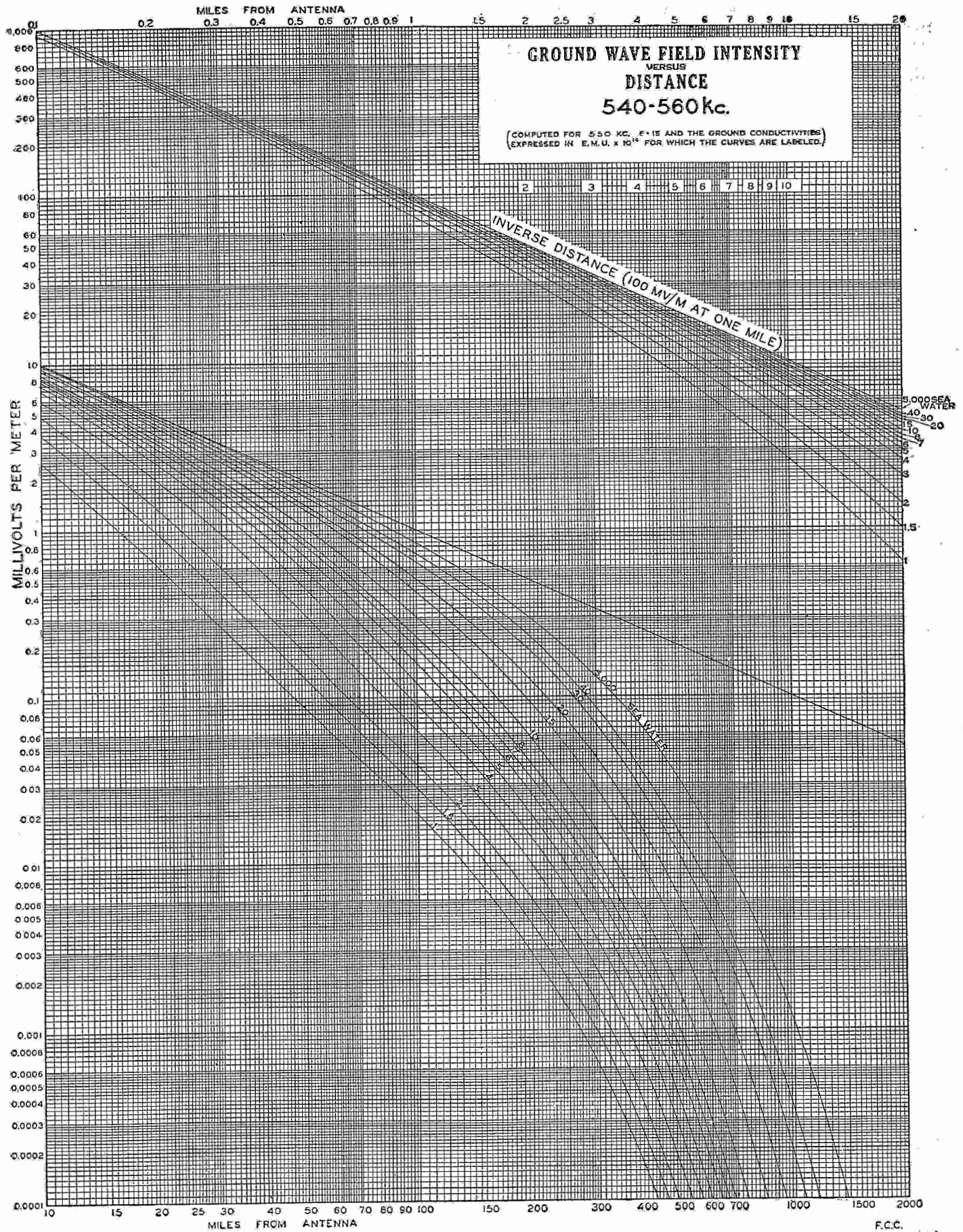
*This reproduction is based upon the Standards revised by the Commission to January 9, 1946, but also includes the following FCC Amendments (which actually bring the Standards up to date as of July 15, 1949):

FCC Amendment No. 307 - November 7, 1946
FCC Amendment No. 336 - June 12, 1947
FCC Amendment No. 363 - October 27, 1947
FCC Amendment No. 364 - October 16, 1947
FCC Amendment No. 367 - July 15, 1948

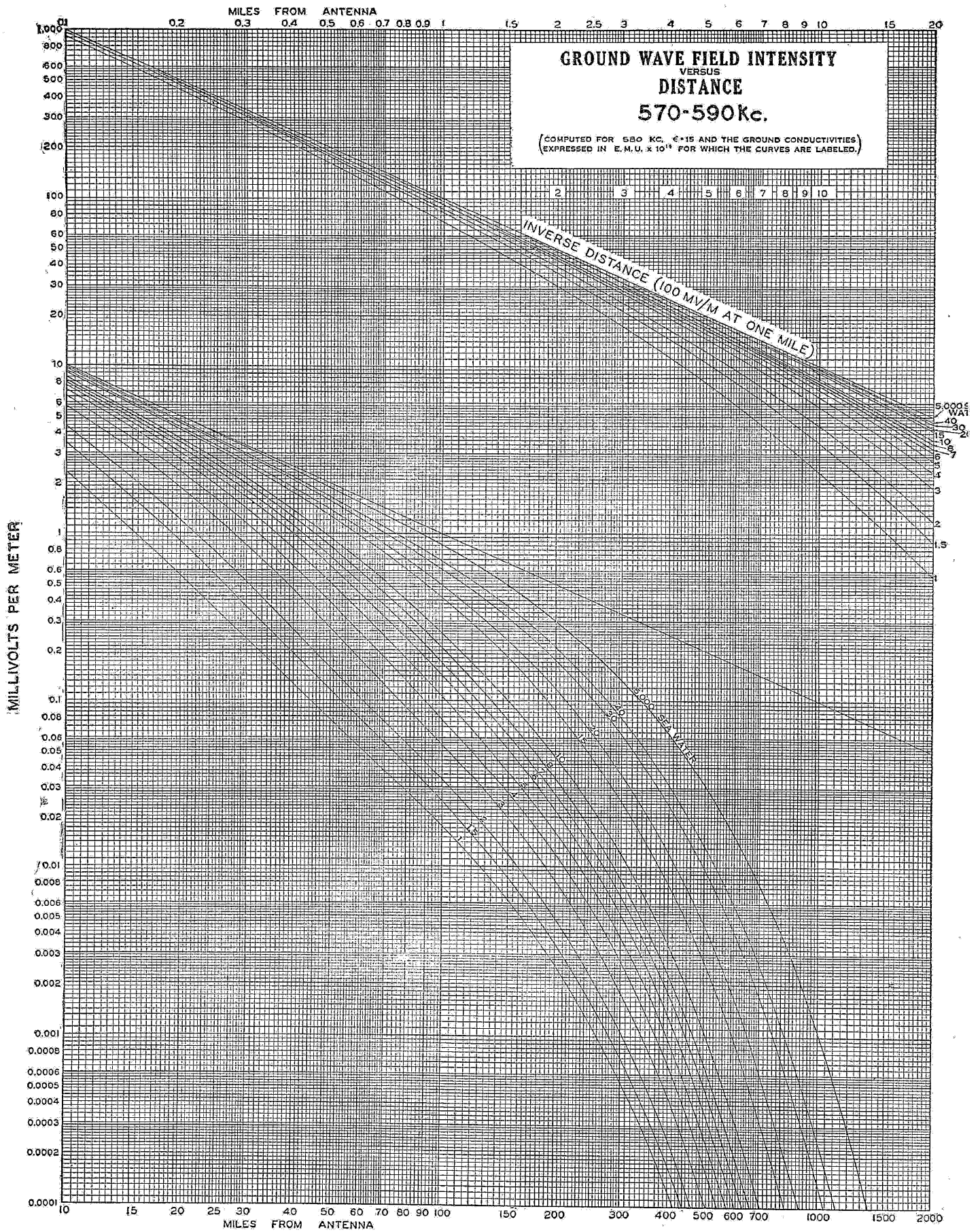
As additional amendments are made they will be indicated or printed in NAB MEMBER SERVICE.

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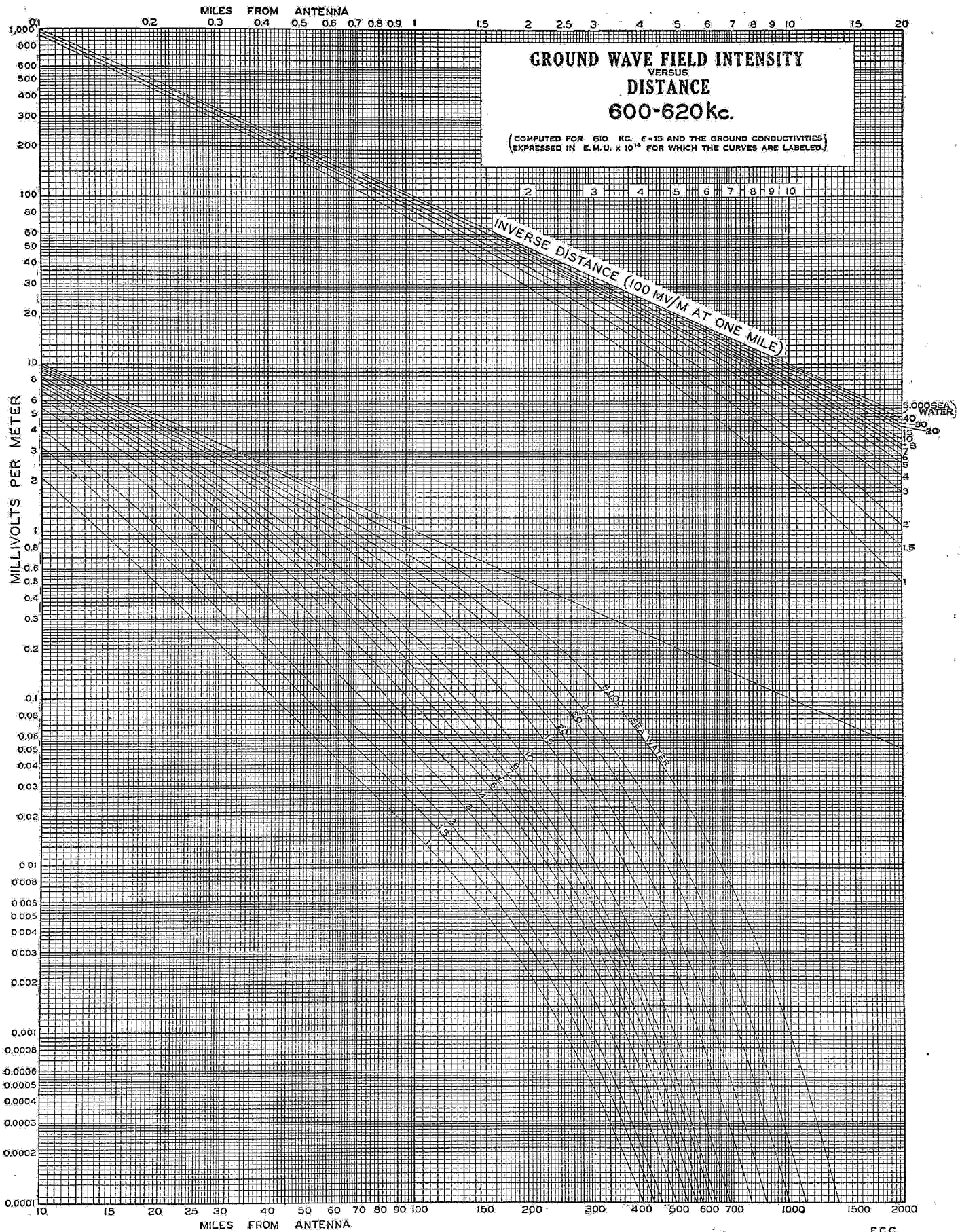
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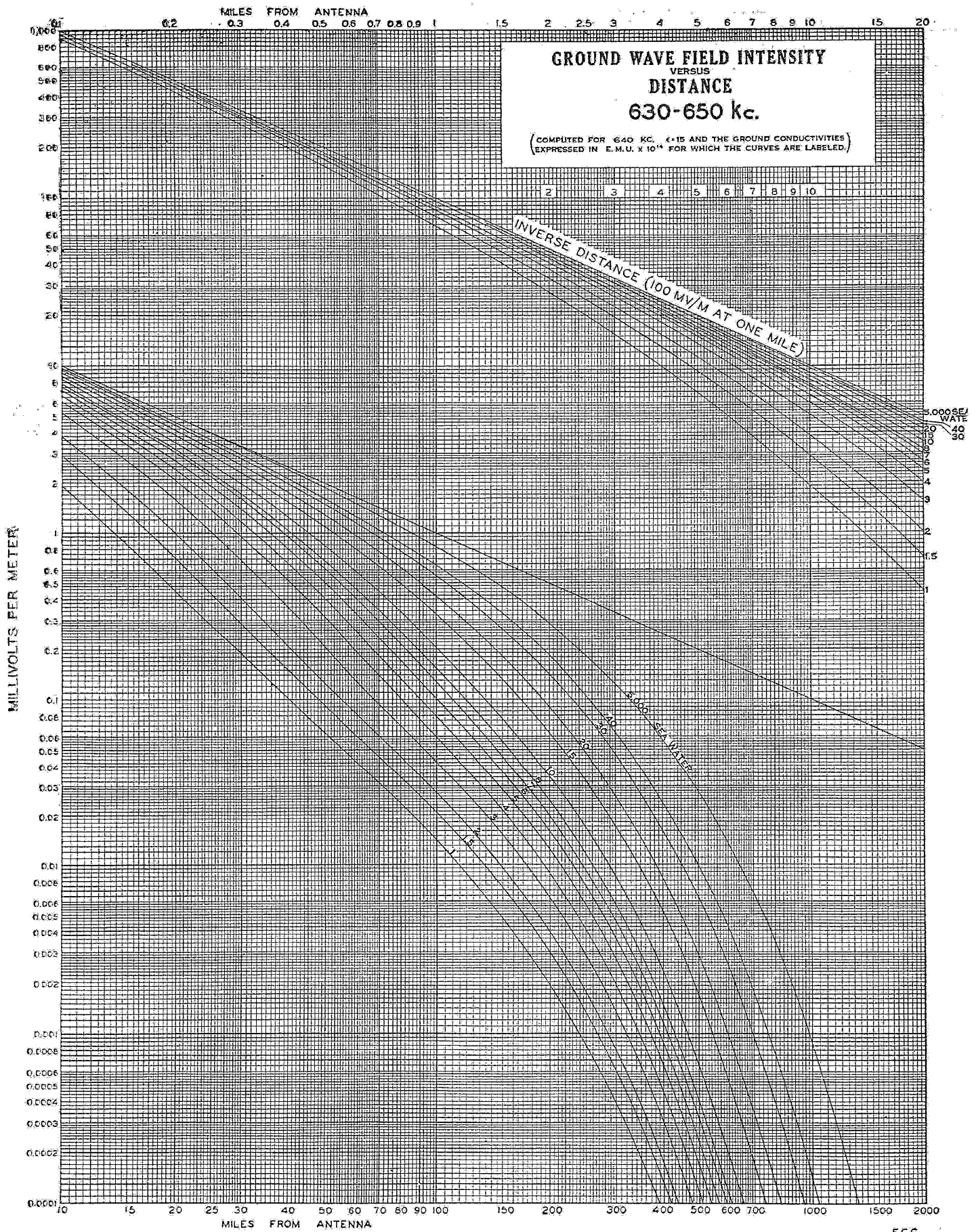
APPENDIX I - GRAPH 1



APPENDIX I - GRAPH 2



APPENDIX I - GRAPH 3



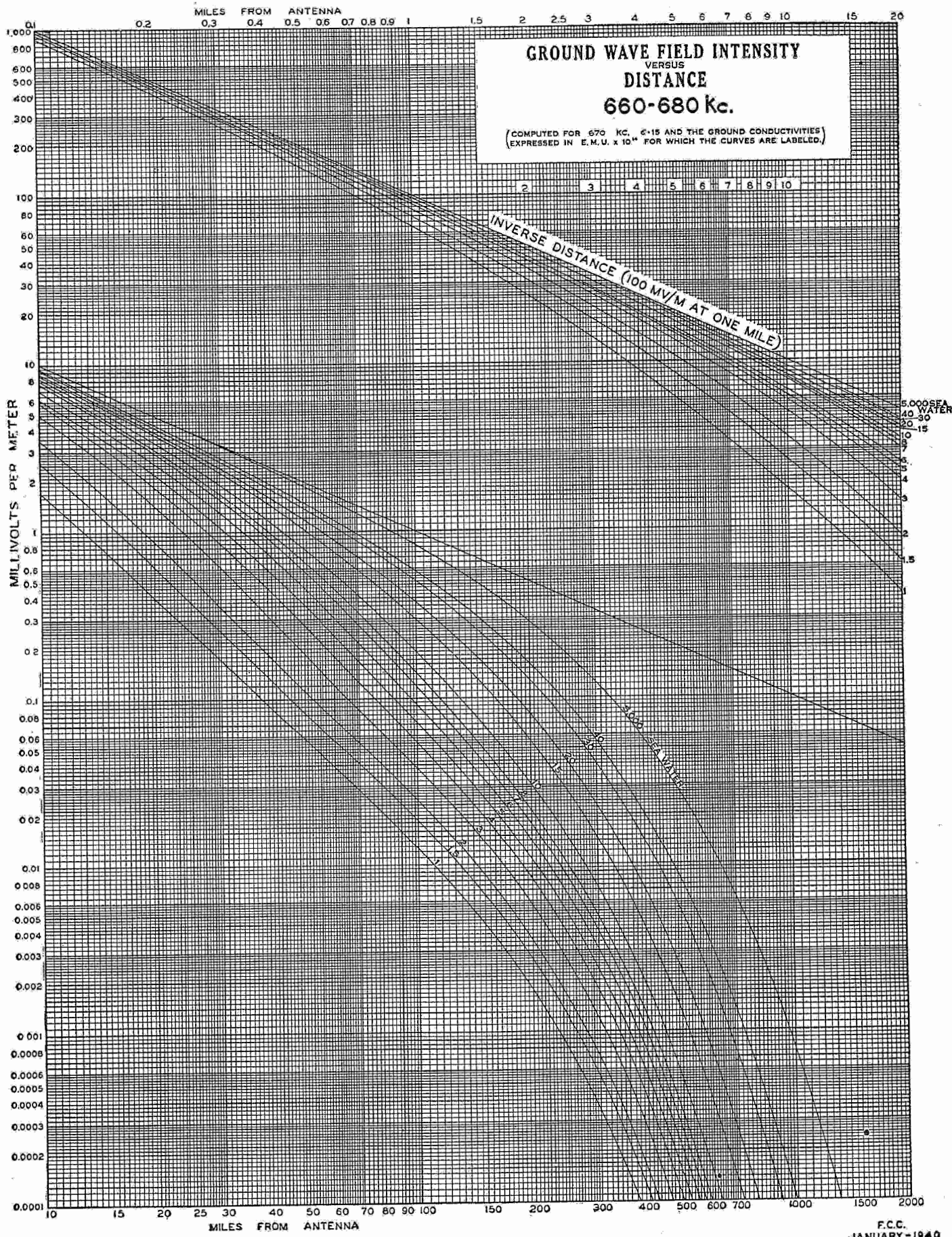
MILES FROM ANTENNA

MILLVOLTS PER METER

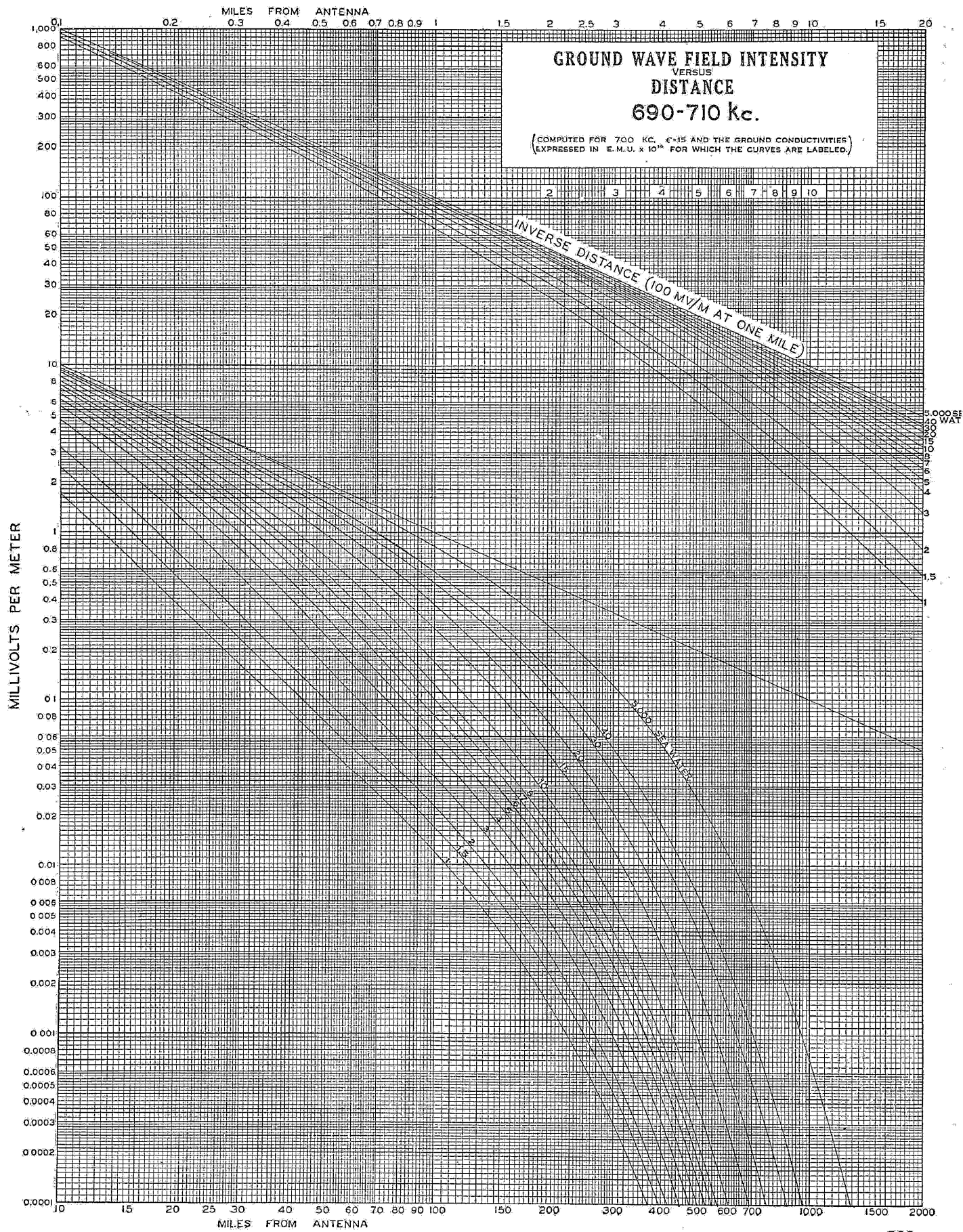
MILES FROM ANTENNA

F.C.C.
JANUARY-1940

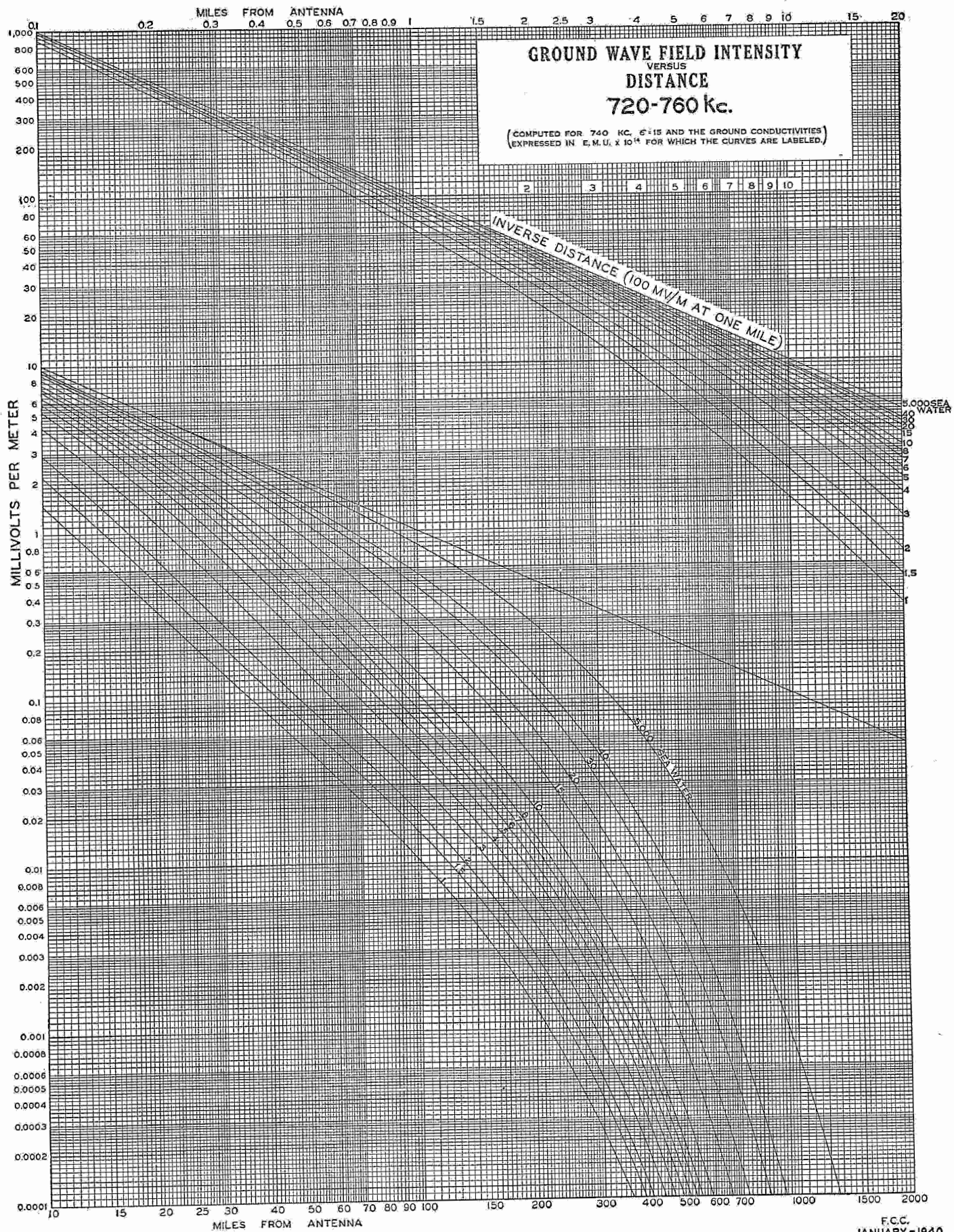
APPENDIX I - GRAPH 4



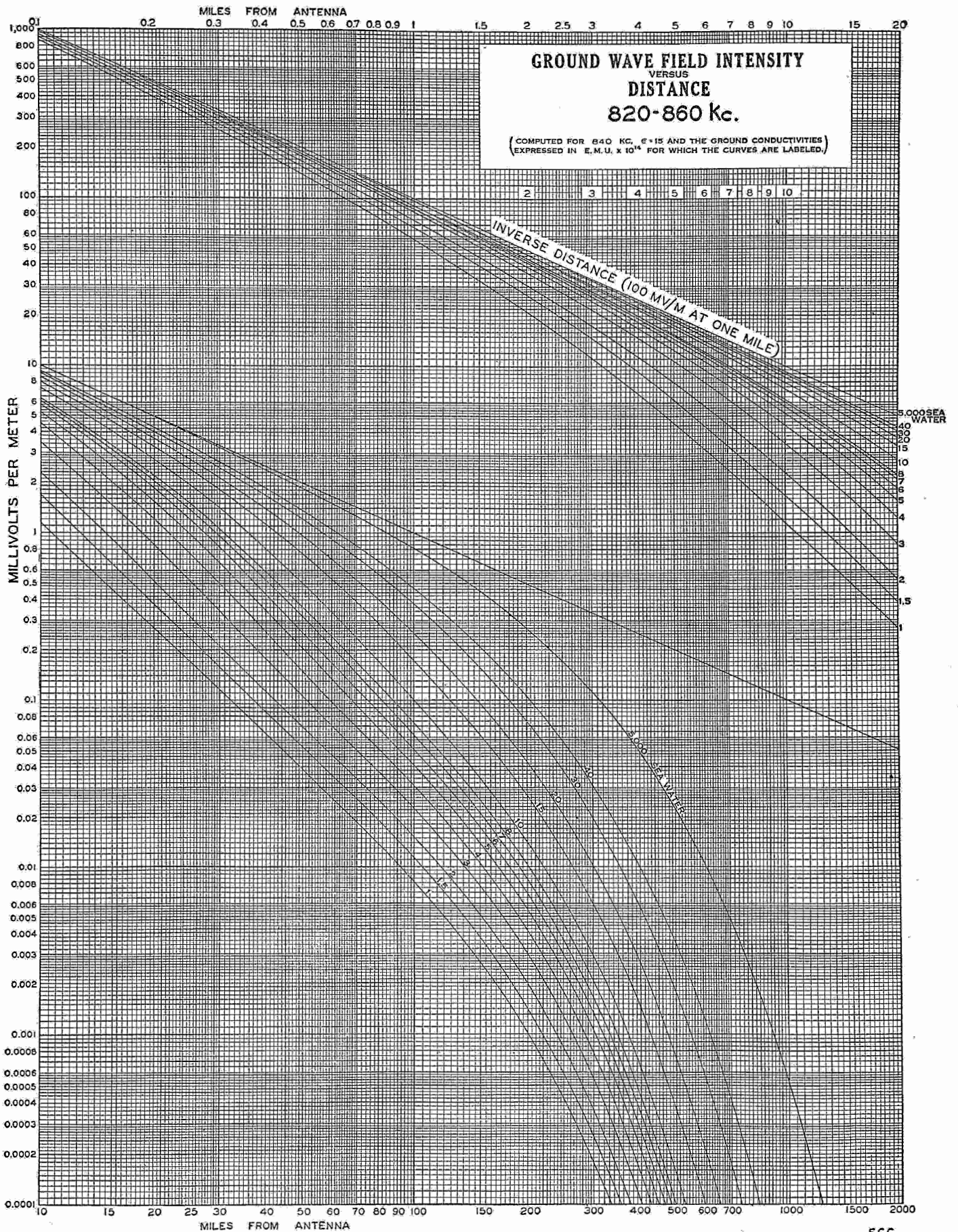
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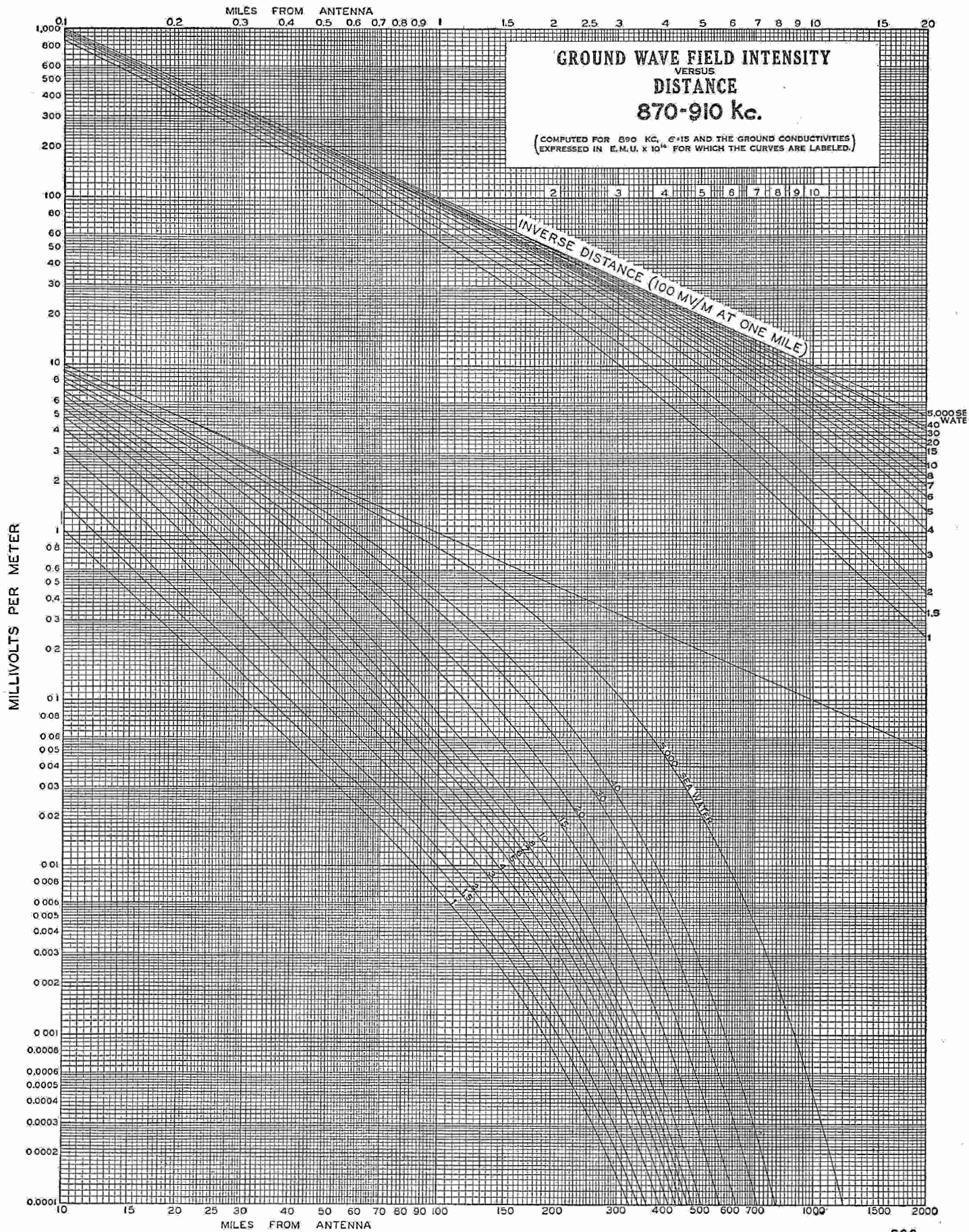
APPENDIX I - GRAPH 6



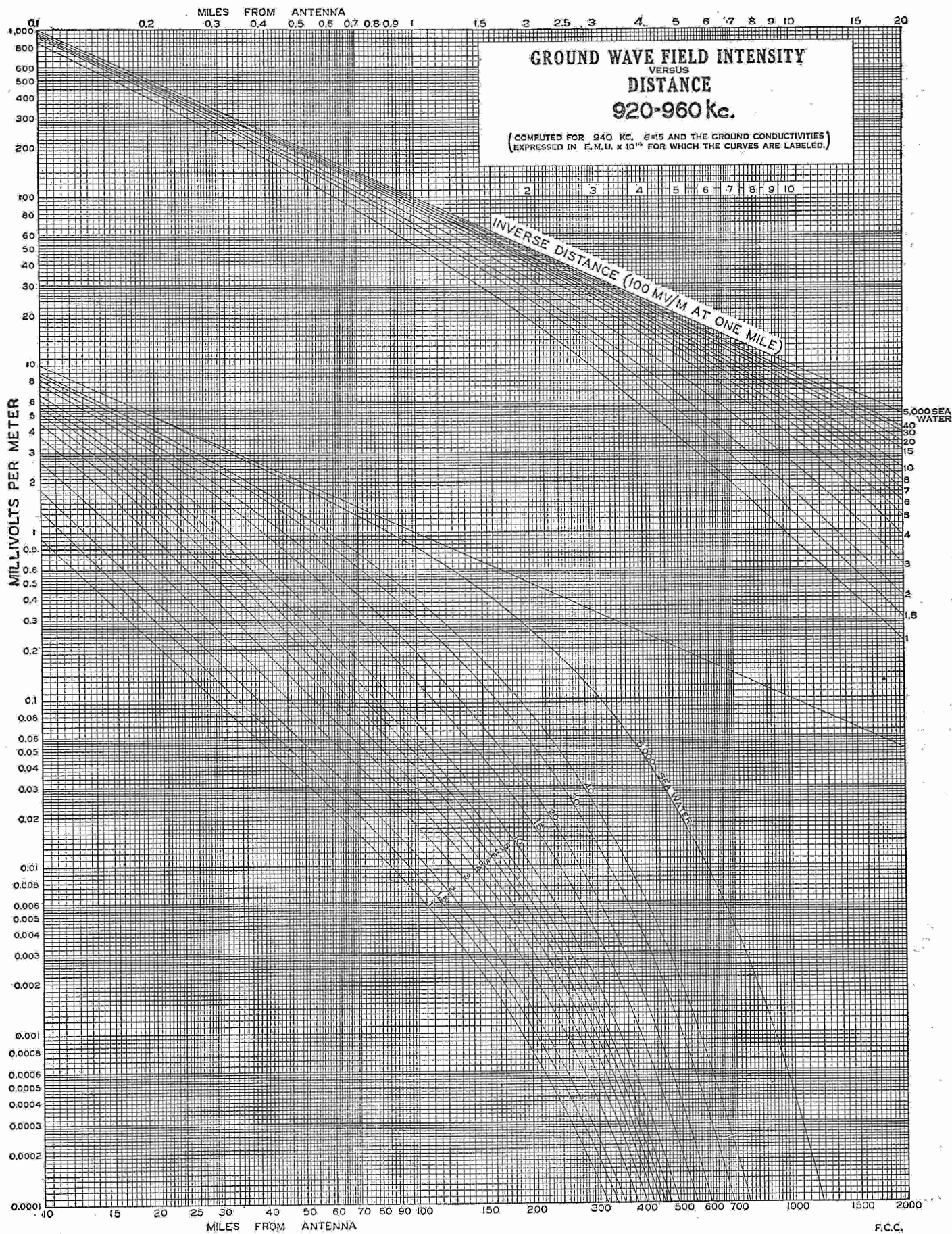
APPENDIX I - GRAPH 7



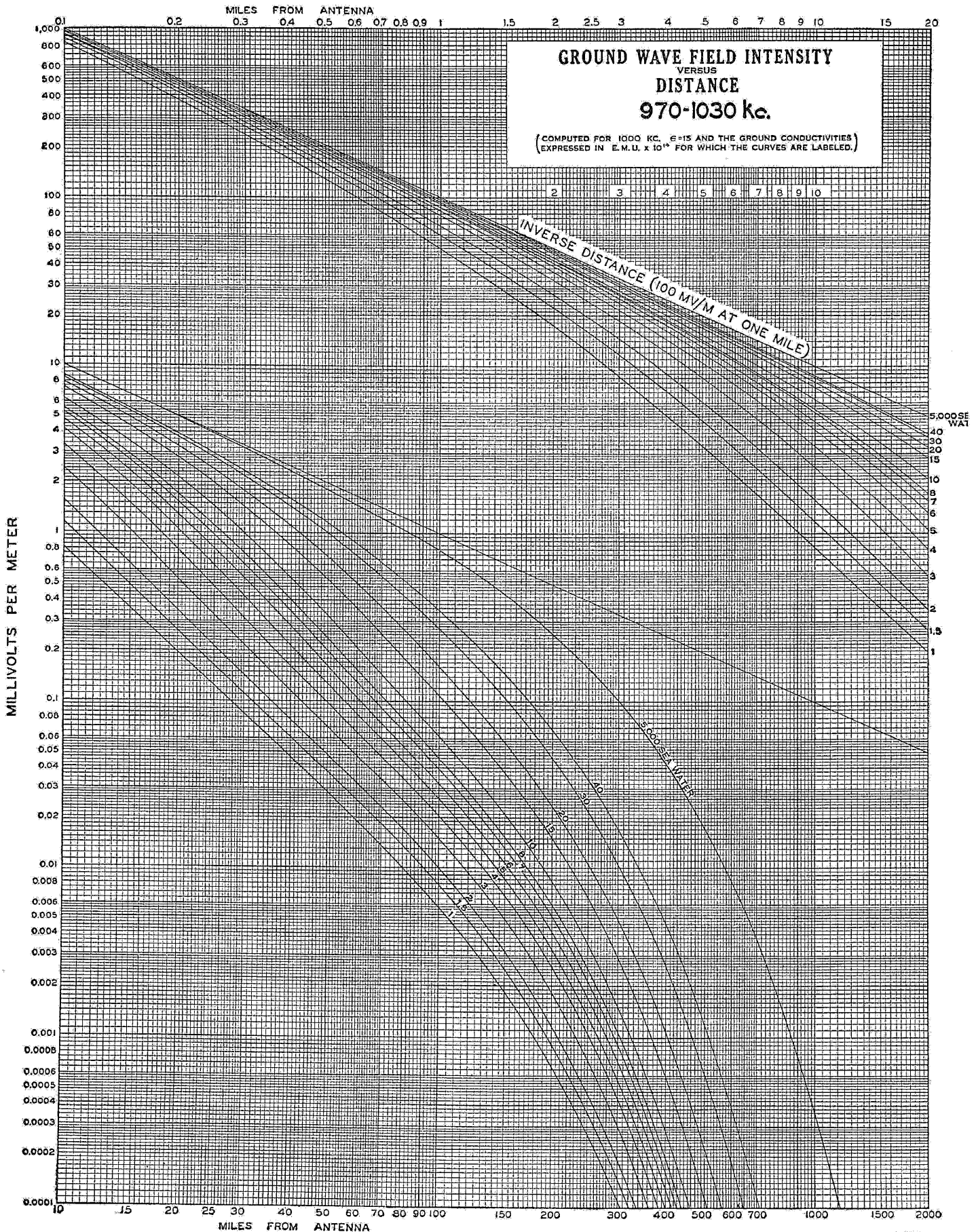
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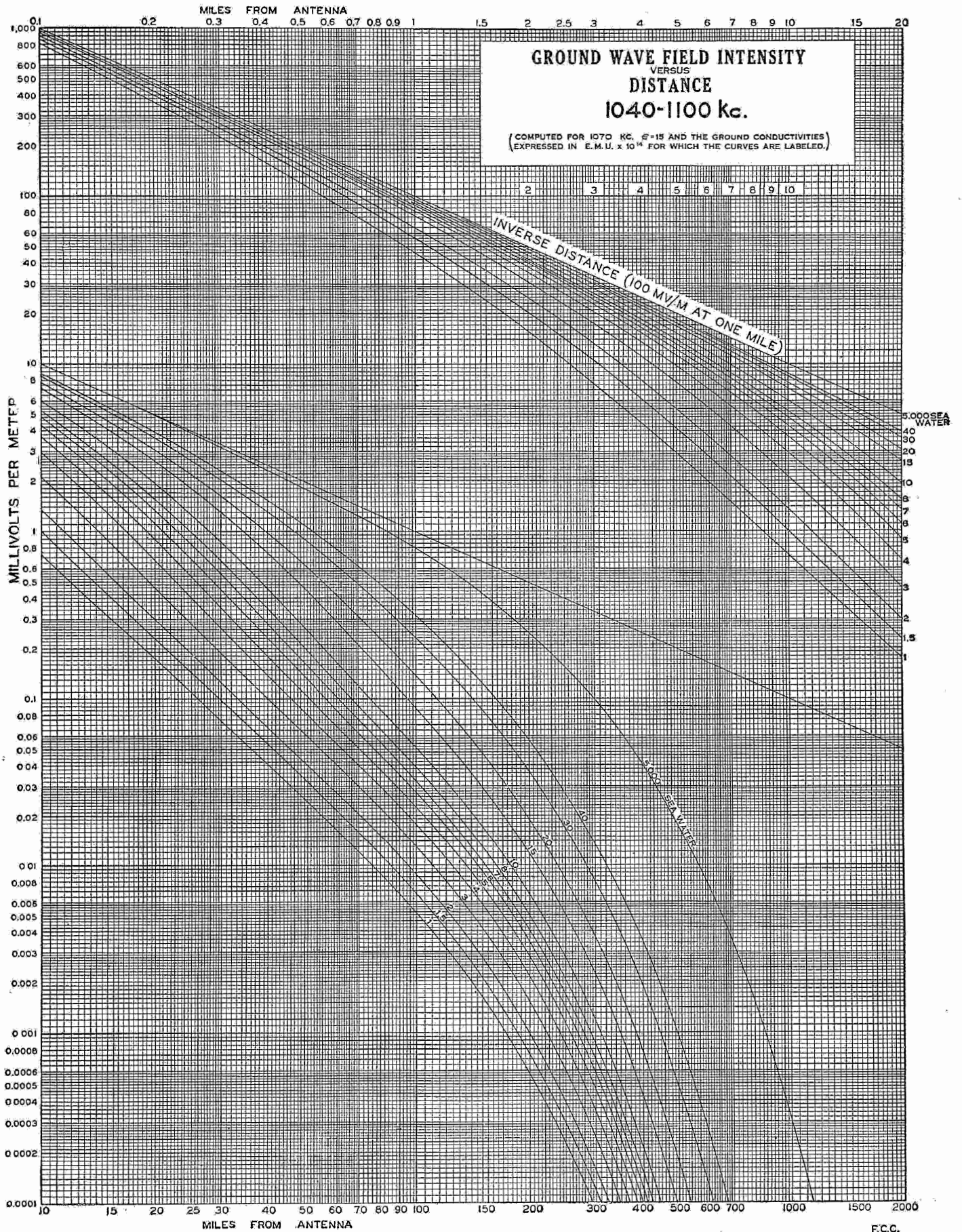
APPENDIX I - GRAPH 10



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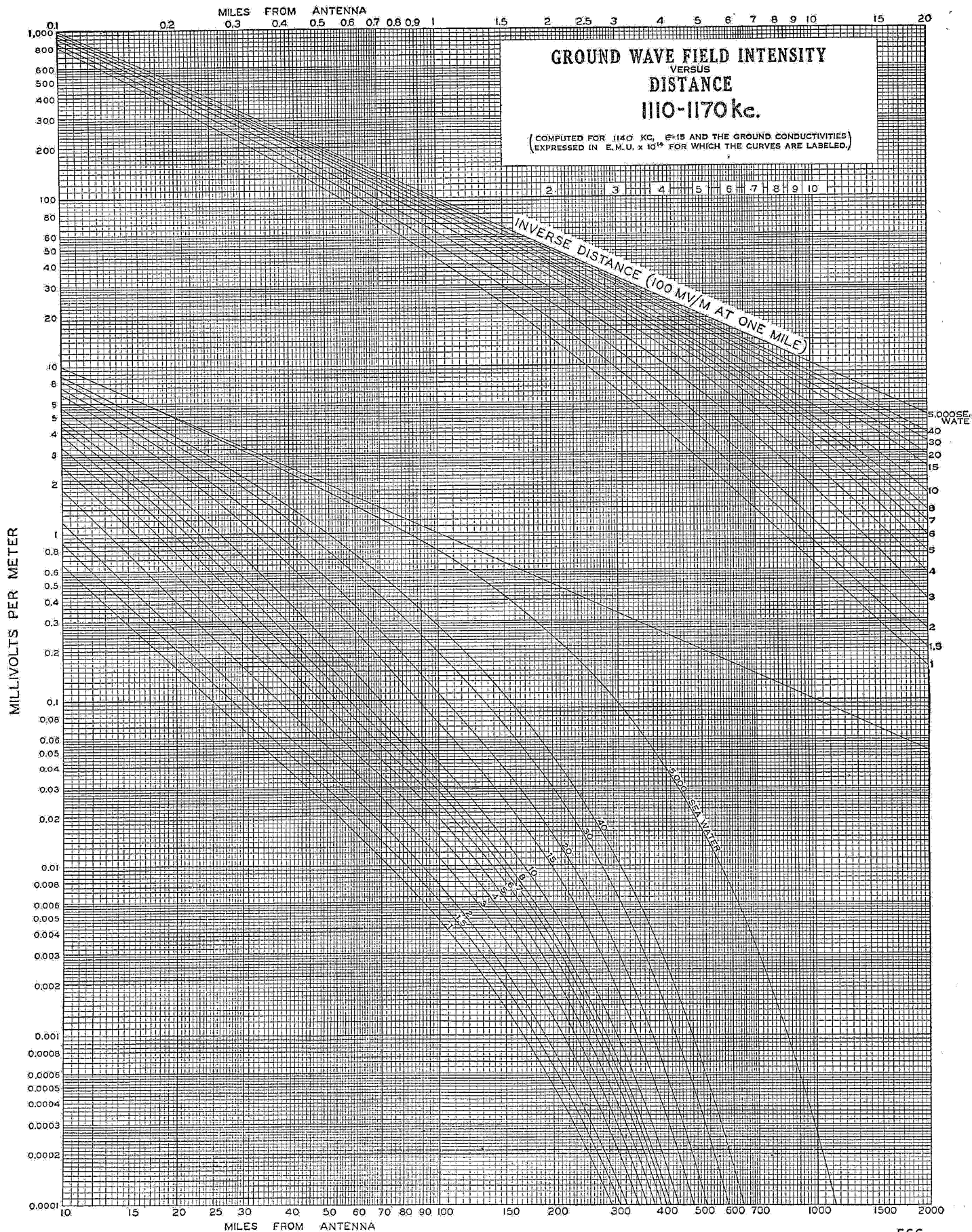


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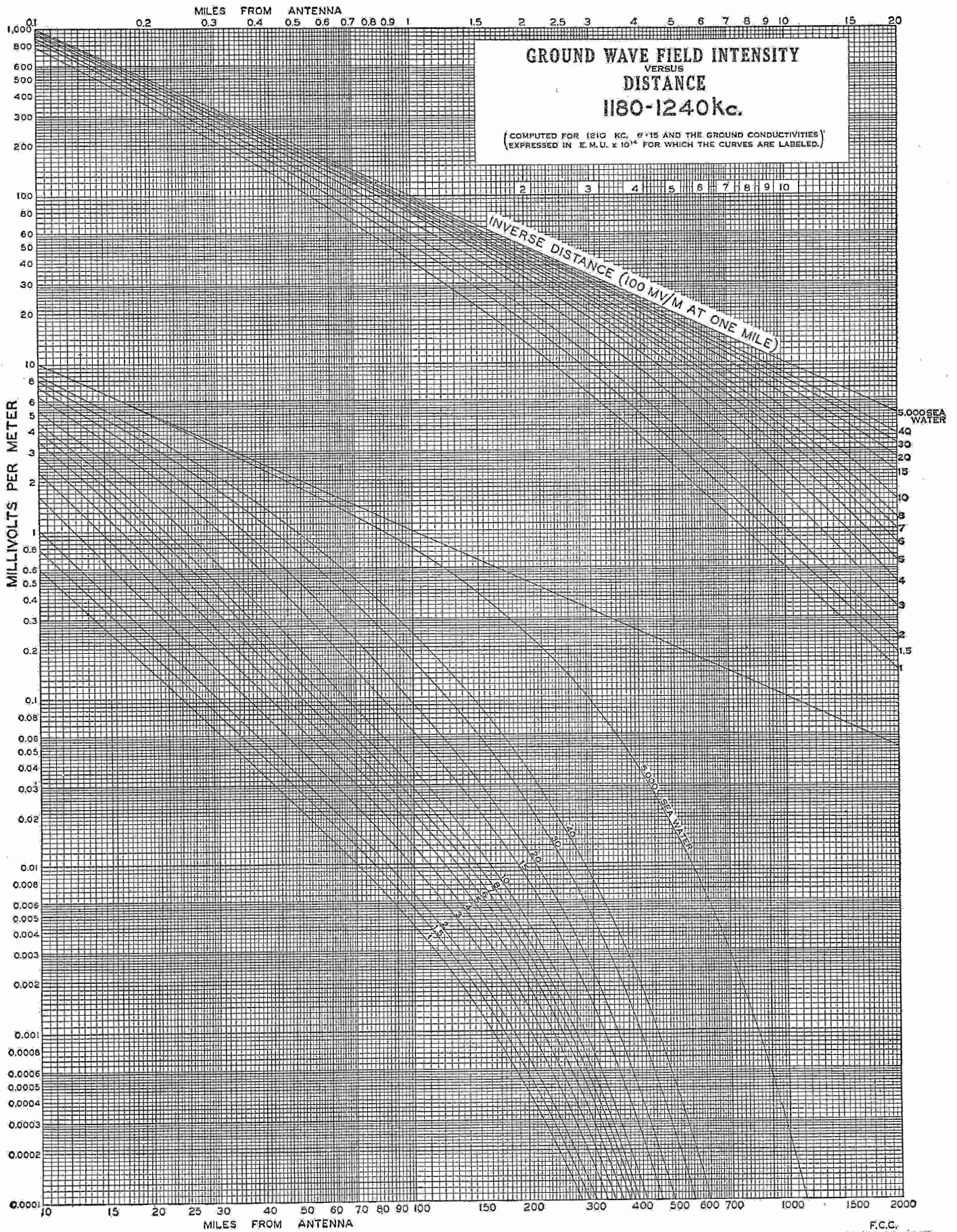


F.C.C.
JANUARY-1940

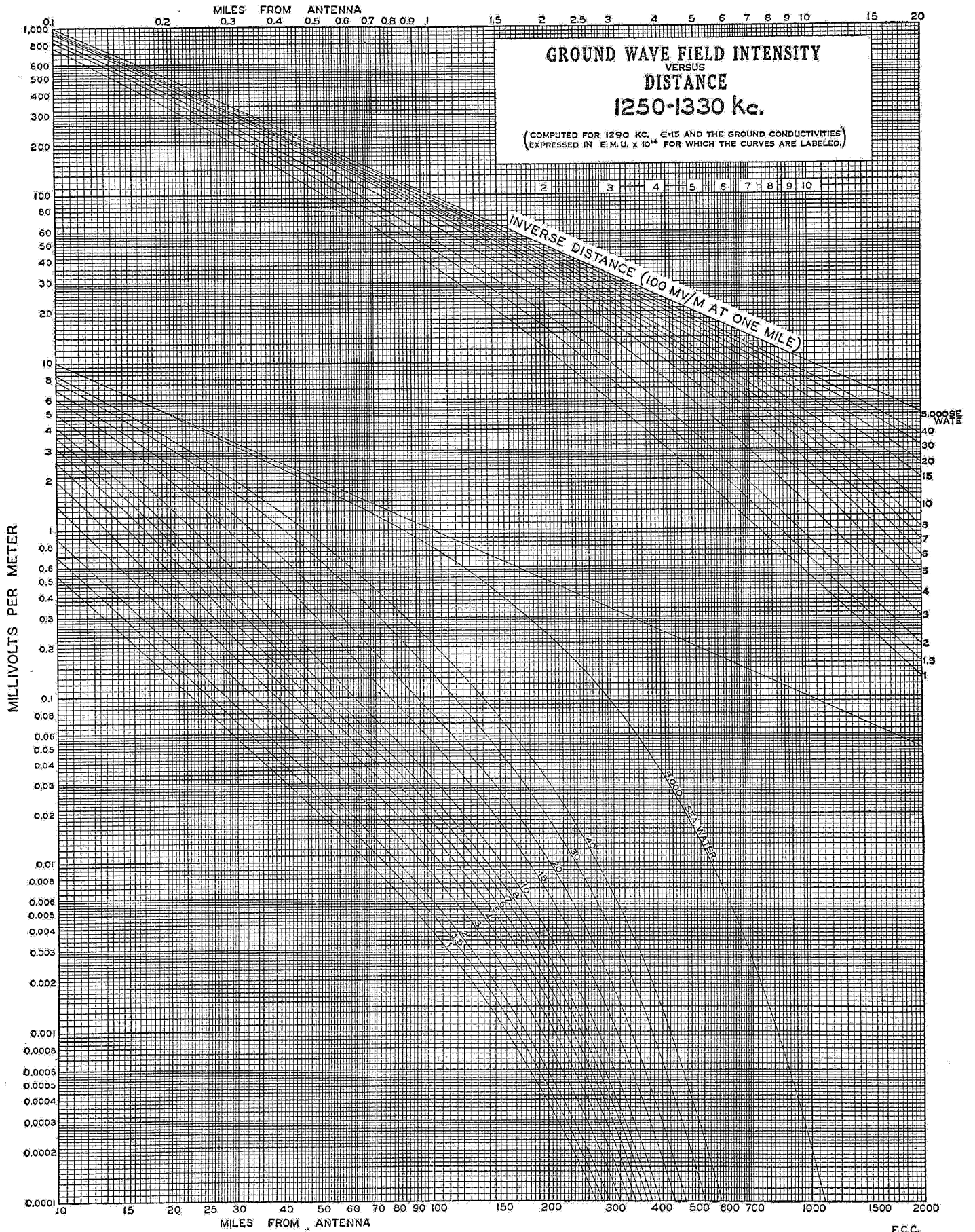
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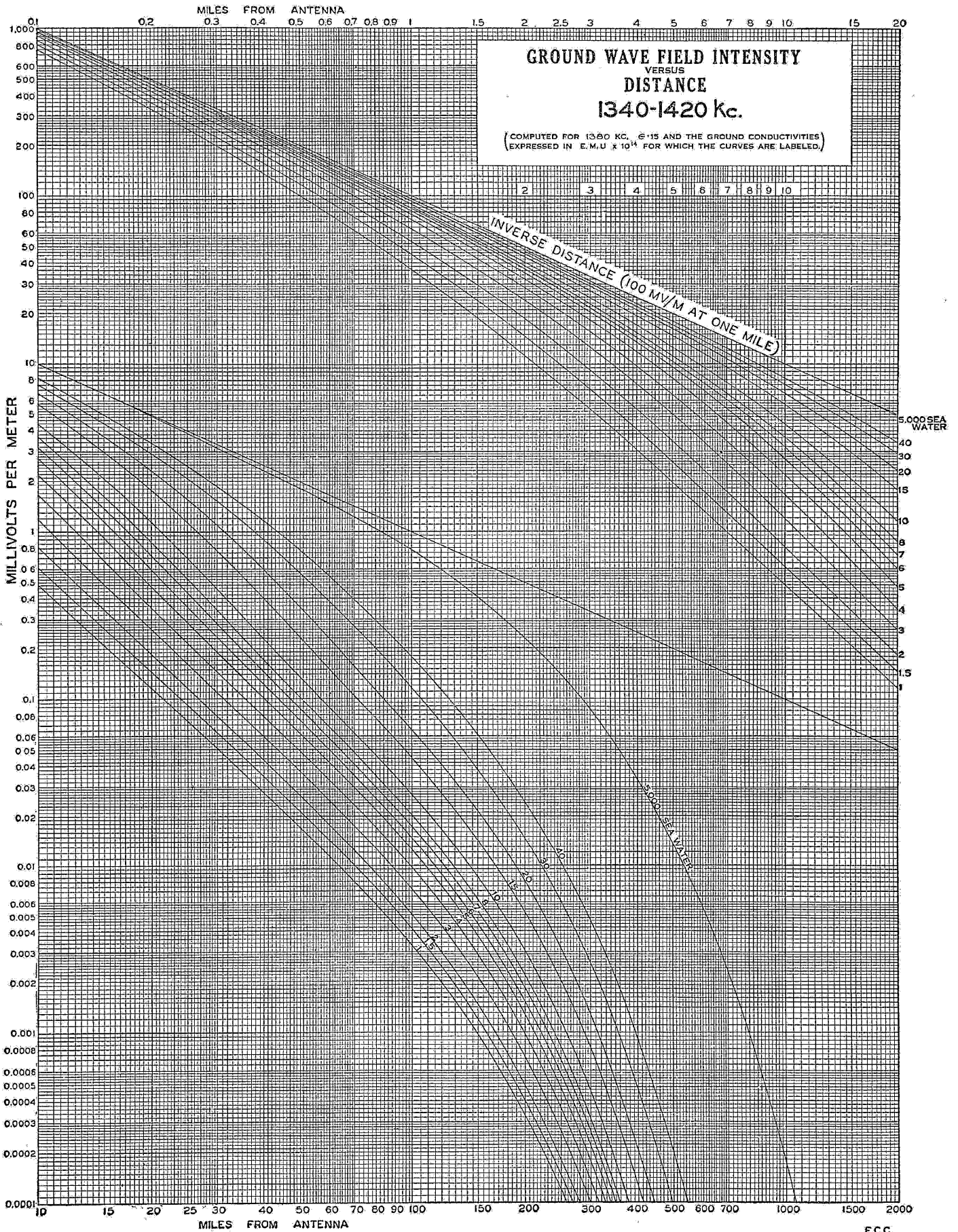
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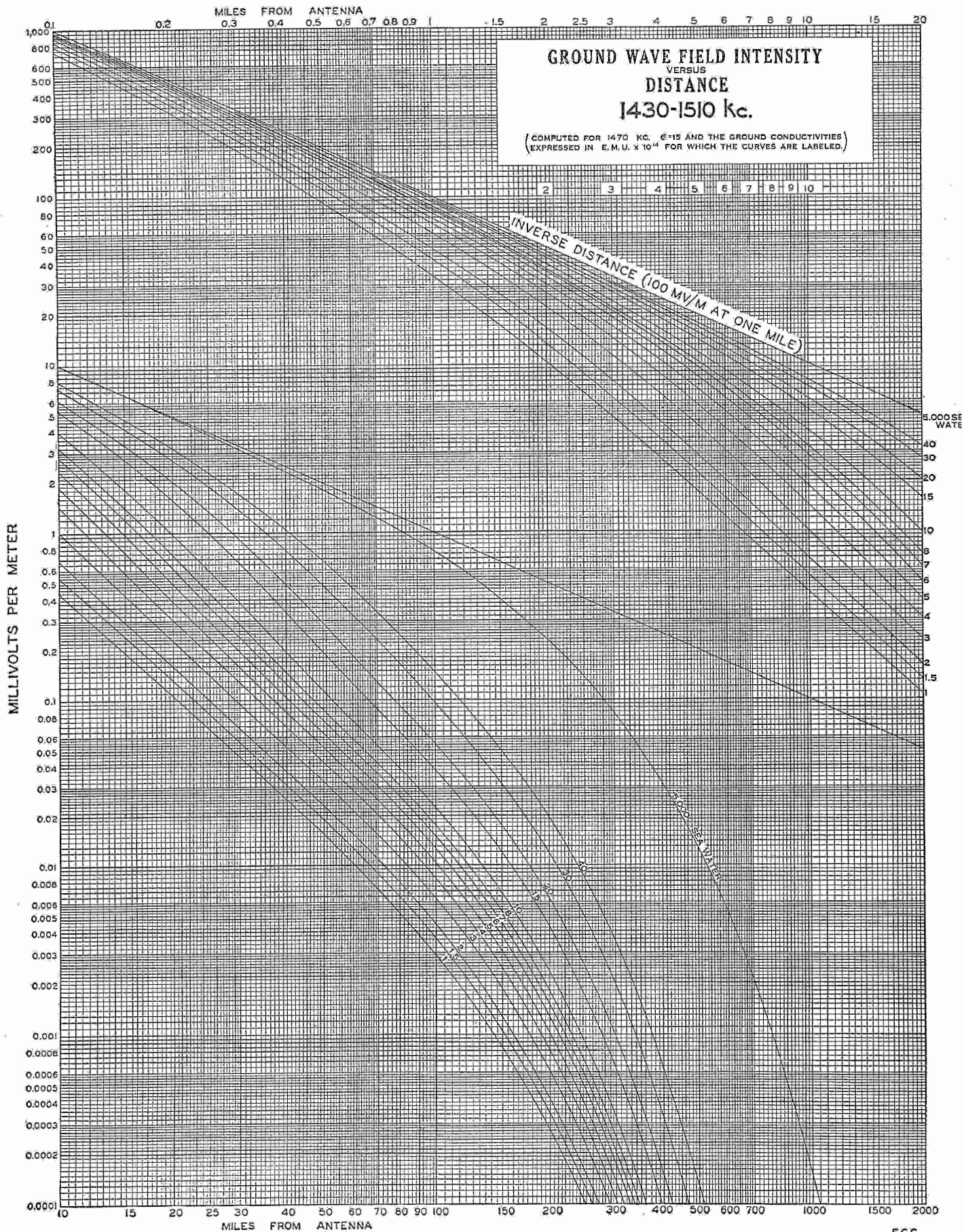
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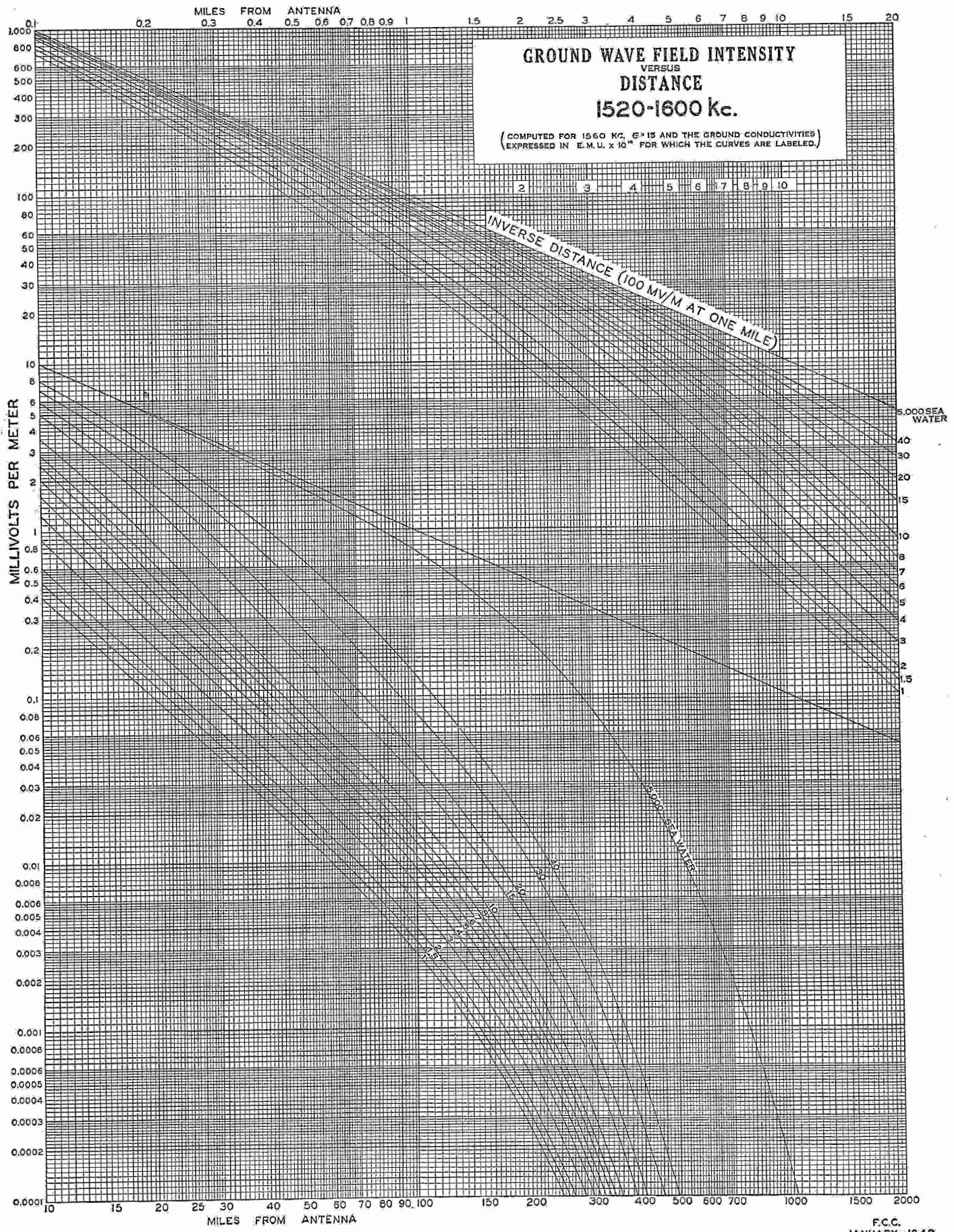
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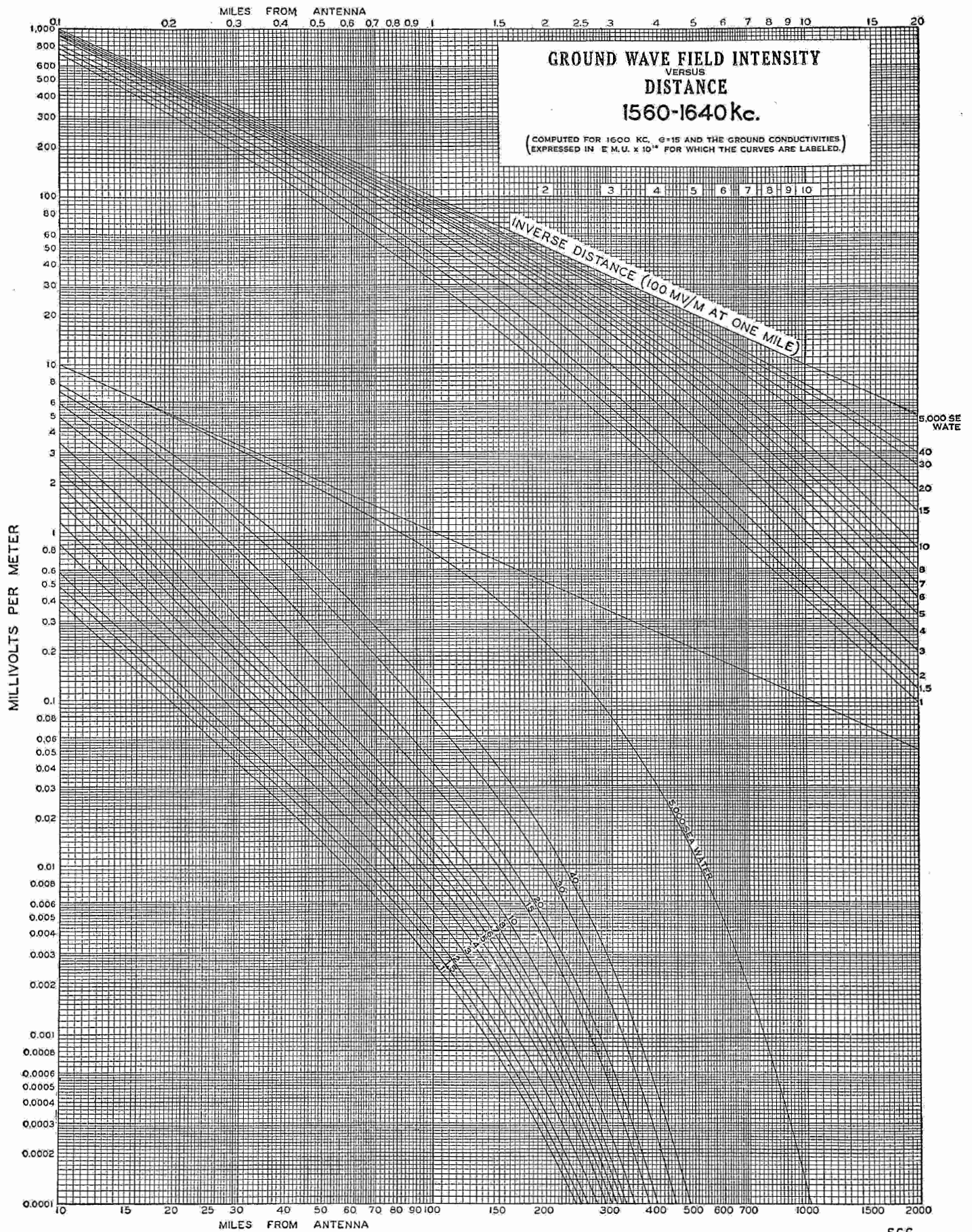
APPENDIX I - GRAPH 17



APPENDIX I - GRAPH 18



APPENDIX I - GRAPH 19



APPENDIX 1 - GRAPH 20

STANDARDS OF GOOD ENGINEERING PRACTICE CONCERNING FM BROADCAST STATIONS

I. Definitions

A. FM broadcast station.--The term "FM broadcast station" means a station employing frequency modulation in the FM broadcast band and licensed primarily for the transmission of radio-telephone emissions intended to be received by the general public.

B. Frequency modulation.--The term "frequency modulation" means a system of modulation where the instantaneous radio frequency varies in proportion to the instantaneous amplitude of the modulating signal (amplitude of modulating signal to be measured after pre-emphasis, if used) and the instantaneous radio frequency is independent of the frequency of the modulating signal.

C. FM broadcast band.--The term "FM broadcast band" means the band of frequencies extending from 88 to 108 megacycles, which includes those assigned to noncommercial educational broadcasting.

D. Center frequency.--The term "center frequency" means:

(1) The average frequency of the emitted wave when modulated by a sinusoidal signal.

(2) The frequency of the emitted wave without modulation.

E. Frequency swing.--The term "frequency swing" means the instantaneous departure of the frequency of the emitted wave from the center frequency resulting from modulation.

F. FM broadcast channel.--The term "FM broadcast channel" means a band of frequencies 200 kilocycles wide and is designated by its center frequency. Channels for FM broadcast stations begin at 88.1 megacycles and continue in successive steps of 200 kilocycles to and including 107.9 megacycles.

G. Antenna field gain.--The term "antenna field gain" of an FM broadcast antenna means the ratio of the effective free space field intensity produced at one mile in the horizontal plane expressed in millivolts per meter for 1 kilowatt antenna input power to 137.6 mv/m.

H. Free space field intensity.--The term "free space field intensity" means the field intensity that would exist at a point in the absence of waves reflected from the earth or other reflecting objects.

I. Multiplex transmission.--The term "multiplex transmission" means the simultaneous transmission of two or more signals within a single

channel. Multiplex transmission as applied to FM broadcast stations means the transmission of facsimile or other signals in addition to the regular broadcast signals.

J. Percentage modulation.--The term "percentage modulation" as applied to frequency modulation means the ratio of the actual frequency swing to the frequency swing defined as 100 percent modulation, expressed in percentage. For FM broadcast stations a frequency swing of ± 75 kilocycles is defined as 100 percent modulation.

K. Effective radiated power.--The term "effective radiated power" means the product of the antenna power (transmitter output power less transmission line loss) times (1) the antenna power gain, or (2) the antenna field gain squared. Where circular or elliptical polarization is employed the term effective radiated power is applied separately to the horizontal and vertical components of radiation. For allocation purposes, the effective radiated power authorized is the horizontally polarized component of radiation only.

L. Service area.--The term "service area" as applied to FM broadcasting means the service resulting from an assigned effective radiated power and antenna height above average terrain.

M. Antenna height above average terrain.--
(1) The term "antenna height above average terrain" means the height of the radiation center of the antenna above the terrain 2 to 10 miles from the antenna. (In general a different antenna height will be determined for each direction from the antenna. The average of these various heights is considered as the antenna height above average terrain.)

(2) Where circular or elliptical polarization is employed the antenna height above average terrain shall be based upon the height of the radiation center of the antenna which transmits the horizontal component of radiation.

N. Field intensity.--The term "field intensity" as used in these standards shall mean the electric field intensity in the horizontal direction.

O. Index of cooperation.--The index of cooperation as applied to facsimile broadcasting is the product of the number of lines per inch, the available line length in inches, and the reciprocal of the line-use ratio (e.g., $105 \times 8.2 \times 8/7 = 984$).

P. Line-use ratio.--The term "line-use ratio" as applied to facsimile broadcasting is

the ratio of the available line to the total length of scanning line.

Q. Available line.--The term "available line" means the portion of the total length of scanning line that can be used specifically for picture signals.

R. Rectilinear scanning.--The term "rectilinear scanning" means the process of scanning an area in a predetermined sequence of narrow straight parallel strips.

S. Optical density.--The term "optical density" means the logarithm (to the base 10) of the ratio of incident to transmitted or reflected light.

2. ENGINEERING STANDARDS OF ALLOCATION

A. Sections 3.202 to 3.206 inclusive of the Rules and Regulations describe the basis for allocation of FM broadcast stations, including the division of the United States into Areas I and II.

B. FM broadcast stations shall determine the extent of their 1 mv/m and 50 uv/m contours in accordance with the methods prescribed in these Standards.

C. Although some service is provided by tropospheric waves, the service area is considered to be only that served by the ground wave. The extent of service is determined by the point at which the ground wave is no longer of sufficient intensity to provide satisfactory broadcast service. The field intensity considered necessary for service is as follows:

Table I

<u>Area</u>	<u>Median Field Intensity</u>
City business or factory areas	1 mv/m
Rural Areas	50 uv/m

A median field intensity of 3 to 5 mv/m should be placed over the principal city to be served and for class B stations, a median field intensity of 1 mv/m should be placed over the business district of cities of 10,000 or greater within the metropolitan district served. A field intensity of 5 mv/m should be provided over the main studio of a class B station except as otherwise provided in Section 3.205 of the Rules. The location of the main studio of a class A station is specified in Section 3.203 of the Rules. These figures are based upon the usual noise levels encountered in the several areas and upon the absence of interference from other FM stations.

D. A basis for allocation of satellite stations has not yet been determined. For the

present, applications will be considered on their individual merits.

E. The service area is predicted as follows:
--Profile graphs must be drawn for at least eight radials from the proposed antenna site. These profiles should be prepared for each radial beginning at the antenna site and extending to 10 miles therefrom. Normally the radials are drawn for each 45° of azimuth; however, where feasible the radials should be drawn for angles along which roads tend to follow. (The latter method may be helpful in obtaining topographical data where otherwise unavailable, and is particularly useful in connection with mobile field intensity measurements of the station and the correlation of such measurements with predicted field intensities.) In each case one or more radials must include the principal city or cities to be served, particularly in cases of rugged terrain, even though the city may be more than 10 miles from the antenna site. The profile graph for each radial should be plotted by contour intervals of from 40 to 100 feet and, where the data permits, at least 50 points of elevation (generally uniformly spaced) should be used for each radial. In instances of very rugged terrain where the use of contour intervals of 100 feet would result in several points in a short distance, 200- or 400-foot contour intervals may be used for such distances. On the other hand, where the terrain is uniform or gently sloping the smallest contour interval indicated on the topographic map (see below) should be used, although only a relatively few points may be available. The profile graph should accurately indicate the topography for each radial, and the graphs should be plotted with the distance in miles as the abscissa and the elevation in feet above mean sea level as the ordinate. The profile graphs should indicate the source of the topographical data employed. The graph should also show the elevation of the center of the radiating system. The graph may be plotted either on rectangular coordinate paper or on special paper which shows the curvature of the earth. It is not necessary to take the curvature of the earth into consideration in this procedure, as this factor is taken care of in the chart showing signal intensities (fig. 1).

The average elevation of the 8-mile distance between 2 and 10 miles from the antenna site should then 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 for 50 percent of the distance) in sectors and averaging these values.

To determine the distance to a particular contour, figure 1 concerning the range of FM broadcast stations should be used. This chart has been prepared for a frequency in the center of the band and is to be used for all FM broadcast channels, since little change results over this frequency range. The distance to a contour

is determined by the effective radiated power and the antenna height. The height of the antenna used in connection with figure 1 should be the height of the center of the proposed antenna radiator above the average elevation obtained by the preceding method. The distances shown by figure 1 are based upon an effective radiated power of 1 kilowatt; to use the chart for other powers, the sliding scale associated with the chart should be trimmed and used as the ordinate scale. This sliding scale is placed on the chart with the appropriate gradation for power in line with the lower line of the top edge of the chart. The right edge of the scale is placed in line with the appropriate antenna height graduations and the chart then becomes direct reading for this power and antenna height. Where the antenna height is not one of those for which a scale is provided, the signal strength or distance is determined by interpolation between the curves connecting the equidistant points.

The foregoing process of determining the extent of the required contours shall be followed in determining the boundary of the proposed service area. The areas within the required contours must be determined and submitted with each application for these classes of FM broadcast stations. Each application shall include a map showing these contours, and for this purpose sectional aeronautical charts or other maps having a convenient scale may be used. The map shall show the radials along which the profile charts and expected field strengths have been determined. The area within each contour should then be measured (by planimeter or other approximate means) to determine the number of square miles therein. In computing the area within the contours, exclude (1) areas beyond the borders of the United States, and (2) large bodies of water, such as ocean areas, gulfs, sounds, bays, large lakes, etc., but not rivers.

In cases where the terrain in one or more directions from the antenna site departs widely from the average elevation of the 2 to 10 mile sector, the application of this prediction method may indicate contour distances that are different from those which may be expected in practice. In such cases the prediction method should be followed, but a showing may be made if desired concerning the distance to the contour as determined by other means. Such showing should include data concerning the procedure employed and sample calculations. For example, a mountain ridge may indicate the practical limit of service although the prediction method may indicate the contour elsewhere. In cases of such limitation, the map of predicted coverage should show both the regular predicted area and the area as limited or extended by terrain. Both areas should be measured as previously described; the area obtained by the regular prediction method should be given in the application form, with a supplementary note giving the limited or extended

area. In special cases the Commission may require additional information as to the terrain in the proposed service area.

In determining the population served by FM broadcast stations, it is considered that the built-up city areas and business districts in cities having over 10,000 population and located beyond the 1 mv/m contour do not receive adequate service. Minor civil division maps (1940 census) should be used in making population counts, excluding cities not receiving adequate service. Where a contour divides a minor division, uniform distribution of population within the division should be assumed in order to determine the population included within the contour unless a more accurate count is available.

3. TOPOGRAPHICAL DATA

In the preparation of the profile graphs previously described, the elevations or contour intervals shall be taken from the U. S. Geological Topographical Quadrangle Sheets for all areas for which such maps are available. If such maps are not published for the area in question, the next best topographic information should be used. Topographic data may sometimes be obtained from state and municipal agencies. The data from the Sectional Aeronautical Charts (including bench marks), or railroad depot elevations and highway elevations from road maps, may be used where no better information is available. In cases where limited topographic data can be obtained, use may be made of an altimeter in a car driven along roads extending generally radially from the transmitter site.

The Commission will not ordinarily require the submission of topographical maps for areas beyond 15 miles from the antenna site, but the maps must include the principal city or cities to be served. If it appears necessary, additional data may be requested.

The U. S. Geological Survey Topography Quadrangle Sheets may be obtained from the U. S. Geological Survey, Department of the Interior, Washington, D. C., for ten cents each. The Sectional Aeronautical Charts are available from the U. S. Coast and Geodetic Survey, Department of Commerce, Washington, D. C., for twenty-five cents each. Other sources of topographic maps or data will be furnished at a later date.

4. INTERFERENCE STANDARDS

Field intensity measurements are preferable in predicting interference between FM broadcast stations and should be used, when available, in determining the extent of interference. (For methods and procedure, see sec. 5). In lieu of measurements, the interference should be predicted in accordance with the method described herein.

Objectionable interference is considered to exist when the interfering signal exceeds that

given by the ratios of Table II. In Table II the desired signal is median field and the undesired signal is the tropospheric signal intensity exceeded for 1 per cent of the time.

TABLE II

<u>Channel Separation</u>	<u>Ratio of desired to undesired signals</u>
Same channel	10:1
200 kc.	2:1
400 kc.	To be determined
600 kc.	To be determined
800 kc. and above	No restriction ¹

Standards have not been established for channel separations in excess of 200 kc; various types of present FM receivers are under study by the Commission to provide data for determining such standards. Pending the completion of such studies and the promulgation of such standards, stations normally will not be authorized to operate in the same city or in nearby cities with a frequency separation of less than 800 kc, provided that stations may be authorized to operate in nearby cities with a frequency separation of not less than 400 kc where necessary in order to provide an equitable and efficient distribution of facilities, and provided further that class B stations will not be authorized in the same metropolitan district with a frequency separation of less than 800 kc. In the assignment of FM broadcast facilities the Commission will endeavor to provide the optimum use of the channels in the band, and accordingly may assign a channel different from that requested in an application.

In predicting the extent of interference within the ground wave service area of a station, the tropospheric signal intensity (from co-channel and adjacent channel stations) existing for 1 per cent of the time shall be employed. The 1 per cent values for 1 kilowatt of power and various antenna heights are given in figure 2, and values for other powers may be obtained by use of the sliding scale as for figure 1. The values indicated by figure 2 are based upon available data, and are subject to change as additional information concerning tropospheric wave propagation is obtained.²

¹Intermediate frequency amplifiers of most FM broadcast receivers are designed to operate on 10.7 megacycles. For this reason the assignment of two stations in the same area, one with a frequency 10.6 or 10.8 megacycles removed from that of the other, should be avoided if possible.

²Fig. 2 will be available at some future date when sufficient measurements of tropospheric signals are available. Until that time, interference should be predicted on the basis of the ground wave chart. (Fig. 1).

In determining the points at which the interference ratio is equal to the values shown in Table II, the field intensities for the two interfering signals under consideration should be computed for a considerable number of points along the line between the two stations. Using this data, field intensity versus distance curves should be plotted (e.g., cross-curves on graph paper) in order to determine the points on this path where the interference ratios exist. The points established by this method together with the points along the contours where the same ratios are determined, are considered to be generally sufficient to predict the area of interference. Additional points may be required in the case of irregular terrain or the use of directional antenna systems.

The area of interference, if any, shall be shown in connection with the map of predicted coverage required by the application form, together with the basic data employed in computing such interference. The map shall show the interference within the 50 uv/m contour.

5. FIELD INTENSITY MEASUREMENTS IN ALLOCATIONS

When field intensity measurements are required by the Commission's rules or when employed in determining the extent of service or interference of existing stations, such measurements should be made in accordance with the procedure outlined herein.

Measurements made to determine the service and interference areas of FM broadcast stations should be made with mobile equipment along roads which are as close and similar as possible to the radials showing topography which were submitted with the application for construction permit. Suitable measuring equipment and a continuous recording device must be employed, the chart of which is either directly driven from the speedometer of the automobile in which the equipment is mounted or so arranged that distances and identifying landmarks may be readily noted. The measuring equipment must be calibrated against recognized standards of field intensity and so constructed that it will maintain an acceptable accuracy of measurement while in motion or when stationary. The equipment should be so operated that the recorder chart can be calibrated directly in field intensity in order to facilitate analysis of the chart. The receiving antenna shall be nondirectional and primarily responsive to the horizontal electric field.

Mobile measurements should be made with a minimum chart speed of 3 inches per mile and preferably 5 or 6 inches per mile. Locations shall be noted on the recorder chart as frequently as necessary to definitely fix the relation between the measured field intensity and the location. The time constant of the equipment should be such to permit adequate analysis of the charts, and the time constant employed shall be

shown. Measurements should be made to a point on each radial well beyond the particular contour under investigation. The transmitter power shall be maintained as close as possible to the authorized power throughout the survey.

After the measurements are completed, the recorder chart shall be divided into not less than 15 sections on each equivalent radial from the station. The field intensity in each section of the chart shall be analyzed to determine the field intensity received 50 percent of the distance (median field) throughout the section, and this median field intensity associated with the corresponding sector of the radial. The field intensity figures must be corrected for a receiving antenna elevation of 30 feet and for any directional effects of the automobile not otherwise compensated. This data should be plotted for each radial, using log-log coordinate paper with distance as the abscissa and field intensity as the ordinate. A smooth curve should be drawn through these points (of median fields for all sectors), and this curve used to determine the distance to the desired contour. The distances obtained for each radial may then be plotted on the map of predicted coverage or on polar coordinate paper (excluding water areas, etc.) to determine the service and interference areas of a station.

In making measurements to establish the field intensity contours of a station, mobile recordings should be made along each of the radials drawn in section 2E above. Measurements should extend from the vicinity of the station out to the 1000 uv/m measured contour and somewhat beyond (at the present time it is not considered practical to conduct mobile measurements far beyond this contour due to the fading ratio at weak fields, which complicates analysis of the charts). These measurements would be made for the purpose of determining the variation of the measured contours from those predicted, and it is expected that initially the correlation of the measured 1000 uv/m. with the predicted 1000 uv/m. contour will be used as a basis in determining adherence to authorized service areas within the 50 uv/m. contour. Adjustment of power or antenna may be required to fit the actual contours to that predicted.

In addition to the 1000 uv/m. contour, the map of measured coverage shall show the 50 uv/m. contour as determined by employing figure 1 and the distance to the 1000 uv/m. contour along each radial. The sliding scale shall be placed on the figure at the appropriate antenna height for the radial in question and then moved so the distance to the 1000 uv/m. contour (as measured) and the 1000 uv/m. mark are opposite. The distance to the 50 uv/m. contour is then given opposite the 50 uv/m. mark on the scale.

In predicting tropospheric interference on the basis of the above measurements, such meas-

urements shall be carried out in the manner indicated above to determine the 1000 uv/m. contour. Using figure 1 and its associated sliding scale, the equivalent radiated power shall be determined by placing the sliding scale on the chart (using the appropriate antenna height) and moving the scale until the distance to the 1000 uv/m. contour (as determined above), and the 1000 uv/m. mark are opposite. The equivalent radiated power is then read from the sliding scale where it crosses the lower line of the top edge of the chart. Changing to figure 2 and using the equivalent radiated power just determined, the distance to the interfering contour under investigation is read in the usual manner.

In certain cases the Commission may desire more information or recordings and in these instances special instructions will be issued. This may include fixed location measurements to determine tropospheric propagation and fading ratios.

Complete data taken in conjunction with field intensity measurements shall be submitted to the Commission in affidavit form, including the following:

(a) Map or maps showing the roads or points where measurements were made, the service and/or interference areas determined by the prediction method and by the measurements, and any unusual terrain characteristics existing in these areas. (This map may preferably be a type showing topography in the area.)

(b) If a directional transmitting antenna is employed, a diagram on polar coordinate paper showing the predicted free space field intensity in millivolts per meter at one mile in all directions. (See sec. 7.)

(c) A full description of the procedures and methods employed including the type of equipment, the method of installation and operation, and calibration procedures.

(d) Complete data obtained during the survey, including calibration.

(e) Antenna system and power employed during the survey.

(f) Name, address, and qualifications of the engineer or engineers making the measurements.

All data shall be submitted to the Commission in triplicate, except that only the original or one photostatic copy need be submitted of the actual recording tapes.

6. TRANSMITTER LOCATION

A. The transmitter location should be as near the center of the proposed service area as possible consistent with the applicant's ability to find a site with sufficient elevation to provide service throughout the area. Location of

provided full data is supplied in the application concerning the basis employed in establishing the rating and the need therefor. The operating range of such transmitters shall be from one-third of the power rating to the power rating.

The transmitter shall operate satisfactorily in the operating power range with a frequency swing of ± 75 kilocycles, which is defined as 100 percent modulation.

(2) The transmitting system shall be capable of transmitting a band of frequencies from 50 to 15,000 cycles. Preemphasis shall be employed in accordance with the impedance-frequency characteristic of a series inductance-resistance network having a time constant of 75 microseconds. (See fig. 3.) The deviation of the system response from the standard preemphasis curve shall lie between two limits as shown in figure 3. The upper of these limits shall be uniform (no deviation) from 50 to 15,000 cycles. The lower limit shall be uniform from 100 to 7,500 cycles, and 3 db. below the upper limit; from 100 to 50 cycles the lower limit shall fall from the 3 db. limit at a uniform rate of 1 db. per octave (4 db. at 50 cycles); from 7,500 to 15,000 cycles the lower limit shall fall from the 3 db. limit at a uniform rate of 2 db. per octave (5 db. at 15,000 cycles).

(3) At any modulation frequency between 50 and 15,000 cycles and at modulation percentages of 25, 50, and 100 percent, the combined audio frequency harmonics measured in the output of the system shall not exceed the root-mean-square values given in the following table:

Modulating frequency:	<i>Distortion percent</i>
50 to 100 cycles-----	3.5
100 to 7,500 cycles-----	2.5
7,500 to 15,000 cycles-----	3.0

Measurements shall be made employing 75 microsecond deemphasis in the measuring equipment and 75 microsecond preemphasis in the transmitting equipment, and without compression if a compression amplifier is employed. Harmonics shall be included to 30 kc.³

It is recommended that none of the three main divisions of the system (transmitter, studio to transmitter circuit, and audio facilities) contribute over one-half of these percentages since at some frequencies the total distortion may become the arithmetic sum of the distortions of the divisions.

(4) The transmitting system output noise level (frequency modulation) in the band of 50

³See Sec. 13 for measurement frequencies and other information.

to 15,000 cycles shall be at least 60 decibels below the audio frequency level representing a frequency swing of ± 75 kilocycles. The noise-measuring equipment shall be provided with standard 75-microsecond deemphasis; the ballistic characteristics of the instrument shall be similar to those of the standard VU meter.

(5) The transmitting system output noise level (amplitude modulation) in the band of 50 to 15,000 cycles shall be at least 50 decibels below the level representing 100 percent amplitude modulation. The noise-measuring equipment shall be provided with standard 75-microsecond deemphasis; the ballistic characteristics of the instrument shall be similar to those of the standard VU meter.

(6) Automatic means shall be provided in the transmitter to maintain the assigned center frequency within the allowable tolerance (± 2000 cycles).

(7) The transmitter shall be equipped with suitable indicating instruments for the determination of operating power and with other instruments as are necessary for proper adjustment, operation, and maintenance of the equipment (see sec. 9).

(8) Adequate provision shall be made for varying the transmitter output power to compensate for excessive variations in line voltage or for other factors affecting the output power.

(9) Adequate provision shall be provided in all component parts to avoid overheating at the rated maximum output power.

(10) Means should be provided for connection and continuous operation of approved frequency and modulation monitors.

(11) If a limiting or compression amplifier is employed, precaution should be maintained in its connection in the circuit due to the use of preemphasis in the transmitting system.

B. Construction.--In general, the transmitter shall be constructed either on racks and panels or in totally enclosed frames protected as required by article 810⁴ of the National Electrical Code and set forth below:

(1) Means shall be provided for making all tuning adjustments, requiring voltages in excess of 350 volts to be applied to the circuit, from the front of the panels with all access doors closed.

(2) Proper bleeder resistors or other automatic means shall be installed across all capacitor banks to lower any voltage which may remain accessible with access door open to less than 350 volts within 2 seconds after the access door is opened.

(3) All plate supply and other high voltage equipment, including transformers, filters, rectifiers and motor generators, shall be protected so as to prevent injury to operating personnel.

(a) Commutator guards shall be provided on all high voltage rotating machinery. Coupling guards should be provided on motor generators.

(b) Power equipment and control panels of the transmitter shall meet the above requirements (exposed 220 volt AC switching equipment on the front of the power control panels is not recommended but is not prohibited).

(c) Power equipment located at a broadcast station but not directly associated with the transmitter (not purchased as part of same), such as power distribution panels, are not under the jurisdiction of the Commission; therefore Section 3.254 does not apply.

(4) Metering equipment.

(a) All instruments having more than 1,000 volts potential to ground on the movement shall be protected by a cage or cover in addition to the regular case. (Some instruments are designed by the manufacturer to operate safely with voltages in excess of 1,000 volts on the movement. If it can be shown by the manufacturer's rating that the instrument will operate safely at the applied potential, additional protection is not necessary.)

(b) In case the plate voltmeter is located on the low potential side of the multiplier resistor with the potential of the high potential terminal of the instrument at or less than 1,000 volts above

ground, no protective case is required. However, it is good practice to protect voltmeters subject to more than 5,000 volts with suitable over-voltage protective devices across the instrument terminals in case the winding opens.

(c) Transmission line meters and any other radio frequency instrument which may be necessary for the operator to read shall be so installed as to be easily and accurately read without the operator having to risk contact with circuits carrying high potential radio frequency energy.

(5) It is recommended that component parts comply as much as possible with the component specifications designated by the Army-Navy Electronics Standards Agency.

C. Wiring and shielding.--(1) The transmitter panels or units shall be wired in accordance with standard switchboard practice, either with insulated leads properly cabled and supported or with rigid busbar properly insulated and protected.

(2) Wiring between units of the transmitter, with the exception of circuits carrying radio frequency energy, shall be installed in conduits or approved fiber or metal raceways for protection from mechanical injury.

(3) Circuits carrying radio frequency energy between units shall be coaxial, two wire balanced lines, or properly shielded.

(4) All stages or units shall be adequately shielded and filtered to prevent interaction and radiation.

(5) The frequency and modulation monitors and associated radio frequency lines to the transmitter shall be thoroughly shielded.

D. Installation.--(1) The installation shall be made in suitable quarters.

(2) Since an operator must be on duty during operation, suitable facilities for his welfare and comfort shall be provided.

E. Spare tubes.--A spare tube of every type employed in the transmitter and frequency and modulation monitors shall be kept on hand at the equipment location. When more than one tube of any type are employed, the following table determines the number of spares of that type required:

Number of each type employed:	Spares required
1 or 2-----	1
3 to 5-----	2
6 to 8-----	3
9 or more-----	4

⁴The pertinent sections of article 810 of the National Electrical Code read as follows: "8191. *General*.--Transmitters shall comply with the following:

"a. *Enclosing*.--The transmitter shall be enclosed in a metal frame or grille, or separated from the operating space by a barrier or other equivalent means, all metallic parts of which are effectually connected to ground.

"b. *Grounding of controls*.--All external metallic handles and controls accessible to the operating personnel shall be effectually grounded. No circuit in excess of 150 volts shall have any parts exposed to direct contact. A complete dead-front type of switchboard is preferred.

"c. *Interlocks on doors*.--All access doors shall be provided with interlocks which will disconnect all voltages in excess of 350 volts when any access door is opened."

monitors at auxiliary transmitters of FM broadcast stations in compliance with these rules:

In case the auxiliary transmitter location is at a site different from that of the main transmitter, an approved frequency monitor shall be installed at the auxiliary transmitter except when the frequency of the auxiliary transmitter can be monitored by means of the frequency monitor at the main transmitter. When the auxiliary transmitter is operated without a frequency monitor under this exemption, it shall be monitored by means of the frequency monitor at the main transmitter.

The licensee will be held strictly responsible for any center frequency deviation of the auxiliary transmitter in excess of 2,000 cycles from the assigned frequency, even though exempted by the above from installing an approved frequency monitor.

Installation of an approved modulation monitor at the location of the auxiliary transmitter, when different from that of the main transmitter, is optional with the licensee. However, when it is necessary to operate the auxiliary transmitter beyond two calendar days, a modulation monitor shall be installed and operated at the auxiliary transmitter. The monitor (if taken from the main transmitter) shall be reinstalled at the main transmitter immediately upon resumption of operation of the main transmitter.

In all cases where the auxiliary transmitter and the main transmitter have the same location, the same frequency and modulation monitors may be used for monitoring both transmitters, provided they are so arranged as to be readily switched from one transmitter to the other.

13. REQUIREMENTS FOR TYPE APPROVAL OF TRANSMITTERS⁶

Section 3.254 of the Rules and section 8 of these Standards concern the design, construction, and technical operation of FM broadcast station equipment. In order to facilitate the filing of and action on applications for construction permits specifying equipment of standard manufacture, the Commission will approve, as complying with the technical requirements, such equipment by type, subject to the following conditions and in accordance with the following procedure:

A. Approval of equipment by the Commission is only to the effect that insofar as can be determined from the data supplied, the equipment complies with the current requirements of good engineering practice and the current technical Rules and Regulations of the Commission. The approval may be withdrawn upon subsequent inspection or operation showing the equipment is

not as represented or does not comply with the technical Rules and Regulations of the Commission and the requirements of good engineering practice.

B. Such approval shall not be construed to mean that the equipment will be satisfactory as the state of the art progresses and/or as the Rules and Regulations of the Commission may be changed as deemed advisable.

C. Applicants specifying equipment of approved manufacture need not submit detailed descriptions and diagrams where the correct type number is specified provided that the equipment proposed is identical with that approved.

D. In passing on equipment, no consideration is given by the Commission to patent rights.

E. For approval of FM broadcast transmitters manufacturers shall submit FCC Form 319 completed with respect to all pertinent sections (two sworn copies). In addition or included therein shall be the data set forth below, all of which shall be verified before a notary public.⁷

(1) Photographs or drawings, or any other evidence that construction is in accordance with the requirements of good engineering practice.

(2) Data and curves showing over-all audio frequency response from 50 to 15,000 cycles for approximately 25, 50, and 100 percent modulation. Measurements shall be made on at least the following modulation frequencies: 50, 100, 400, 5000, 10,000 and 15,000 cycles. This shall be plotted below a standard 75 microsecond preemphasis curve (see fig. 3).

(3) Data on audio frequency harmonics for 25, 50, and 100 percent modulation for the fundamental frequencies of 50, 100, 400, 1000, and 5000 cycles. Data on audio frequency harmonics for 100 percent modulation for fundamental frequencies of 10,000 and 15,000 cycles. Measurements shall include harmonics to 30,000 cycles. (Measurements at 10,000 and 15,000 cycles at 25 and 50 percent modulation are not practical at this time, due to the deemphasis in the measuring equipment.)

(4) Carrier hum and extraneous noise (AM and FM) generated within the equipment and measured as the level below 100 percent modulation.

(5) Means of varying output power to compensate for power supply voltage variations.

(6) Data and curves on mean frequency stability for variations in ambient temperatures over the ranges encountered in practice.

⁷In connection with its type approval of FM equipment, the Commission may send a representative to observe tests made of such equipment by the manufacturer.

⁶Tentative standard.

(7) Data and curves on frequency stability for variations in power supply voltage from 85 to 115 percent normal.

(8) Net sale price.

F. In case any manufacturer decides to produce a 100 kw. transmitter and submit data on it for approval, or any power rating not listed as standard, he shall give notice to the Commission which will release by public notice the manufacturer's name and the standard power rating of the transmitter to be produced at least 6 months prior to the delivery date or completion of such transmitter.

14. REQUIREMENTS FOR TYPE APPROVAL OF FREQUENCY MONITORS

Section 3.252 of the Rules requires each FM broadcast station to have in operation, at the transmitter, an approved frequency monitor independent of the frequency control of the transmitter. The frequency monitor shall be approved by the Commission and shall have a stability and accuracy of at least one-half (± 1000 cycles) of the permitted frequency deviation of the FM broadcast station. Visual indication of the operating frequency shall be provided.

A. General requirements.--In general a frequency monitor for FM broadcast stations requires a stable source of radio frequency energy whose frequency is accurately known and a means of comparing the transmitter center frequency with this stable source. The visual indicator is calibrated to indicate the deviation of the transmitter center frequency from the frequency assigned.

Approval of a frequency monitor for FM broadcast stations will be considered on the basis of data submitted by the manufacturer. Any manufacturer desiring to submit a monitor for approval shall supply the Commission with full details (two sworn copies).

In approving a frequency monitor based on these tests and specifications, the Commission merely recognizes that the type of monitor has the inherent capability of functioning in compliance with section 3.252, if properly constructed, maintained and operated. The Commission accepts no responsibility beyond this and further realizes that monitors may have a limited range over which the visual indicator will determine deviations. Accordingly, it may be necessary that adjunct equipment be used to determine major deviations.

No change whatsoever will be permitted in the monitors sold under approval number issued by the Commission except when the licensee or the manufacturer is specifically authorized to make such changes. When it is desired to make any change, either mechanical or electrical, the

details shall be submitted to the Commission for its consideration.

Approval is given subject to withdrawal if the unit proves defective in service and cannot be relied upon under usual conditions of maintenance and operation encountered in the average FM broadcast station. Withdrawal of approval means that no further units may be installed by FM broadcast stations for the purpose of complying with section 3.252; however, this will not affect units already sold unless it is found that there has been an unauthorized change in design or construction or that the material or workmanship is defective.

B. General specifications.--The general specifications that frequency monitors shall meet before they will be approved by the Commission are as follows:⁸

(1) The unit shall have an accuracy of at least ± 1000 cycles under ordinary conditions (temperature, humidity, power supply variations and other conditions which may affect its accuracy) encountered in FM broadcast stations throughout the United States, for any channel within the FM broadcast band.

(2) The range of the indicating device shall be at least from 2000 cycles below to 2000 cycles above the assigned center frequency.

(3) The scale of the indicating device shall be so calibrated as to be accurately read within at least 100 cycles.

(4) Means shall be provided for adjustment of the monitor indication to agree with an external standard.

(5) The monitor shall be capable of continuous operation and its circuit shall be such as to permit continuous monitoring of the transmitter center frequency.

(6) Operation of the monitor shall have no deleterious effect on the operation of the transmitter or the signal emitted therefrom.

C. Tests to be made for approval of FM broadcast frequency monitors.--The manufacturer of a monitor shall submit data on the following at the time of requesting approval:

(1) Constancy of oscillator frequency, as measured several times in 1 month.

(2) Constancy of oscillator frequency when subjected to vibration tests which would corre-

⁸In connection with its type approval of FM equipment, the Commission may send a representative to observe tests made of such equipment by the manufacturer.

17. APPROVED FREQUENCY MONITORS

MANUFACTURER'S NAME	TYPE NO.
Doolittle Radio, Inc., Chicago, Ill.	FD11
General Electric Company, Schenectady, N. Y.	EM-1-A
Radio Engineering Laboratories, Long Island City, N. Y.	600
Hewlett-Packard Co., Palo Alto, Calif.	335B

18. APPROVED MODULATION MONITORS

MANUFACTURER'S NAME	TYPE NO.
Doolittle Radio, Inc., Chicago, Ill.	FD11
General Electric Company, Schenectady, N. Y.	EM-1-A
Radio Engineering Laboratories, Long Island City, N. Y.	600
Hewlett-Packard Co., Palo Alto, Calif.	335B

19. FM BROADCAST APPLICATION FORMS

FCC Form 301. --Application for Authority to Construct a New Broadcast Station or Make Changes in an Existing Broadcast Station.

FCC Form 302. --Application for New Broadcast Station License.

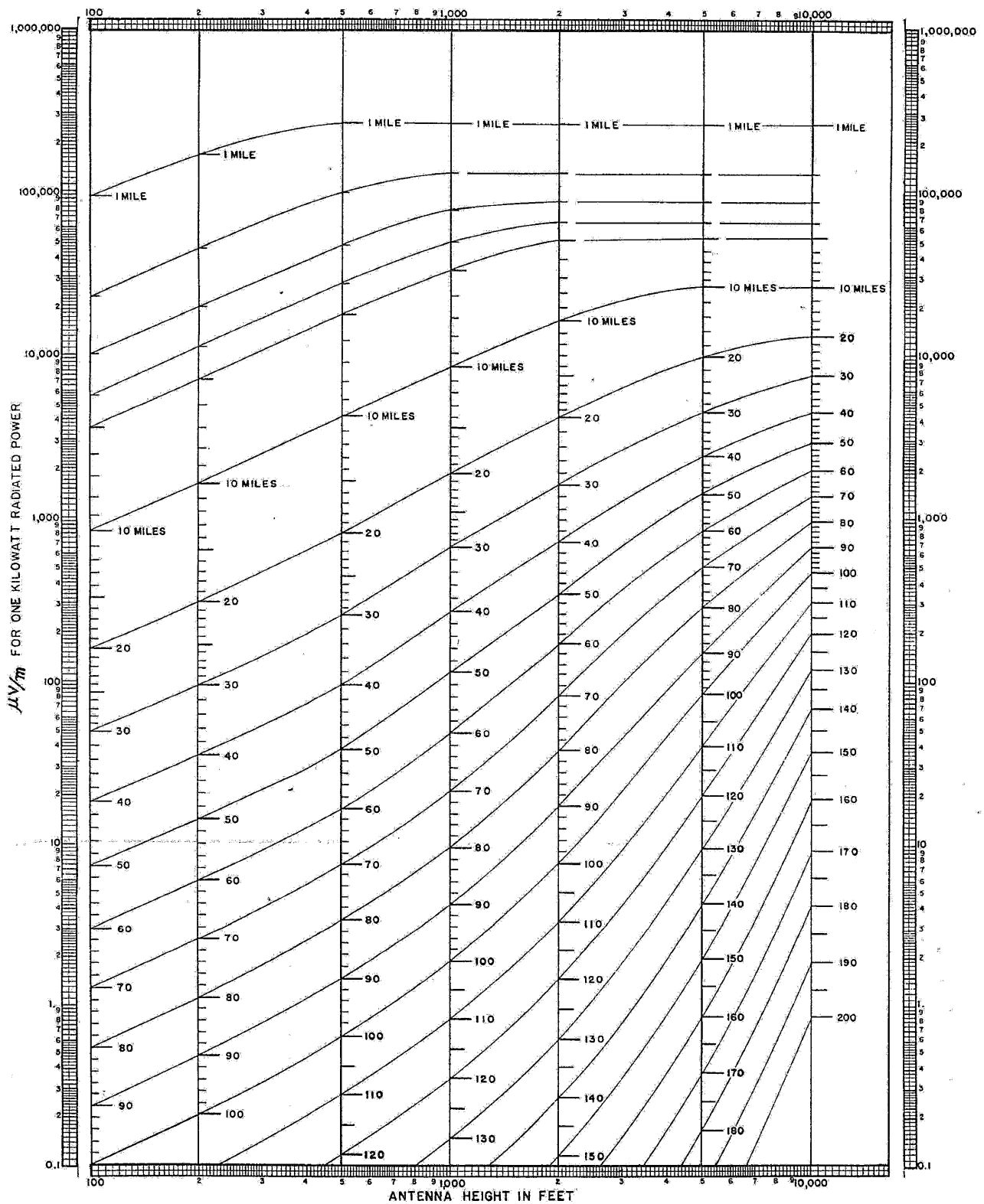
FCC Form 303. --Application for Renewal of Broadcast Station License.

FCC Form 314. --Application for Consent to Assignment of Radio Broadcast Station Construction Permit or License.

FCC Form 315. --Application for Consent to Transfer of Control of Corporation Holding Radio Broadcast Station Construction Permit or License.

FCC Form 321. --Application for Construction Permit to Replace Expired Permit.

FCC Form 701. --Application for Additional Time to Construct a Radio Station.



GROUND WAVE SIGNAL RANGE FOR F M BROADCASTING

98mc, $\sigma = 5 \times 10^{-6}$ s.m.u., $\epsilon = 15$, RECEIVING ANTENNA HEIGHT 30 FEET
 FOR HORIZONTAL (AND APPROX. FOR VERTICAL) POLARIZATION

FIGURE 1.

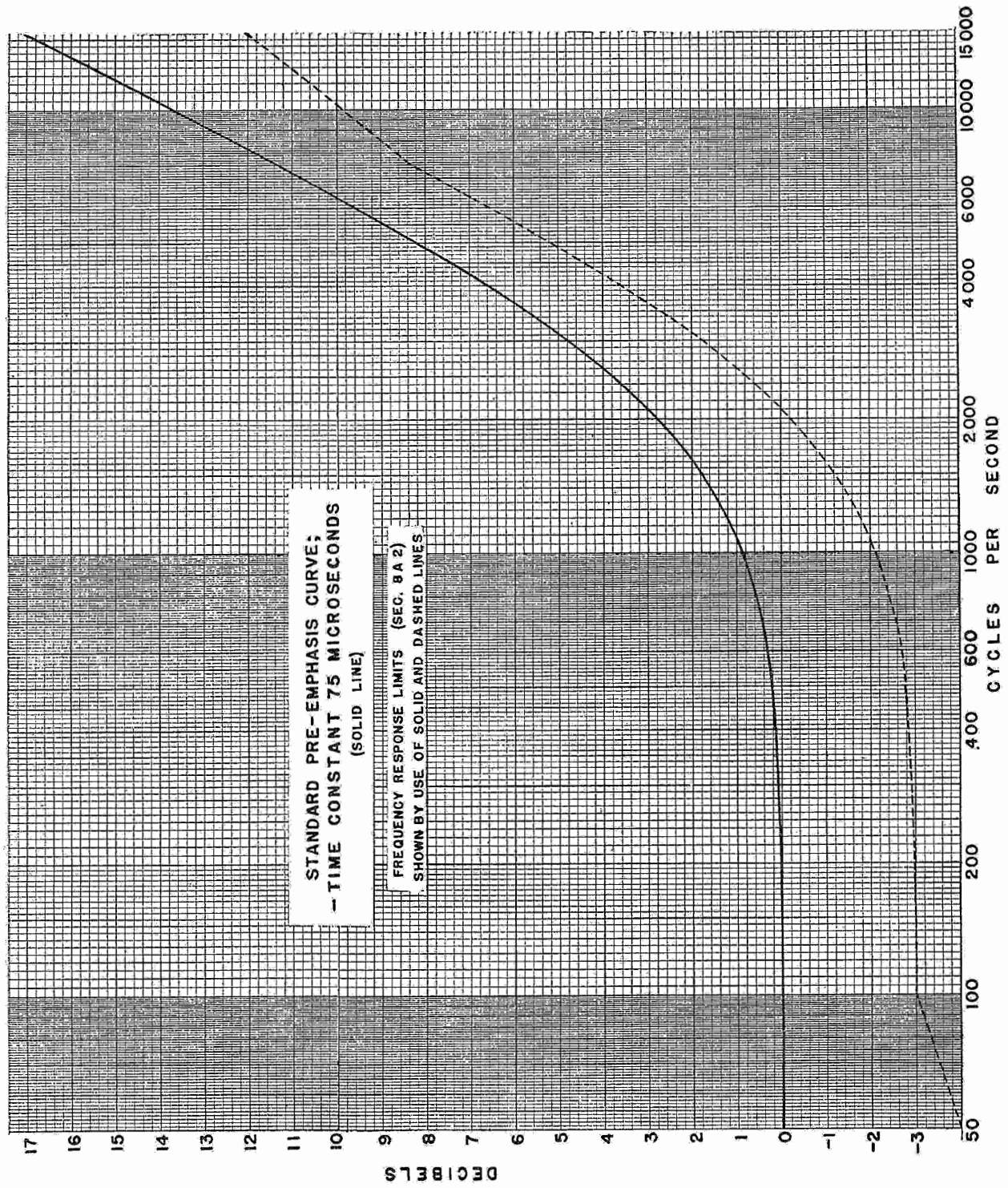


FIGURE 3.