

Full Text of North American Regional Broadcasting Agreement

(Allocations Treaty Adopted at Havana, December 13, 1937)

Governments Participating—Canada, Cuba, Dominican Republic, Haiti, Mexico and United States

I

Purpose and Scope of This Agreement

1. *Purpose of Agreement*—The purpose of this Agreement is to regulate and establish principles covering the use of the standard broadcast band in the North American Region so that each country may make the most effective use thereof with the minimum technical interference between broadcast stations.

2. *North American Region*—The North American Region (hereinafter referred to as "Region") for the purpose of this Agreement shall be deemed to include and to consist of the following countries: Canada, Cuba, Dominican Republic, Haiti, Mexico, Newfoundland, and United States of America.

3. *Standard broadcast band*—The standard broadcast band shall be deemed to be the band of frequencies extending from 550 to 1600 kc, both inclusive, both 550 kc and 1600 kc being the carrier frequencies of broadcasting channels as hereinafter defined. The Governments agree, subject to the provisions of Article 7 of the General Radio Regulations annexed to the International Telecommunications Convention Madrid, 1932, that this band of frequencies shall be allocated exclusively to broadcasting in the Region.

4. *Sovereign right to use channels*—The sovereign right of all countries, parties to this Agreement, to the use of every channel in the standard broadcast band is recognized. The Governments recognize, however, that until technical developments reach a state permitting the elimination of radio interference of international character, a regional arrangement between them is necessary in order to promote standardization and to minimize interference.

5. *Regional character of Agreement*—The Governments recognize that this Agreement, and each provision thereof, is a regional arrangement within the meaning of, and authorized by the International Telecommunications Convention and the General Radio Regulations annexed thereto.

II

Technical

A. Definitions

1. *Broadcast station*—A station the emissions of which are primarily intended to be received by the general public.

2. *Broadcast channels—550 to 1600 kc.*—A broadcast channel is a band of frequencies ten (10) kc. in width, with the carrier frequency at the center. Channels shall be designated by their assigned carrier frequencies. Carrier frequencies assigned to broadcast stations shall begin at 550 kc. and be in successive steps of 10 kc. No intermediate frequency shall be assigned as the carrier frequency of any broadcast station.

3. *Service areas:*

(a) *Primary service area*—The primary service area of a broadcast station is the area in which the ground wave is not subject to objectionable interference or objectionable fading.

(b) *Secondary service area*—The secondary service area of a broadcast station is the area served by the sky wave and not subject to objectionable interference. The signal is subject to intermittent variations in intensity.

4. *Dominant stations*—A "dominant" station is a Class I station, as hereinafter defined, operating on a clear channel.

5. *Secondary station*—A "secondary" station is any station except a Class I station operating on a clear channel.

6. *Objectionable interference*—Objectionable interference is the degree of interference produced when, at a specified boundary or field intensity contour with respect to the desired

Following is the complete text of the treaty governing the distribution of the 106 channels in the broadcast band, ranging from 550 to 1600 kc., drawn up at the Inter-American Radio Conference in Havana, Nov. 1 to Dec. 13, 1937. The treaty became valid when the four principal nations (United States, Canada, Mexico and Cuba) ratified it. It provides that it may be made effective one year after ratification, to remain in force for five years. Cuba ratified Dec. 22, 1937; the United States, June 15, 1938; Canada, Nov. 29, 1938; Mexico, Dec. 28, 1939. Effective date is to be ordered some time in 1940 by agreement of the signatory administrations.

station, the field intensity of an undesired station (or the root-mean-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 hereinafter set forth in this Agreement.

7. *Power*—The power of a radio transmitter is the power supplied to the antenna. The power in the antenna of a modulated-wave transmitter shall be expressed in two numbers, one indicating the power of the carrier frequency supplied to the antenna, and the other the actual maximum percentage of modulation.

8. *Spurious radiation*—A spurious radiation from a transmitter is any radiation outside the frequency band of emission normal for the type of transmission employed, including any harmonic modulation products, key clicks, parasitic oscillations and other transient effects.

9. *English, French and Spanish equivalents*—It is agreed that, as used in this Agreement, the French and Spanish words below set forth are respectively the equivalent of, and mean the same as, the English terms opposite which they appear:

English	French	Spanish
Clear channel	fréquence libre	canal despejado
Objectionable interference	Brouillage nuisible	Interferencia objetable

Classes of Channels and Allocation Thereof

1. *Three classes*—The 106 channels in the standard broadcast band are divided into three principal classes—clear, regional and local.

2. *Clear channel*—A clear channel is one on which the dominant station or stations render service over wide areas and which are cleared of objectionable interference, within their primary service areas and over all or a substantial portion of their secondary service areas.

3. *Regional channel*—A regional channel is one on which several stations may operate with powers not in excess of 5 kw. The primary service area of a station operating on any such channel may be limited, as a consequence of interference, to a given field intensity contour.

4. *Local channel*—A local channel is one on which several stations may operate with powers not in excess of 250 watts. The primary service area of a station operating on any such

channel may be limited, as a consequence of interference, to a given field intensity contour.

5. *Number of channels of each class*—The number of channels of each class shall be as follows:

Clear channels	59
Regional channels	41
Local channels	6

106

6. *Allocation of specific channels to each class*—The channels are allocated to the several classes as follows:

Clear channels. The following channels are designated as clear channels: 640 650 660 670 680 690 700 710 720 730 740 750 760 770 780 800 810 820 830 840 850 860 870 880 890 900 940 990 1000 1010 1020 1030 1040 1050 1060 1070 1080 1090 1100 1110 1120 1130 1140 1160 1170 1180 1190 1200 1210 1220 1500 1510 1520 1530 1540 1550 1560 1570 and 1580.

Regional channels. The following channels are designated as regional channels: 550 560 570 580 590 600 610 620 630 790 910 920 930 950 960 970 980 1150 1250 1260 1270 1280 1290 1300 1310 1320 1330 1350 1360 1370 1380 1390 1410 1420 1430 1440 1460 1470 1480 1590 1600.

Local channels. The following channels are designated as local channels: 1230 1240 1340 1400 1450 and 1490 kc.

7. *Use of regional and local channels by countries*—All countries may use all regional and all local channels, subject to the power limitations and standards for prevention of objectionable interference set forth in this Agreement.

8. *Priority of use of clear channels by countries*—

(a) The clear channels are assigned for priority of use by Class I and II stations in the several countries in accordance with the table set forth in Appendix I.

(b) Each such channel shall be used in a manner conforming to the best engineering practice with due regard to the service to be rendered by the dominant stations operating thereon, as set forth elsewhere in this Agreement. If, for one year within the term of this Agreement, a country fails to make any use of a clear channel thus assigned to it, the channel shall be considered open for use by the other countries, parties to this Agreement, pursuant to such arrangements as may be agreed upon by their respective administrations and without any necessity for revision of this Agreement.

(c) No country to which a clear channel has been thus assigned shall permit, or agree to permit, any other country to use such channel in a manner not in conformity with this Agreement without first giving 60 days (calendar days) advance notice of its intention so to do to all other countries, parties to this Agreement. If during this period of 60 days (calendar days) any other country shall present objections to such proposed use of the channel, the country to which the clear channel has been assigned shall not permit, or agree to permit, such proposed use until the difference presented by the objection has been amicably resolved.

(d) If within the period of this Agreement the country to which a clear channel has been assigned shall have made use of the channel but not in the manner above prescribed or not to the extent required by the provisions of this Agreement, such country shall be considered as having relinquished that portion of the rights which it has not used and at the expiration of this Agreement the other countries party thereto shall have the right, if they see fit, to withdraw the unused privileges from such country and to reassign them to any or all of the other interested countries.

C—Classes of Stations and Use of The Several Classes of Channels

1. *Classes of stations*—Broadcast stations are divided into four principal

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Changes of Channel Assignments Under the Havana Treaty

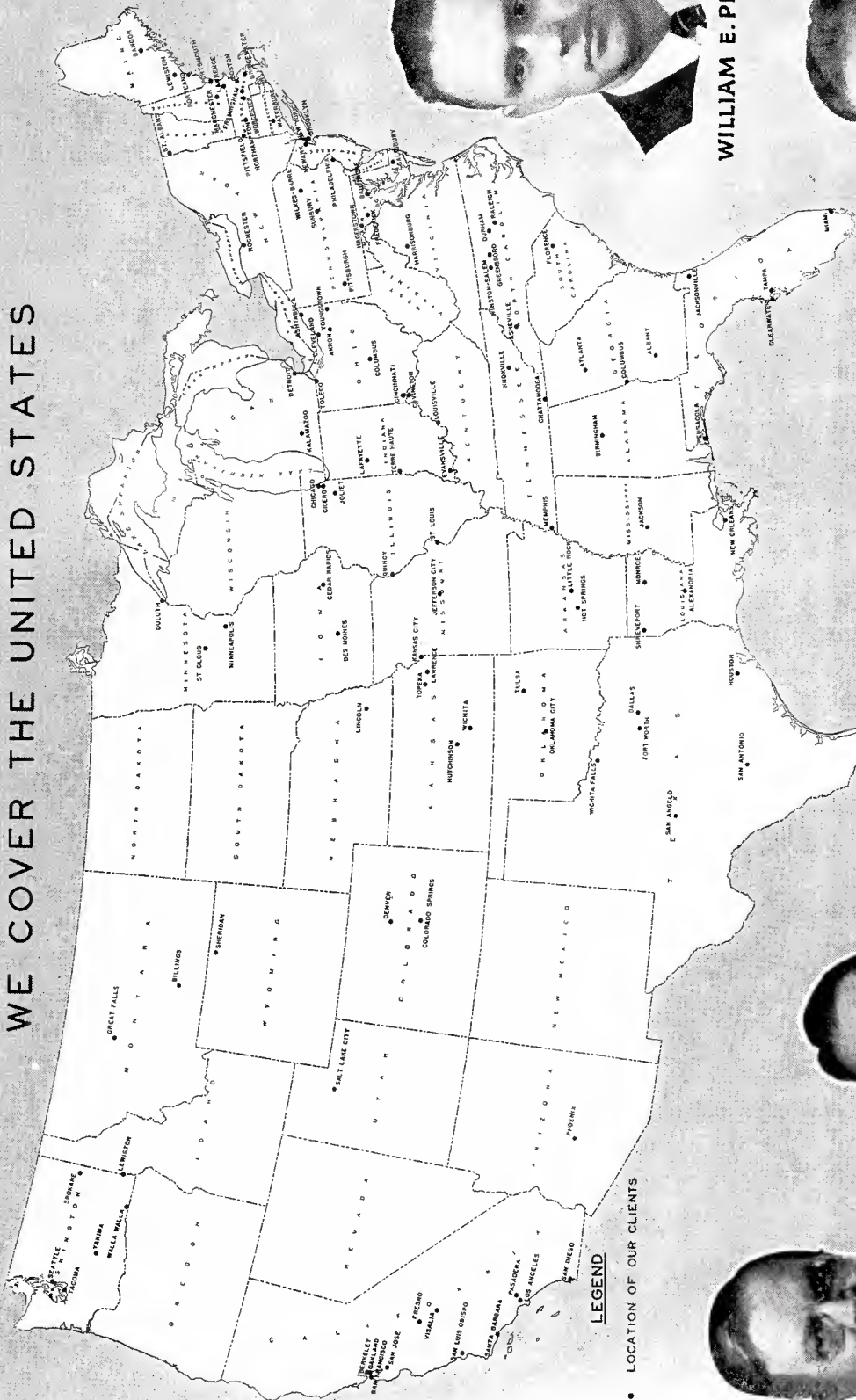
A broadcast station assigned to a channel in Column 1 will be changed to the channel on the same horizontal line in Column 2 to comply with North American Regional Broadcasting Agreement (see note). Figures indicate kilocycles.

Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2
550	550	910	*	1260	1290
560	560	920	950	1270	1300
570	570	930	960	1280	1310
580	580	940	970	1290	1320
590	590	950	980	1300	1330
600	600	960	*	1310	1340
610	610	970	1000	1320	1350
620	620	980	1020	1330	1360
630	630	990	1030	1340	1370
640	640	1000	1040	1350	1380
650	650	1010	690, 740,	1360	1390
660	660		990 or 1050	1370	1400
670	670	1020	1060	1380	1410
680	680	1030	*	1390	1420
690	*	1040	1080	1400	1430
700	700	1050	1070	1410	1440
710	710	1060	1090	1420	1450
720	720	1070	1100	1430	1460
730	*	1080	1110	1440	1470
740	750	1090	1120	1450	1480
750	760	1100	1130	1460	1500
760	770	1110	1140	1470	1510
770	780 or 1110	1120	1150	1480	1520
780	790	1130	1160	1490	1530
790	810	1140	1070 or 1170	1500	1490
800	820	1150	1180	1510	*
810	830	1160	1170 or 1190	1520	*
820	840	1170	1200	1530	1590
830	850	1180	1170 or 1200	1540	*
840	*	1190	1210	1550	1600
850	870	1200	1230	1560	*
860	880	1210	1240	1570	*
870	890	1220	1250	1580	*
880	910	1230	1260	1590	*
890	920	1240	1270	1600	*
900	930	1250	1280		

*Not assigned in U. S.

Some changes in individual cases not in accordance with the above change of channels may be necessary to avoid interference on adjacent channels or other considerations.

WE COVER THE UNITED STATES



LEGEND

• LOCATION OF OUR CLIENTS



WILLIAM E. PLUMMER



CLYDE H. BOND

**GLENN D. GILLETT
& ASSOCIATES**

Consulting Radio Engineers

WASHINGTON, D. C.



MARCY EAGER



GLENN D. GILLETT

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pal classes, to be designated Class I, Class II, Class III, and Class IV, respectively.

2. Definitions of classes—The four classes of broadcast stations are defined as follows:

Class I: A dominant station operating on a clear channel and designed to render primary and secondary service over an extended area and at relatively long distances. Class I stations are subdivided into two classes:

Class I-A: A Class I station which operates with power of 50 kw or more and which has its primary service area, within the limits of the country in which the station is located, free from objectionable interference from other stations on the same and adjacent channels, and its secondary service area, within the same limits, free from objectionable interference from stations on the same channel, in accordance with the engineering standards hereinafter set forth.

Class I-B: A Class I station which operates with power of not less than 10 kw or more than 50 kw and which has its primary service area free from objectionable interference from other stations on the same and adjacent channels and its secondary service area free from objectionable interference from stations on the same channel, in accordance with the engineering standards hereinafter set forth.

(a) When two Class I-B stations on the same channel are separated by a distance of 2500 miles or more, neither station shall be required to install a directional antenna.

(b) When two Class I-B stations on the same channel are separated by a distance of more than 1800 miles and less than 2500 miles, it will, in the absence of proof to the contrary, be assumed that each station is free of objectionable interference caused by the other and neither shall be required to install directional antennae or take other precautions to avoid such interference. In case the existence of objectionable interference is proved, the governments concerned will consult with each other regarding the desirability and practicality of installation of directional antennae or the taking of other precautions to eliminate the interference and will determine by special arrangement the measures, if any, to be taken.

(c) When two Class I-B stations on the same channel are separated by a distance less than 1800 miles, it will, in the absence of proof to the contrary, be assumed that the installation of directional antennae or the taking of other precautions to avoid interference is necessary, and the governments concerned will consult with each other and will take such measures as may be agreed upon between them to the end that the objectionable interference may be reduced or eliminated.

Class II: A "secondary" station which operates on a clear channel and is designed to render service over a primary service area which, depending on geographical location and power used, may be relatively large, but which is limited by and subject to such interference as may be received from Class I stations. A station of this class shall operate with power of not less than 0.25 kw, or more than 50 kw. Whenever necessary a Class II station shall use a directional antenna or other means to avoid interference, in accordance with the engineering standards hereinafter set forth, with Class I stations and with other Class II stations.

Class III: A station which operates on a regional channel and is designed to render service primarily to a metropolitan district and the rural area contained therein and contiguous thereto. Class III stations are subdivided into two classes:

Class III-A: A Class III station which operates with power not less than one kilowatt or more than five kilowatts and the service area of which is subject to interference in ac-

cordance with the engineering standards hereinafter set forth.

Class III-B: A Class III station which operates with a power not less than 0.5 kw or more than 1 kw night and 5 kw daytime and the service area of which is subject to interference in accord with the engineering standards hereinafter set forth:

Class IV: A station using a local channel and designed to render service primarily to a city or town and the suburban and rural areas contiguous thereto. The power of a station of this class shall not be less than 0.1 kw or more than 0.25 kw and its service area is subject to interference in accord with the engineering standards hereinafter set forth.

3. Change of class—If a station or stations in Class III-B located in any country can, through the use of directional antennae or otherwise, so reduce the interference caused or received by such station or stations to the field contour to which interference to stations in Class III-A is allowed, such station or stations shall automatically be classified and included in Class III-A and shall thereafter be so recognized and treated by the Administrations of all countries within the Region.

4. Use of clear channels:

(a) In principle and subject only to the exception hereinafter set forth, Class I stations shall be assigned only to clear channels.

(b) Class II stations may be assigned to clear channels only on condition that objectionable interference will not be caused to any Class I stations. Where any country has priority of use of a clear channel for any class I-A station, no other country shall assign any Class II station to that channel for nighttime operation (from sunset to sunrise at the location of the Class II station) unless such Class II station is located not less than 650 miles from the nearest border of the country in which the Class I-A station is located; provided, however, that where an assignment for a Class II station is specifically stated in Appendix I, such assignment shall be deemed as authorized under the limitations therein set forth.

5. Use of regional channels:

(a) In general only Class III-A and Class III-B stations shall be assigned to regional channels.

(b) On condition that interference be not caused to any Class III-A or Class III-B station, and subject to such interference as may be received from Class III-A or Class III-B stations, Class IV stations may be assigned to regional channels.

(c) Because of their geographical location with respect to the North American continent, special consideration will be given to the use by Cuba, the Dominican Republic, Haiti and Newfoundland of stations of Classes I and II assigned to certain regional channels under certain conditions, with respect to power and precautions to avoid objectionable interference as set forth in Appendix VII.

6. Use of local channels—Only Class IV stations shall be assigned to local channels.

D. Service and Interference

1. Satisfactory signal—It is recognized that, in the absence of interference from other stations and in regions where the natural electrical noise level is not abnormally high, a signal of 100 microvolts per meter constitutes a usable signal in rural and sparsely settled areas but that, because of the higher electrical noise levels in more thickly populated communities, greater field intensities (ranging as high as 25 millivolts or more in cities) are necessary to render satisfactory service. It is further recognized that it is not possible to accord protection to stations from objectionable interference over the entire areas over which their signals are or may be above the electrical noise level, particularly at night, and that it is necessary to specify boundaries

or contours at or within which stations are protected from objectionable interference from other stations.

2. Areas protected from objectionable interference—The boundaries or contours at and within which the several classes of stations shall be protected from objectionable interference are as set forth in Appendix II. No station, however, need be protected from objectionable interference at any point outside the boundaries of the country in which such station is located.

With respect to the root-mean-square values of interfering field intensities referred to herein, it shall be understood to apply in determining the interference between existing stations and no station thereafter assigned the channel shall increase the root-mean-square value of the interfering field intensity above the maximum specified in the attached tables.

3. Objectionable interference on the same channel—Objectionable interference shall be deemed to exist to a station when, at the boundary or field intensity contour specified in Appendix II with respect to the class to which the station belongs, the field intensity of an interfering station (or the root-mean-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 Appendix II.

4. Interference to dominant clear channel stations—A station shall be considered as not capable of causing objectionable interference to a Class I clear channel station on the same frequency when it is separated from the dominant clear channel station by a difference of 70 degrees or more of longitude.

5. Objectionable interference on adjacent channels—It is recognized, in principle, that objectionable interference may be caused to a desired station when, at or within the specified contours of a desired station, the field intensity of the ground wave of an undesired station operating on an adjacent channel (or the root-mean-square value of the field intensities of two or more such undesired stations operating on the same adjacent channel) exceeds a value determined by the following ratio:

Separation between channels	Minimum permissible ratio of desired to undesired signals
10 kc.	1 to 0.5
20 kc.	1 to 10
30 kc.	1 to 50

For convenient reference, the maximum permissible values of interfering signals on such adjacent channels at specified contours are set forth in Appendix III, Table I.

6. Application of standards to existing stations:

(a) For the purpose of estimating objectionable interference, all stations (other than those of Class II) shall be assumed to use the maximum power permitted to their respective classes. In this connection, the power of Class I-A stations shall be considered to be 50 kw, or the actual power, if higher.

(b) After this agreement has been placed in operation a station thereafter assigned a channel already assigned to other stations shall not be considered as preventing existing stations from increasing their power to the maximum allowed their class, even though such power increase may limit the newly assigned station to a field intensity contour of higher value than that permitted its class.

7. Frequency stability—The operating frequency of each broadcast station shall be maintained to within 50 cycles of the assigned frequency until January 1, 1939, and thereafter the frequency of each new station or each station where a new transmitter is installed shall be maintained within 20 cycles of the assigned frequency,

and after January 1, 1942, the frequency of all stations shall be maintained within 20 cycles of the assigned frequency.

8. Spurious radiation—The governments shall endeavor to reduce and, if possible, eliminate spurious radiations from broadcast stations. Such radiations shall be reduced in all cases until they are not of sufficient intensity to cause interference outside the frequency band required for the type of emission employed. With respect to type A-3 emissions (radio-telephony) the transmitter should not be modulated in excess of its modulation capability to the extent that interfering spurious radiations occur, and, with respect to amplitude modulation, the operating percentage of modulation should not be less than seventy-five (75) percent on peaks of frequent recurrence. Means should be employed to insure that the transmitter is not modulated in excess of its modulation capability.

E. Determination of Presence of Objectionable Interference

1. Antenna performance—For the purpose of calculating the presence and the degree of objectionable interference, stations of the several classes shall be assumed to produce effective field, corrected for absorption, for one kilowatt of input power to the antenna, as follows:

Class of Station	At One Mile	At One Kilometer
I	225 mv/m	362 mv/m
II and III	175 mv/m	282 mv/m
IV	150 mv/m	241 mv/m

In case a directional antenna is employed, the interfering signal of a broadcasting station will vary in different directions. To determine the interference in any direction, in the absence of actual interference measurements, the horizontal and vertical field intensity patterns of the directional antenna must be calculated and by comparing the appropriate vectors in the horizontal or vertical pattern with that of a nondirectional with the same effective field, the interfering signal toward any other station can be expressed in terms of kilowatts. This rating in kilowatts shall be applied in the use of mileage separation tables or in computing distances from the propagation curves or tables.

2. Power—The power of a station shall, for the purposes of notifications required by this Agreement, be determined in one of the following manners:

(a) By taking the product of the square of the antenna current and the antenna resistance (antenna input power).

(b) By determination of the station's effective field intensity, corrected for absorption, by making sufficient field intensity measurements on at least eight radials as nearly equally spaced as practicable and by relating the field intensity thus determined to the effective field intensity of a station having the antenna efficiency stipulated above for its class.

3. Methods of determining the presence of objectionable interference—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 contained in the method hereinafter prescribed;

or, with the mutual consent of the countries concerned:

(b) By reference to the propagation curves in Appendices IV and V, or

(c) By reference to the distance tables set forth in Appendix VI.

4. Actual proof of existence or absence of objectionable interference—The existence or absence of objectionable interference may be proved by field intensity measurements or recordings made with suitable apparatus, duly calibrated, by Government

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engineers or other engineers as may be mutually acceptable to the Governments concerned. Such field intensity measurements shall be made in the manner and for the periods of time mutually agreed upon by the Governments concerned.

The contracting Governments agree to facilitate the making of the measurements by requiring the stations involved to remain silent or operate in the manner deemed necessary, and at such times as not to interrupt regular schedules.

5. *Proof based on propagation curves and distance tables:*

(a) *Sky wave curves*—In computing the distance to the 50 per cent sky wave field intensity contour of a Class I station of a given power, and also in computing the 10 percent sky-wave field intensity of an alleged interfering station, of any class and given power, at a specified distance, use may be made of the appropriate graphs set forth in Appendix V, entitled "Average Sky Wave Field Intensity Corresponding to the Second Hour after Sunset in the Recording Station, 100 Millivolt per Meter at One Mile (161 at one kilometer)".

(b) *Ground wave curves*—The distance to any specified ground wave field intensity contour may be determined from appropriate ground wave 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. A family of curves is necessary for this purpose. A graph for a conductivity of 10-13 is set forth in Appendix IV, entitled "Ground Wave

Field vs. Distance for One Kilowatt Radiated From Short Antenna". Three frequencies in the standard broadcast band are given. For other frequencies and soil conditions (conductivity and dielectric constant) other curves are required. A conductivity of 10-13 is considered average and is used throughout in determining the ground wave value for computing the mileage separation tables.

(c) *Distance tables*—Table I shows the required day separation in miles between broadcast stations on the same channel. Table II gives the required distance in miles from the boundary of a country in which a Class I-A station is located for the daytime operation of a Class II station on the same channel in another country. Table III gives the required separation in miles between broadcast stations on adjacent channels during both daytime and nighttime. Table IV gives the required night separation in miles between broadcast stations operating on the same channel. The assumed conditions of operation are given in Appendix VI.

The tables are based upon the use of nondirectional antennas but, in case a directional antenna is employed at a particular station, it will be necessary to consider the radiation distribution of the directional antenna involved and to modify the mileage separation tables accordingly. The night separation tables for stations on the same frequency are computed from the skywave curve given in Appendix V. These curves are based on extensive measurements of the skywave produced by broadcasting stations and shall be considered as accurate in all cases unless proof to the contrary is available as set out in Section E 4. The mileage separation tables for the same channel during daytime and for

adjacent channels day and night are computed from the groundwave curve in Appendix IV. Tables apply only in case the frequency is 1000 kc and the assumed soil conductivity and dielectric constant prevail. Since these values vary in every case the tables for daytime and adjacent channel separation cannot be used except as a general guide. In any case under consideration an estimate of the mileage separation required may be made from the operating frequency and known or assumed soil conditions. To determine the interference accurately, measurements must be made in accordance with Section E 4 on the frequency under consideration or on another frequency and from the curves the values may be determined for the desired frequency.

F. Miscellaneous

1. *Engineering standards*—The engineering standards set forth in this Agreement are subject to revision when justified by technical advances in the art, with the mutual consent of the governments parties to this Agreement.

Attachments:
Appendix I—Priority of use of clear channels for Class I and II stations.

Appendix II—Protected service and interference.

Appendix III—Adjacent channel interference.

Appendix IV—Ground wave graphs.

Appendix V—Sky wave graphs.

Appendix VI—Mileage separation tables.

Appendix VII—Engineering requirements for use of regional channels by Class II stations.

III

Notification and Effect Thereof

1. *Initial notification*—Each Government shall, as soon as possible af

ter ratification of this Agreement, and in any event not later than 180 days prior to the effective date thereof, transmit to the other Governments:

(a) A complete list of all broadcast stations actually in operation in its country in the standard broadcast band both as of the date of the signing of this Agreement and as of the date of transmitting said list, showing with respect to each station its call signal, location, frequency, power, and antenna characteristics together with all changes authorized to be made with respect to said stations on or before the effective date of this Agreement, and the classification claimed for each such station.

(b) A complete list of all changes authorized to be made with respect to said stations after the effective date of this Agreement, the dates on or before which such changes are to be consummated, and the classification claimed for each such station under this Agreement when the proposed change has been consummated.

(c) A complete list of all new broadcast stations authorized but not yet in operation, showing with respect to each such station its call signal, location, frequency, power and antenna characteristics, the date and or before which each such station shall commence operation, and the classification claimed for it under this Agreement.

(d) The Governments agree that prior to the effective date of this Agreement, they will, so far as possible, resolve all conflicts that may arise between them as a result of the foregoing initial listings, and that, notwithstanding some such conflicts may

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ENGINEERING SERVICES FOR RADIO STATIONS

Allocation Engineering

Frequency Surveys

Equipment Studies

Engineering Counsel

Antenna Designs
of all Types

Particular Consideration to Directional
Characteristics

Counsel on Station Construction
Location of Station Sites

Field Intensity Measurements

General Communication Problems

Engineering Consultants
Before

Federal Communications Commission

McNARY and CHAMBERS

NATIONAL PRESS BUILDING

NATIONAL 4048

WASHINGTON, D. C.

James C. McNary

Joseph A. Chambers

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remain unresolved, they will cooperate to the end that there be no delay in putting the provisions of this Agreement into full force and effect on that date.

(e) In resolving conflicts in the use of clear channels, and in the listing of Class I and Class II stations, the provisions of this Agreement and particularly of Appendix I shall be controlling. In resolving conflicts in the use of regional and local channels, and in the listing of Class III and Class IV stations, priority of use shall be recognized in each country with respect to stations which at the time of signing of this Agreement are in actual operation, which in substance conform to the definitions of said classes as set forth in this Agreement, and with respect to which no substantial change is made or proposed; a change of frequency in order to conform to the designation of channels in this Agreement shall not be deemed a substantial change.

2. *Subsequent notifications*—After the effective date of this Agreement and throughout the period during which it shall remain in effect, each Government shall promptly notify the other Governments by registered letter of all further changes in existing broadcast stations and of all further new broadcast stations, together with similar information with regard to each such change or new station, and the proposed date on which each such change is to go into effect and on which each such new station is to actually commence operation.

3. *Effect of notification*—Each government may, within 30 days of receiving notification of any proposed change in the assignment of an existing station or of the authorization of a new station in another country, not-

ify the Government of the latter country of any objection it may have thereto under the terms of this Agreement.

4. *Conflict between notifications*—To be valid, notifications of changes in the assignments of existing stations, or of authorizations of new stations must be such that the assignments proposed therein are in accordance with this Agreement and are such as not to involve objectionable interference to existing stations in other countries, assigned and operating in accordance with this Agreement. As between two or more notifications of changes or authorizations of new stations proceeding from different countries, after the effective date of this Agreement, priority in the date of mailing of notification shall govern.

5. *Cessation of effect*—(a) A notification of a proposed change in the assignment of an existing station or of an authorization of a new station shall cease to have any force and effect if, within one year of the date thereof of such change shall not have been actually consummated or such new station shall not have actually commenced continuous operation.

(b) In special cases in which circumstances beyond the control of the Administration concerned have prevented the completion of the change or the construction of the new station, the term of the original notification may be extended for a period of six months.

6. *Berne Bureau*—The foregoing notifications shall be made independently of and in addition to those which, under current practice, are sent to the Bureau of the International Telecommunications Union.

IV Arbitration

In case of disagreement between two or more contracting Governments concerning the execution of this Agreement the dispute, if it is not settled through diplomatic channels, shall be submitted to arbitration at the request of one of the Governments in disagreement. Unless the parties in disagreement agree to adopt a procedure already established by treaties concluded between them for the settlement of international disputes, the procedure shall be that provided for in Article 15 of the International Telecommunications Convention of Madrid, 1932.

V

Ratification, Execution and Denunciation

1. *Ratification*—To be valid this Agreement must be ratified by Canada, Cuba, Mexico and the United States of America.

If and when three of said four countries shall have ratified and the fourth shall, through unavoidable circumstances, have been unable to ratify but shall have signified its readiness, pending ratification and as an administrative measure, to put the provisions of this Agreement (including the contents of Appendix I) into effect in whole or in part, then such country, together with those countries which shall have ratified, may, by administrative agreement between them, fix a definite date on which they shall give effect to such provisions, which date shall preferably be one year from the date of such administrative agreement.

The ratification must be deposited, as soon as possible, through diplomatic channels, in the archives of the Government of Cuba. This same Government shall, through diplomatic channels, notify the other signatory Governments of the ratifications as soon as they are received.

2. *Effect of ratification*—This Agreement shall be valid only as between such countries as shall have ratified it.

3. *Execution*—The contracting Governments undertake to apply the provisions of this Agreement, and to take steps necessary to enforce said provisions upon the private operating agencies recognized or authorized by them to establish and operate broadcast stations within their respective countries.

4. *Denunciation*—Each contracting Government shall have the right to denounce this Agreement by a notification addressed, through diplomatic channels, to the Government of Cuba, and announced by that Government, through diplomatic channels, to all the other contracting Governments. This denunciation shall take effect at the expiration of the period of one year from the date on which the notification was received by the Government of Cuba. This effect shall apply only to the author of the denunciation. This Agreement shall remain in force for the other contracting Governments but only as between such Governments.

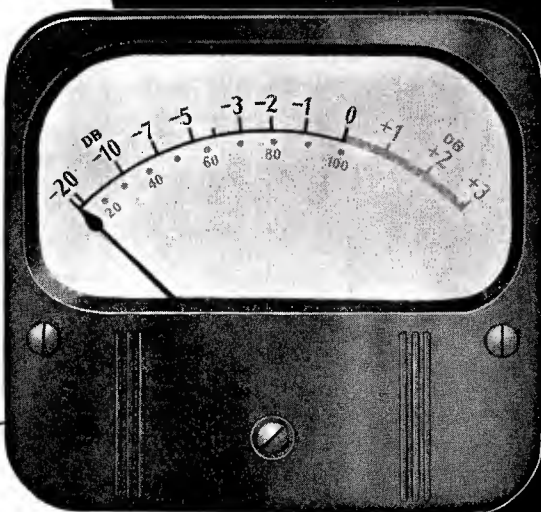
VI

Effective Date and Term of the Agreement

1. Except for the provisions of Section 1 of Part III, Section 1 of Part V, and paragraph 3 of Table VI of

(Continued on page 367)

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Appendices and Tables: Allocation Provisions of Havana Agreement

APPENDIX I

Under the provisions of Section II of this Agreement each country may use all the 106 channels when technical conditions with respect to interference to established stations are such as to render such use practicable. However, priority of use on specified clear channels is recognized for the following number of Class I and II stations in each country.

TABLE I

Canada	14
Cuba	9*
Dominican Republic	1
Haiti	1
Mexico	15
Newfoundland	2*
United States	63

*See Table V for special arrangements provided for Cuba and Newfoundland.

These stations and the conditions of their operation are as specified in Tables II, III, IV, V, VI, VII and VIII following herewith.

TABLE II
Class I-A Stations

(Canada, Cuba, and Mexico)

Frequency	Location of Stations
690	Quebec, Canada
730	Mexico, D. F.
740	Ontario, Canada
800	Sonora, Mexico
860	Ontario, Canada
900	Mexico, D. F.
990	Manitoba, Canada
1010	Alberta, Canada
1050	Nuevo Leon, Mexico
1220	Yucatan, Mexico
1540	Santa Clara, Cuba
1570	Nuevo Leon, Mexico
1580	Quebec, Canada

TABLE III
Class I-B Stations

Frequency	Location of stations	Power Limitation (Kw.)	Requirements as to directional antennas
810	New York, U. S. A.	—	None
810	California, U. S. A.	—	To be determined
940	Quebec, Canada	5 kw. min. permissible	Determine from operation
940	Mexico, D. F.	—	Determine from operation
1000	Jalisco, Mexico	20	To be determined
1000	Washington, U. S. A.	—	To be determined
1000	Illinois, U. S. A.	—	To be determined
1010	Havana, Cuba	—	Determine from operation
1060	Mexico, D. F.	—	To be determined
1060	Pennsylvania, U. S. A.	—	To be determined
1070	Maritime Provinces, Canada	—	None
1070	California, U. S. A.	—	None
1080	Connecticut, U. S. A.	—	To be determined
1080	Texas, U. S. A.	—	To be determined
1090	Baja Calif., Mexico	—	To be determined
1090	Maryland, U. S. A.	—	To be determined
1090	Arkansas, U. S. A.	—	To be determined
1110	North Carolina, U. S. A.	—	To be determined
1110	Nebraska, U. S. A.	—	To be determined
1130	British Columbia, Canada	5 kw. min. permissible	None
1130	New York-New Jersey, U. S. A.	—	None
1140	Chihuahua, Mexico	—	To be determined
1140	Virginia, U. S. A.	—	To be determined
1170	Oregon, U. S. A.	—	To be determined
1170	Oklahoma, U. S. A.	—	To be determined
1170	West Virginia, U. S. A.	—	To be determined
1190	Sinaloa, Mexico	—	To be determined
1190	Indiana, U. S. A.	—	To be determined
1550	Ontario, Canada	—	Determine from operation
1550	Vera Cruz, Mexico	20	Determine from operation
1560	Havana, Cuba	—

Text of the Havana Treaty

(Continued from page 366)

Appendix I annexed hereto (which provisions shall go into effect immediately upon this Agreement becoming valid), this Agreement shall become effective one year after the date it shall have been ratified by the fourth of those Governments whose ratification is requisite to the validity of this Agreement. The Governments will cooperate to the end that, wherever possible, the provisions of this Agreement shall be carried out in advance of said effective date.

2. This Agreement shall remain in effect for a period of five years after said effective date.

VII Adherence

This Agreement shall be open to adherence in the name of Newfoundland.

In witness whereof the respective plenipotentiaries have signed the Agreement in triplicate, one copy in English, one in Spanish, and one copy in French, each of which shall remain deposited in the archives of the Government of Cuba and a copy of each of which shall be forwarded to each Government.

Done at Habana, Cuba, December 13, 1937.

TABLE IV
Class II Stations

Frequency	Location of stations	Power Limitation (Kw.)	Requirements as to directional antennas
640	Newfoundland	—	None
690	Kansas-Oklahoma, U. S. A.	—	To be determined ^a
740	Calif., U. S. A.	—	To be determined ^b
800	Ontario, Canada	5	To be determined
810	Tamaulipas (Tampico) Mexico	50	To be determined
900	Quebec, Canada	5	To be determined
990	Tennessee, U. S. A.	—	To be determined ^c
1000	Oriente, Cuba	10	To be determined
1050	New York, U. S. A.	—	To be determined
1060	Alberta, Canada	10	To be determined
1070	Alabama, U. S. A.	—	To be determined
1080	Manitoba, Canada	15	To be determined
1080	Haiti	10	To be determined
1110	Mexico, D. F.	20	To be determined
1130	Louisiana, U. S. A.	—	To be determined
1170	Dominican Republic	10	To be determined
1190	Havana, Cuba	15	To be determined

^a Permissible to increase field intensity above 25 uv/m (10% skywave) west of Minnesota on Canadian border.

^b Same as ^a except west of North Dakota.

^c Same as ^a except east of Minnesota. Also 650 miles from border requirement waived.

TABLE V
Class II Stations^a on Regional Channels
(Cuba and Newfoundland)

Frequency	Location of Stations	Maximum Power in kw.
560	Newfoundland	10
570	Santa Clara, Cuba	15
590	Havana, Cuba	25
630	Havana, Cuba	15
1270	Havana, Cuba	10

^a These stations shall use directional antennas to prevent objectionable interference to the Class III stations on the channel in accordance with Appendix VII.

TABLE VI

Special Conditions Affecting the United States

The 24 Class I and II stations in the United States which use clear channels with other countries party to this agreement are given in Tables III and IV. The remaining 39 Class I and II stations of the United States will be assigned the following clear channels:

640 650 660 670 680 700 710 720 750 760 770 780 820 830 840 850 870 890 900 1020 1030 1040 1100 1120 1160 1180 1200 1210 1500 1510 1520 1530

It is recognized that the United States must make extensive adjustments in the assignments of its existing stations in order to make possible the carrying out of this Agreement, that these adjustments will require approximately a year, and that it is not possible for the United States at this time to specify on which of the said 32 channels it will have priority of use for Class I-A stations, Class I-B stations and Class II stations respectively, nor the locations of such stations, power and other information with respect thereto. The United States may assign Class I-A stations to at least 25 of said channels. The United States agrees that ninety days before the effective date of this Agreement it will communicate this information to each of the other countries parties to this Agreement, and such information, when communicated, shall be considered part of this Agreement as if fully set forth herein.

Nothing stated in this Agreement shall be construed to preclude the United States of America from asserting, and enjoying recognition of, priority of use with reference to certain other Class II stations (not included in the 63 stations mentioned in Table I) which are now in actual operation in the band 640-1190 kc. and which are known under the Regulations of the Federal Communications Commission as "limited time stations" and "daytime stations" (having hours of operation limited to sunset taken either at their respective locations or at the locations of the respective dominant stations on clear channels and in some cases including hours not actually used by said dominant stations) which stations may, so far as permitted by the terms of this Agreement and the engineering standards herein set forth, be given assignments substantially equivalent to those they now enjoy.

TABLE VII

Special Conditions Regarding the Use of 1010 kc. by Cuba and Canada

With regard to the use of the clear channel of 1010 kc by a Class I-A station in Canada, and by a Class I-B station in Cuba, both countries mutually agree that the interfering signal shall not exceed for 10 per cent of the time or more the value of 50 microvolts per meter at the following points of measurement: in Cuba at any point east of the province of Camaguey, and in Canada at any point west of the province of Manitoba.

TABLE VIII

Special Conditions Affecting Canada

Nothing stated in this Agreement shall be construed to preclude Canada from asserting priority of use with reference to certain Class III and IV stations now in operation in Canada on existing clear and regional channels which through this Agreement will become of a class of channel which may not permit their use by Class III and IV stations.

(Continued on page 368)

Appendices and Tables: Allocation Provisions of Havana Agreement

(Continued from page 367)

PROTECTED SERVICE CONTOURS AND PERMISSIBLE INTERFERENCE SIGNALS FOR BROADCAST STATIONS

APPENDIX II

TABLE I

Class of station	Class of channel used	Permissible power	Boundary or signal intensity contour of area protected from objectionable interference a		Permissible interfering signal b	
			Day	Night	Day	Night c
I A	Clear	50 kw or more	Boundary of country in which station is located		5 uv/m	25 uv/m d
I B	Clear	10 kw to 50 kw	100 uv/m	500 uv/m (50% sky wave)	5 uv/m	25 uv/m
II	Clear d	0.25 kw to 50 kw	500 uv/m e	2500 uv/m e (Ground wave)	25 uv/m e	125 uv/m e
III A	Regional	1 kw to 5 kw	500 uv/m	2500 uv/m (Ground wave)	25 uv/m	125 uv/m
III B	Regional	0.5 kw to 1 kw night and 5 kw day	500 uv/m	4000 uv/m (Ground wave)	25 uv/m	200 uv/m
IV	Local	0.1 kw to 0.25 kw	500 uv/m	4000 uv/m (Ground wave)	25 uv/m	200 uv/m

a In accordance with other provisions in this Agreement this freedom of interference does not apply outside the boundaries of the country in which the station is located.
 b From other stations on same channel only. For adjacent channels see Appendix III, Table I.
 c Sky wave field intensity exceeded for 10% of the time.
 d No Class II station shall be assigned to the same channel as a Class I-A station for nighttime operation (from sunset to sunrise) less than 650 miles of the nearest border of the country in which the Class I-A station is located.

e These values are with respect to interference from all stations except Class I, 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 I stations will not exceed these values. If the Class II stations are limited by Class I stations to higher values, then such values shall be the standard established with respect to interference from all other classes of stations.

APPENDIX III

TABLE I

ADJACENT CHANNEL INTERFERENCE

Channel separation between desired and undesired stations	Maximum ground wave field intensity of undesired station
10 kc	0.25 mv/m
20 kc	5.0 mv/m
30 kc	25.0 mv/m

The undesired ground wave signal shall be measured at or within the 0.5 mv/m ground wave contour of the desired station. These values apply to all classes of stations both day and night and are based on ground waves only. No adjacent channel interference is considered on the basis of an interfering sky wave.

APPENDIX VI

Mileage Separation Tables

The required separations between broadcasting stations as tabulated below are based upon the following conditions:

- The use of nondirectional antennas.
- Antenna efficiencies (in mv/m at one mile for one kilowatt).
 Class I—225 mv/m
 Class II and III—175 mv/m
 Class IV—150 mv/m
- Frequency, 1000 kc.
- Soil conductivity, $s = 10-13$.
- Soil dielectric constant, $e = 15$.
- Groundwave transmission as shown on chart in Appendix IV.
- Skywave transmission as shown on chart in Appendix V.
- Protection to service areas as shown in Appendix II, Table I.
- Ratio of desired to undesired signal:

Channel Separation Same frequency	Ratio of Desired to Undesired
10 kc.	20:1
20 kc.	2:1
30 kc.	1:10
	1:50

TABLE I
REQUIRED DAY SEPARATION IN MILES BETWEEN BROADCAST STATIONS ON THE SAME CHANNEL

Class and Power	Class IV		Classes II and III							Class I					
	100 W.	250 W.	0.25 Kw.	0.5 Kw.	1 Kw.	5 Kw.	10 Kw.	25 Kw.	50 Kw.	10 Kw.	25 Kw.	50 Kw.	100 Kw.	250 Kw.	500 Kw.
Class IV															
100 W.	143	165	172	192	213	265	285	310	335	390	417	437	462	486	513
250 W.	165	173	180	200	221	273	293	318	343	415	442	462	487	511	538
Classes II and III															
0.25 Kw.	172	180	183	203	224	276	296	321	346	418	446	465	490	514	541
0.5 Kw.	192	200	203	210	231	283	303	328	353	446	473	493	518	542	569
1 Kw.	213	221	224	231	239	291	311	336	361	467	494	514	539	563	590
5 Kw.	265	273	276	283	291	313	333	358	383	520	547	567	592	616	643
10 Kw.	285	293	296	303	311	333	345	370	395	540	567	587	612	636	663
25 Kw.	310	318	321	328	336	358	370	399	414	585	612	632	657	681	708
50 Kw.	335	343	346	353	361	383	395	414	430	612	644	664	689	713	740
Class I															
10 Kw.	390	415	418	446	467	520	540	565	587	556	585	605	620	655	682
25 Kw.	417	442	446	473	494	547	567	592	614	585	612	632	657	682	709
50 Kw.	437	462	465	493	514	567	587	612	634	605	632	652	677	702	729
100 Kw.	462	487	490	518	539	592	612	637	659	628	657	677	697	727	754
250 Kw.	486	511	514	542	563	616	636	661	683	655	682	702	727	751	778
500 Kw.	513	538	541	569	590	643	663	688	710	682	709	729	754	778	805

TABLE II

REQUIRED DISTANCE IN MILES FROM THE BOUNDARY OF A COUNTRY IN WHICH A CLASS I-A STATION IS LOCATED FOR DAYTIME OPERATION OF A CLASS II ON THE SAME CHANNEL

Power of Station	Class II						
	0.25 Kw.	0.5 Kw.	1 Kw.	5 Kw.	10 Kw.	25 Kw.	50 Kw.
Miles from Boundary	237	261	282	335	355	380	402

(Continued on page 370)

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Appendices and Tables: Allocation Provisions of Havana Agreement

(Continued from page 368)

TABLE III

REQUIRED DAY AND NIGHT SEPARATION IN MILES BETWEEN BROADCAST STATIONS ON ADJACENT CHANNELS

Class & Power	Class IV						Classes II and III															
	0.1 Kw.		0.25 Kw.		0.5 Kw.		0.25 Kw.			0.5 Kw.			1 Kw.			5 Kw.			10 Kw.			
	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	
Class IV																						
0.1 Kw.	73	37	32	82	45	40	86	47	42	94	55	50	105	63	58	183	84	79	149	98	93	
0.25 Kw.	82	45	40	90	48	41	94	50	43	102	58	51	113	66	59	141	87	80	157	101	94	
Classes II & III																						
0.25 Kw.	86	47	42	94	50	43	96	51	43	104	59	51	115	67	59	143	88	80	159	102	94	
0.5 Kw.	94	55	50	102	58	51	104	59	51	112	62	52	123	70	60	151	91	81	167	105	95	
1 Kw.	105	63	58	113	66	59	115	67	59	123	70	60	131	73	62	159	94	83	175	108	97	
5 Kw.	133	84	79	141	87	80	143	88	80	151	91	81	159	94	83	180	104	87	196	118	101	
10 Kw.	149	98	93	157	101	94	159	102	94	167	105	95	175	108	97	196	118	101	210	125	104	
25 Kw.	172	115	110	180	118	111	182	119	111	190	122	112	198	125	114	219	135	118	233	140	121	
50 Kw.	190	131	126	198	134	127	200	135	127	208	138	128	216	141	130	237	151	134	251	156	137	
Class I																						
10 Kw.	162	107	102	170	110	103	172	111	103	180	114	104	188	117	106	209	127	118	223	132	113	
25 Kw.	188	126	121	191	129	122	193	130	122	201	133	123	209	136	125	230	146	129	244	151	132	
50 Kw.	203	144	139	211	147	140	213	148	140	221	151	141	229	154	143	250	164	147	264	169	150	
500 Kw.	277	211	206	285	214	207	287	215	207	295	218	208	303	221	210	324	231	214	338	236	217	

Class and Power	Class II						Class I														
	25 Kw.		50 Kw.		10 Kw.		10 Kw.			25 Kw.			50 Kw.			500 Kw.					
	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.	10 Kc.	20 Kc.	30 Kc.			
Class IV																					
0.1 Kw.	172	115	110	190	131	126	162	107	102	183	126	121	208	144	139	277	211	206			
0.25 Kw.	180	118	111	198	134	127	170	110	103	191	129	122	211	147	140	285	214	207			
Classes II and III																					
0.25 Kw.	182	119	111	200	135	127	172	111	103	193	130	122	213	148	140	287	215	207			
0.5 Kw.	190	122	112	208	138	128	180	114	104	201	133	123	221	151	141	295	218	208			
1 Kw.	198	125	114	216	141	130	188	117	106	209	136	125	229	154	143	303	221	210			
5 Kw.	219	135	118	237	151	134	209	127	110	230	146	129	250	164	147	324	231	214			
10 Kw.	233	140	121	251	156	137	223	132	113	244	151	132	264	169	150	338	236	217			
25 Kw.	250	149	125	268	165	141	242	145	123	261	160	136	281	178	154	355	245	221			
50 Kw.	268	165	141	284	172	145	260	161	139	279	163	144	297	185	158	371	252	225			
Class I																					
10 Kw.	242	145	123	260	161	139	232	137	115	253	156	134	273	174	152	347	241	219			
25 Kw.	261	160	136	279	168	144	253	156	134	272	163	139	292	181	157	366	248	224			
50 Kw.	281	178	154	297	185	158	273	174	152	292	181	157	310	190	161	384	257	227			
500 Kw.	365	245	221	371	252	225	347	241	219	366	248	224	384	257	227	451	291	247			

TABLE IV

Required Night Separation in Miles Between Broadcast Stations on the Same Channels

The following tables indicate the mileage protection each class must give all other classes.

Class I-A	Class I-A	Not required to protect Class II stations on same channel at night.			
Class I-B	Class I-B	TABLE IV A			
		Must protect other Class I-B stations as shown below.			
Class I-B	5 kw.	10 kw.	25 kw.	50 kw.	
10 kw.		2665	3010	3280	
25 kw.		3010	3243	3500	
50 kw.		3280	3500	3660	

TABLE IV—C

CLASS III-Aa MUST PROTECT OTHER CLASSES AS SHOWN BELOW

Class III-A	Class III-B		
Class III-A	1 Kw.	5 Kw.	1 Kw.
1 Kw.	739	1025	550
5 Kw.	1025	1039	847

^aSee Appendix VII for protection Class III stations should give Class II stations on regional channels.

TABLE IV D

Class III B b Must protect other classes as shown below.

Class III B	Class III A		Class III B	
Class III B	1 kw.	5 kw.	5 kw.	1 kw.
5 kw.	735	1020	383	550
1 kw.	739	1025	550	553

TABLE IV-B

CLASS II—MUST PROTECT OTHER CLASSES AS SHOWN BELOW

Class II	Class II Stations						Class I-B Stations			Class I-A Stations Distance from Nearest Border of Country in Which Class I-A Station is Located
	.25 Kw.	.5 Kw.	1 Kw.	5 Kw.	10 Kw.	25 Kw.	50 Kw.	10 Kw.	25 Kw.	
.25 Kw.	451	602	732	1018	1136	1271	1529	1378	1610	1938
.5 Kw.	602	606	736	1022	1140	1275	1533	1508	1735	1890
1 Kw.	732	736	739	1025	1143	1280	1535	1658	1855	2080
5 Kw.	1018	1022	1025	1039	1157	1292	1547	2165	2395	2550
10 Kw.	1136	1140	1143	1157	1162	1298	1553	2450	2680	2830
25 Kw.	1271	1275	1280	1292	1298	1310	1560	2880	3120	3260
50 Kw.	1529	1533	1535	1547	1553	1560	1570	3090	3330	3480

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TABLE IV E

Class IV—Must protect other classes as shown below.

Class IV	Class III A		Class III B		Class IV
	1 kw.	5 kw.	.5 kw.	1 kw.	
.1 kw.	300	300	Daytime separation determines	Daytime separation determines	
.25 kw.	395	407			

^b See Note a, Table IV-c

TABLE IV F

Distance Class II Stations must be from Class I A and I B Stations to obtain recommended protection to Class II Station (2.5 mv/m ground wave contour).

Class II (a)	10 kw.	Class I A and I B Stations		
		25 kw.	50 kw.	500 kw.
.25 kw.	1248	1462	1520	2767
.5 kw.	1252	1470	1523	2771
1. kw.	1256	1473	1528	2775
5. kw.	1270	1484	1541	2789
10. kw.	1275	1490	1546	2793
25. kw.	1285	1498	1743	2803
50. kw.	1293	1510	1750	2812

Note (a): Must use directional antenna to protect dominant station or stations with these separations.

TABLE IV G

Distance Class IV Stations must be from Class III-A and III-B Station to obtain recommended protection to Class IV Station (4.0 mv/m ground wave contour).

Class IV Power	Class III-A or III-B		
	.5	1.0	5.0
.10	377	547	847
.25	381	551	851

APPENDIX VII

Engineering Requirements for the Use of Regional Channels by Class II Station under the Provisions of Section C 5 c.

A Class II station assigned to a regional channel in accordance with Section C 5 c shall use a directional antenna or other means to limit the interfering signal within the protected service area of any Class II station on the channel to the value set forth in Appendix II, Table I. The interfering signal in case of projected operation shall be determined from the characteristics of the antenna and appropriate curve in Appendix V. In case of actual operation the interfering signal shall be determined by the method described in Section E 4.

Class III stations, operating on a channel to which a Class II station is assigned, should limit the interference to the Class II station in conformity with the provisions of Appendix II, Table I.

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Frequency Modulation: History and Progress

By PAUL A. deMARS

Technical Director, The Yankee Network

AS RADIO broadcasting enters its twentieth year, a new technical development has captured the interest of engineers and owners of broadcasting stations. This development is Major E. H. Armstrong's system of frequency modulation, now being tried out in the ultra-high frequencies by a number of stations. This new system is being held by its proponents as destined to revolutionize the radio broadcasting art.

It is the purpose of this review to relate something of the history of this development, the state of its development at the present time, and the economic and technological implications that may be estimated from actual observations and experimentation with this new system.

The Armstrong system of frequency modulation, (F-M for short) was presented as an accomplished fact to the Institute of Radio Engineers, Nov. 6, 1935. The outstanding characteristic of Armstrong's system is the virtual elimination of natural static and man-made electrical disturbances. In addition, the system has inherent characteristics which permit transmission of programs with virtually no distortion and fidelity limited only by the quality of loud speakers. This achievement is the result of a quarter century of study and experimentation, during which period Major Armstrong is credited with the invention of the regenerative or "feedback" circuit, the superheterodyne circuit and the superregenerative circuit. Armstrong's inventions have brought modern communications and broadcasting to the present high state of development and there are an increasing number of those in these fields who feel, as does the writer, that his system of frequency modulation will be an even greater contribution than his former achievements.

Armstrong Obtained Patents in 1933

Armstrong applied for patents on his system of frequency modulation in 1932 and secured patents covering his system in 1933. In December 1933, the complete invention was disclosed to the RCA. During 1934, and until the fall of 1935, Major Armstrong's apparatus was used in conjunction with the RCA's transmitter atop the Empire State Building in New York, and a series of laboratory and field demonstrations were run off. Transmitting with a power estimated at about 2 kw. in the 40 mc. region, which is best suited for frequency modulation development, reception was practically perfect 85 miles away, where recordings of reception of the new static-free test programs were made. But the RCA asked Armstrong to remove his equipment in the fall of 1935 to make way for television.

At this juncture, C. R. Runyon,

an old friend and veteran radio "ham", in the summer of 1935 began to build a frequency modulation transmitter of his own in Yonkers to operate at 110 megacycles in the amateur band. It was Runyon's station, W2AG, that provided transmission for the demonstration before the Institute of Radio Engineers on Nov. 6, 1935. Runyon's transmitter, with several changes in frequency in the region of 110 mc., has since been used to demonstrate F-M. Runyon, himself, has contributed a great deal to the engineering design of transmitting equipment for F-M in the ultra-high frequencies.

Art Apathetic, Armstrong Builds Own Station

But the radio art was apathetic to Armstrong's invention and his fighting blood warmed; he took steps to obtain an experimental station of his own to permit experimentation with high power. He was eventually authorized by the Federal Communications Commission to construct a station with power of 40 kw. to operate with frequency modulation in a 200 kc. band on a frequency of 41.6 mc.

In the meantime, television was clamoring for recognition and expressing its need of channels to permit experimentation and development. The FCC called a general hearing on June 15, 1936, to obtain information from the radio services that would guide it in allocating the ultra-high frequencies above 30,000 kc. Just a week previously the writer had been introduced to frequency modulation by Major Armstrong at a talk and demonstration given before the Baltimore-Washington section of the Institute of Radio Engineers. These introductions were timely, for since 1932 The Yankee Network Inc. had been conducting experimentation under the writer's supervision with amplitude modulation (A-M) in the ultra-high frequencies. A detailed and comprehensive survey of the results of operation with 500 watts power on 41 mc. had just been completed. The results indicated definitely that, using the conventional system of modulation, broadcasting in the ultra-high frequencies in the region of 40 mc. offered no advantages over operation in the regular broadcast band and it was concluded that the very short waves could only provide a restricted supplementary service to the regular band. The advantages demonstrated by Armstrong's F-M system changed the picture completely and marked the beginning of Yankee Network's interest in the new system.

Using the recordings made in 1934 and 1935 of transmission from the RCA transmitter on the Empire State Building in New York City to demonstrate his assertions, Major Armstrong urged the FCC to set aside 5 mc. for broadcast ex-

perimentation in the new allocations. The writer was the only other engineer who spoke for frequency modulation at this hearing, which lasted over two weeks.

As a final result of the hearing, the Federal Communications Commission issued General Order 19, which, in its final form today, gives F-M a 1 mc. band, 42.4 to 43.6 mc. (five channels), and an .8 megacycle band, 26.2 to 27.0 mc. (four channels), and a .86 mc. band, 117.070 to 118.030 mc. (four channels) for high frequency broadcast stations.

John Shepard 3d and Dr. Doolittle Interested

In the meantime, the F-M broadcasts from C. R. Runyon's station in Yonkers, and since the fall of 1938, from W2XMN, Armstrong's 40 kw. station on the Hudson River Palisades at Alpine, New Jersey, were bringing others into the situation. John Shepard 3d, president of the Yankee Network Inc., was a convert and applied to the FCC for authorization to erect a 50 kw. F-M station in Massachusetts in the spring of 1937. Delays in securing a suitable site for the Yankee Network station delayed construction for over a year, but in October 1938 work was begun on the construction of Yankee's station on Mt. Asnebumskit in the Town of Paxton, near Worcester, Mass. Installation of transmitting equipment was completed to a power output of 2 kw. by May 1939, and this station, with call letters W1XOJ, has been in regular operation since then, daily from 8 a.m. to midnight, with this power on a frequency of 43 mc.

Back in 1936, Dr. Franklin Doolittle, owner of WDRC, in Hartford, Conn., saw the possibilities of the new system for broadcasting service. Eventually his F-M station, with call letters W1XPW, located on Meriden Mountain, near Hartford, began testing in the spring of 1939 and since late summer has been in regular operation daily with a power of 1 kw. on a frequency of 43.4 mc.

During the period while Shepard and Doolittle were constructing their stations, the General Electric Co. set up one experimental station at Schenectady and another at Albany. These stations were designed to use both F-M and A-M emissions. A large series of tests were conducted to determine by actual operation, the relative advantages or disadvantages of F-M and A-M.

General Electric, Stromberg Bring Out Receivers

During the summer of 1938 the General Electric manufactured a limited number of F-M receivers, and during 1939 has offered F-M receivers in three models—a table model for F-M only, a console model for F-M only, and a console model for the regular band, two shortwave bands and F-M, priced

respectively at \$59.50, \$100 and \$200. The Stromberg-Carlson Co. is introducing receiver models that roughly parallel the GE line. About a half dozen other manufacturers are getting ready to introduce F-M and combination regular-band, shortwave and F-M receivers.

Since the summer of 1939, the FCC has received about 40 applications for F-M broadcasting stations, and as many more stations are known to intend filing applications for F-M stations in the near future. The broadcasting industry is at last waking up to the significance of the 1935 and 1936 disclosures regarding F-M broadcasting.

The FCC scheduled a general hearing for February 28, 1940 to discuss the relative merits of frequency modulation and amplitude modulation and consider recommendations in connection with allocation problems for broadcast service in the ultra-high frequencies. This action by the Commission puts a period at the end of this phase of this new development and marks the beginning of a new era in radio broadcasting service.

Much has been said in the past regarding high fidelity, and as far as the output of the listener's loudspeaker reflects accomplishment, little has been achieved. A high fidelity system of broadcasting requires a freedom from noise that permits the broadcasting of silence together with natural reproduction. The technical limitations of the regular broadcast band cannot meet these requirements day in and day out except to an insignificant portion of broadcast listeners. Furthermore, A-M in the ultra-high frequencies only partially removes the restrictions inherent in the present band.

Hesitancy Seen Due To Misconceptions

Since Armstrong's system of frequency modulation removes the restrictions that prevent a real high fidelity service by present broadcast methods, namely noise and distortion, the question may be fairly asked, "Why is there any hesitancy on the part of engineers and station owners to accept this new system and make it available to the public as quickly as possible?" The answer is probably due to misconceptions concerning and lack of information regarding the inherent characteristics of F-M broadcasting services in the ultra high frequency.

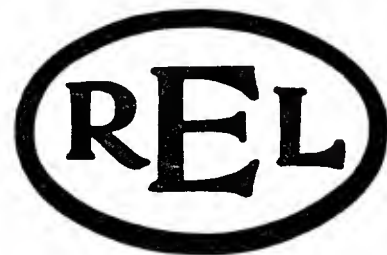
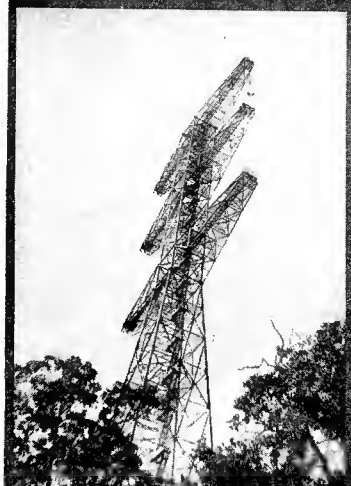
Perhaps the following will tend to clarify this situation. Armstrong's system modulates the radiated power to produce changes in frequency instead of amplitude as in the conventional system. This imposes a characteristic on the radiated wave that is not duplicated by natural static or most man-made interferences. By causing the

(Continued on page 374)

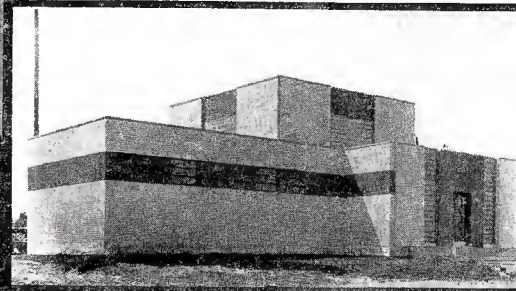
FREQUENCY MODULATION

(ARMSTRONG SYSTEM)

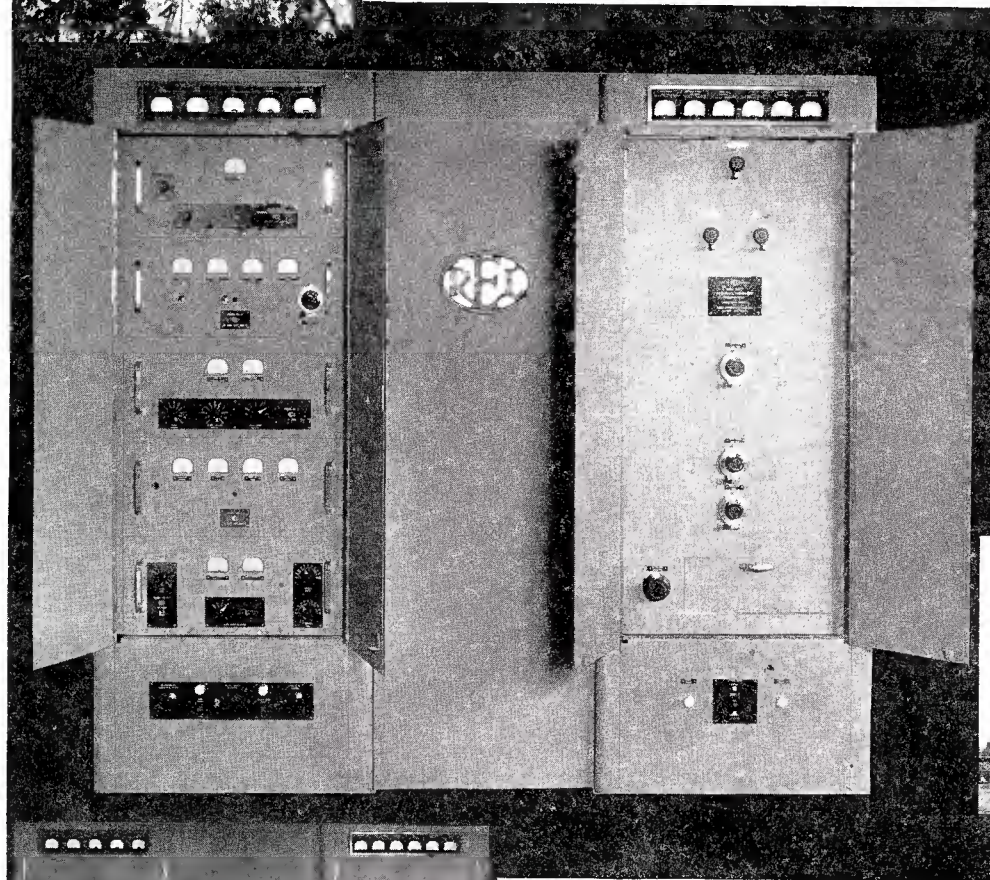
W2XMN, Alpine, N. J., Major E. H. Armstrong's original 40-Kw, Frequency Modulation Transmitter Tower . . . Metropolitan New York's newest landmark.



1-2-5-50 Kw
FREQUENCY
MODULATION
TRANSMITTERS



W1XOJ, Yankee Network's 2,000 Watt mountain-top Frequency Modulation Station at Paxton, Mass. REL now installing 50,000 Watts.



REL 1-2-5 Kw models Frequency Modulation Transmitters, showing attractive arrangement of control, panels, etc.

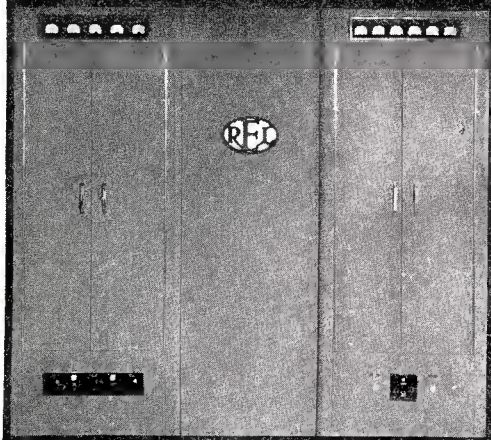
Radio Engineering Laboratories, Inc. are the builders of Frequency Modulation Transmitters (Armstrong System). As pioneers in the field of "high-signal-to-noise-ratio" radio transmission, we have already equipped the following stations with REL Frequency Modulation Transmitters, where they are now in regular use:

STATION	LOCATION	OWNED BY
W2XMN	Alpine, N.J.	Major E. H. Armstrong
W2XCR	Yonkers, N.Y.	C. R. Runyon, Jr.
W1XOJ	Paxton, Mass.	Yankee Network
WEOO	Boston, Mass.	Yankee Network
W3XO	Washington, D. C.	Jansky & Bailey
WEXVB	Rochester, N.Y.	Stromberg-Carlson Telephone Mfg. Co.
W2XQR	New York, N.Y.	J. V. L. Hogan
WTMJ	Milwaukee, Wisc.	The Journal
WHEC	Rochester, N.Y.	WHEC, Inc.

In addition, we are at present building REL Frequency Modulation Transmitters for the following well-known stations:

WGAN	Portland, Me.	Portland Broadcasting System, Inc.
WOR	Newark, N. J.	Bamberger Broadcasting Service, Inc.

Within the next 6 months, pending final approval by the F.C.C., approximately a dozen other of the nation's leading broadcasters are also planning to use REL Frequency Modulation Transmitters (Armstrong System), ranging up to 50 Kw.



Same REL Frequency Modulation Transmitter as above, with doors closed.



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LONG ISLAND CITY, N. Y.

High Frequency Broadcasting Stations in the United States

(Authorized by FCC as of January 15, 1940)

Frequency Groups listed in FCC Rules: Sec. 4.114

FREQUENCY MODULATION

Location	Call Letters	Licensee	Power in Watts	Frequency in Kc.
N. of Alpine, N. J.	W2XMN	Edwin H. Armstrong	40,000	42500 117430
New York City	W2XOR	Bamberger Broadcasting Service (WOR)	CP-1,000	43400
Schenectady, N. Y.	W2XDA	General Electric Co. (WGY)	50	43200
Albany, N. Y.	W2XOY	General Electric Co. (WGY)	150	43200
Superior, Wis.	W9XYH	Head of the Lakes Broadcasting Co. (WEBC)	CP-1,000	43000
New York City	W2XQR	John V. L. Hogan (WQXR)	1,000	43200
Washington, D. C.	W3XO	Jansky & Bailey	1,000	43200
Milwaukee, Wis.	W9XAO	The Journal Co. (WTMJ)	CP-1,000	42600
Bethesda, Md.	W3XMC	McNary & Chambers	CP-100	42600
New York City	W2XWG	National Broadcasting Co. (WEAF)	CP-1,000	42600
Yonkers, N. Y.	W2XAG	Carman R. Runyon, Jr.	5,000	117190
Hartford, Conn.	W1XPW	WDRG, Inc.	1,000	43400
Hartford, Conn.	W1XSO	Travelers Broadcasting Service Corp. (WTIC)	CP-1,000	43200
Rochester, N. Y.	W5XAD	WHEC, Inc.	CP-1,000	42600
Rochester, N. Y.	W5XVB	Stromberg-Carlson Co. (WHAM)	1,000	43200
Boston, Mass.	W1XK	Westinghouse E. & M. Co. (WBZ)	CP-1,000	42600
Springfield, Mass.	W1XSN	Westinghouse E. & M. Co. (WBZA)	1,000	42600
Columbus, O.	W5XVH	WBNS, Inc.	CP-250	43000
Worcester, Mass.	W1XTQ	Telegram Publishing Co.	CP-1,000	43400
Boston, Mass.	W1XOJ	Yankee Network	CP-50,000	43000
Chicago, Ill.	W9XEN	Zenith Radio Corp.	CP-1,000	42800

AMPLITUDE MODULATION

Location	Call Letters	Licensee	Power in Watts	Frequency in Kc.
Boston, Mass.	W1XER	Yankee Network	500	42340
Boston, Mass.	W1XKA	Westinghouse E. & M. Co. (WBZ)	50	42240
Chattanooga, Tenn.	W4XBW	WDDO Broadcasting Corp.	100	26000
Cincinnati, O.	W8XNU	The Crosley Corp. (WLW)	1,000	25650
Cleveland, O.	W8XNT	United Broadcasting Co. (WHK)	50	42340
Dallas, Tex.	W5XD	A. H. Belo Corp. (WFAA)	100	25300
Denver, Col.	W8XLA	KLZ Broadcasting Co. (KLZ)	100	25400
Detroit, Mich.	W8XWJ	Evening News Ass'n. (WWJ)	500	42060
Hartford, Conn.	W1XEH	Travelers Broadcasting Service Corp. (WTIC)	150	42460
Kansas City, Mo.	W9XER	Midland Broadcasting Co. (KMBC)	500	42460
Kansas City, Mo.	W9XA	Commercial Radio Equipment Co.	1,000	26000
Kansas City, Mo.	W9XBA	WHB Broadcasting Co.	100	26100
Los Angeles, Cal.	W6XKG	Ben S. McGlashan (KGFJ)	1,000	25950
Los Angeles, Cal.	W6XRE	Ben S. McGlashan (KGFJ)	500	42300 116950 350000
Los Angeles, Cal.	W6XDA	Columbia Bestg. System (KNX)	100	42300
Memphis, Tenn.	W4XCA	Memphis Commercial Appeal Co. (WMC)	250	26150
Milwaukee, Wis.	W9XAZ	The Journal Co. (WTMJ)	CP-500	42260
Minneapolis, Minn.	W9XHW	Columbia Broadcasting System (WCCO)	50	42300
Nashville, Tenn.	W4XA	National Life & Accident Ins. Co. (WSM)	1,000	26150
New Bedford, Mass.	W1XEQ	E. Anthony & Sons (WNBH)	100	42300
New York City	W2XJI	Bamberger Broadcasting Service (WOR)	100	25300
New York City	W2XWF	Wm. G. H. Finch	1,000	42180
New York City	W2XDV	Columbia Broadcasting System (WABC)	50	42300
New York City	W2XQO	Knickerbocker Broadcasting Co. (WMCA)	100	25500
New York City	W2XVP	Municipal Broadcasting System (WNYC)	CP-1,000	26100
Oklahoma City, Okla.	W5XAU	WKY Radiophone Co.	100	26125
Philadelphia, Pa.	W8XIR	WCAU Broadcasting Co.	100	42140
South Bend, Ind.	W9XH	South Bend Tribune (WSBT)	100	26050
Springfield, Mass.	W1XKB	Westinghouse E. & M. Co. (WBZA)	1,000	42380
St. Louis, Mo.	W9XOK	Star Times Publishing Co. (KXOK)	100	25300
St. Louis, Mo.	W9XPD	Pulitzer Publishing Co. (KSD)	100	25900
Superior, Wis.	W9XJL	Head of the Lakes Broadcasting Co. (WEBC)	250	26100

* Transmitter located at Sargents Purchase, N. H.

Frequency Modulation: History and Progress

(Continued from page 372)

modulation to produce wide frequency deviations from the unmodulated carrier frequency, startling reduction in interference from noise results, the reduction being of the order of 1,000-to-1 in power ratio.

The wide frequency swing used removes all inherent limitations as far as the radio link is concerned to rendering a real high fidelity broadcasting service. It has been demonstrated again and again that noise-free reception is obtained over wide areas from stations of even moderate power, and that all the frequencies within the range of human hearing are transmitted without distortion that can be detected by the human ear. The wide frequency swing used in the new system also permits the simultaneous transmission of other services such as facsimile or telegraph.

It has further been demonstrated that in spite of the quasi-optical nature of the very short waves, whose range are limited by the curvature of the earth, but not to the optical horizon as has been asserted by many authorities, that an F-M station of given power on the ultra-shortwaves renders a superior service in every respect to the regular broadcast band on the medium frequencies and that the primary service area of an F-M station will be much greater.

F-M vs. A-M

Frequency Band Widths

Perhaps the greatest difficulty in accepting the merits of this new system in lieu of the present is because of the wide band of frequencies required to develop its full advantages. Comparing real high fidelity services, an F-M station uses a 200 kc. band, as compared with a 40 kc. band for A-M stations in the ultra-high frequencies. From the above it would appear as though five times as many A-M stations as F-M stations could be accommo-

dated in a given band. Paradoxical as it may seem, the reverse is actually the case. The reason is an inherent characteristic of the new system in respect to the mutual interference between stations operating on the same frequency.

In A-M the presence of an undesired signal produces interference in proportion to its intensity relative to the desired signal. Everyone connected with the broadcasting art is painfully aware of the limitation to coverage, due to interference between stations of relatively low power operating on the same frequency in the regular broadcast band, even though they be separated by as much as a thousand miles. A high fidelity service by present methods would require that the undesired signal be less than 1/100th of the desired signal and less than 1/1000th of the desired signal if the station frequencies deviate by an amount sufficient to produce audible beat notes. It is doubtful if stations operating at frequencies of the order of 40 mc. or higher could be controlled now or ever to such a degree as to prevent audible heterodyne beats between carriers. In an A-M system, therefore, stations could not be assigned for operation on the same frequency unless separated by great distances, and even then they would mutually limit each other's service area to about the same degree as in the present band.

With F-M the picture is radically different. Theory indicates, and actual tests confirm, that if the desired signal is twice the undesired signal, there is neither interference in the form of beat notes, nor impairment to quality of reception. This means that F-M stations may be duplicated on the same channel with due consideration of the service area of each station at any separation without either serious mutual limitation or interference to

the respective service of either station. In the present system the area where the ratio of the desired to undesired signal is not equal to that required for acceptable service is a no-man's land. In the new system, the area where the signals from stations on the same frequency differ by more than 2-to-1 in intensity is merely an area in which the listener can, provided the signals are of sufficient strength to each render satisfactory service in the absence of the other, select either station by using a simple, directive antenna with more than 2-to-1 discrimination. It has been amply demonstrated that this is easily practical.

Duplication of Stations Every 50-300 Miles

From an allocation standpoint, it is only necessary to provide sufficient channels to accommodate the number of stations required to serve the largest metropolitan areas. Stations may be duplicated on these channels every 50 to 300 miles, depending on the power, antenna efficiency and the need for broadcast service. Stations in the same area may operate under any conditions without interference, provided one channel intervenes between assignments, and stations may operate on adjacent channels if the transmitters are located near each other and the ratio of powers and antenna efficiency keep the signal intensities within a ratio of the order of 20-to-1. A 5 mc. band

would, therefore, permit 13 or more stations in each service area of the United States.

Based on the experimental data obtained from the operation of the General Electric's frequency modulation stations in Schenectady and Albany that were previously referred to, I. R. Wier, of GE in a paper presented last February before the Bridgeport section of the Institute of Radio Engineers, showed that even with low standards of noise and interference, more F-M stations than A-M stations can be used in a given band and the advantage in this respect increases in favor of F-M as the standards of broadcasting service are raised.

Granting the above, perhaps the broadcasting art wants to know if F-M has lived up to the claims of its proponents in actual practice. The writer can give first-hand information in this connection, as he has designed and supervised the construction of two F-M stations and made measurements and observations on their performance since May, 1939 and in addition has made measurements and observations of Major Armstrong's station since the spring of 1937.

On May 27, 1939, the Yankee Network's high frequency broadcast station, W1XOJ, went on the air for the first time. It has been in regular operation since then with a power of 2 kw. W1XOJ is located centrally with respect to the populated areas of Massachusetts

(Continued on page 394)

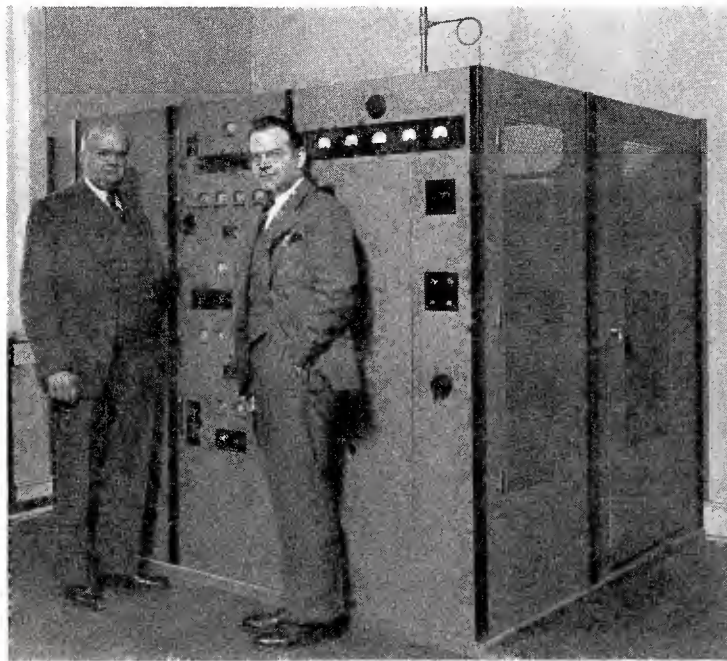
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1000 watt frequency modulated broadcast transmitter Radio Station W3XO, operating on 43,200 kilocycles. Built, owned and operated by Jansky & Bailey, Washington, D. C.

The objective of Jansky & Bailey engineering is to produce the fundamental facts essential to the most effective use of broadcasting as a medium for public service.

Pursuant to its policy of keeping abreast of all technical developments, the firm of Jansky & Bailey for several years has been engaged in frequency modulation and ultra high frequency research and development.

♦ ♦ ♦

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FCC Regulations Governing Broadcast Services Other Than Standard Broadcast

Relay Broadcast Stations

Television Broadcast Stations

High Frequency Broadcast Stations

International Broadcast Stations

Facsimile Broadcast Stations

Developmental Broadcast Stations

Non-Commercial Educational Broadcast Stations

(Rules and Regulations and Standards Applicable to Standard Broadcast Stations

Published by BROADCASTING in Separate Volume; see page 263)

IN GENERAL

Sec. 4.1 *Frequency tolerance.* The operating frequency of the broadcast stations as listed below shall be maintained within plus or minus the percentage of the assigned frequency as given in Table I.

Class of Station	Table I.	Frequency Tolerance
Relay Broadcast Station (a) 1622 to 2830 kc		0.04%
(b) 30,000 to 40,000 kc and above		10 watts or less 0.1% above 10 watts 0.05%
International Broadcast Station		0.005% ¹
Television Broadcast Station		0.01%
Facsimile Broadcast Station		0.05% or less as required
High Frequency Broadcast Station		0.01%
Non-Commercial Educational Broadcast Station		0.01%
Developmental Broadcast Station		0.05% or less as required

Sec. 4.2 *Frequency monitors.*

(a) The licensee of each broadcast station listed in Sec. 4.1, except relay broadcast stations, shall operate at the transmitter a frequency monitor independent of the frequency control of the transmitter.

(b) The frequency monitor shall be designed and constructed in accordance with good engineering practice and shall have an accuracy sufficient to determine that the operating frequency is within one-half (½) of the allowed tolerance.

(c) The licensee of each relay broadcast station shall provide the necessary means for determining that the frequency of the station is within the allowed tolerance.

(d) The frequency of all stations listed in Sec. 4.1 shall be checked at each time of beginning operation and as often thereafter as necessary to maintain the frequency within the allowed tolerance.

Sec. 4.3 *License period; renewal.*

(a) Licenses for the following classes of broadcast stations will be normally issued for a period of one year expiring as follows:

Class of Station	Date of Expiration
Relay Broadcast Station	
(a) 1622 to 2830 kc	October 1
(b) 30,000 to 40,000 kc and above	December 1
International Broadcast Station	November 1
Television Broadcast Station	February 1
Facsimile Broadcast Station	March 1
High Frequency Broadcast Station	April 1
Non-Commercial Educational Broadcast Station	May 1
Developmental Broadcast Station	May 1

(b) Each licensee shall submit the application for renewal of license at least 60 days prior to the expiration date (Sec. 1.360).

(c) A supplemental report shall be submitted with each application for renewal of license of a station licensed experimentally² in accordance with the regulations governing each class of station.

Sec. 4.4 *Requirements, limitations and restrictions.*

(a) No station licensed experimentally will be assigned for exclusive use of any frequency. In case interference would be caused by simultaneous operation of stations licensed experimentally, such licensees shall endeavor to arrange satisfactory time division. If such agreement cannot be reached, the Commission will determine and specify the time division.

(b) The Commission may from time to time require that a station licensed experimentally conduct such experiments that are deemed desirable and reasonable for the development of the service.

(c) The program of research and experimentation as offered by an applicant in compliance with the requirements for obtaining a license for an experimental station² shall be adhered to in the main, unless the licensee is authorized to do otherwise by the Commission.

(d) A licensee of an experimental station is not required to adhere to a regular schedule of operation but shall actively conduct a program of research and experimentation or transmission of programs, provided, however, licensees of developmental broadcast stations which are licensed to conduct special intermittent experiments, such as to develop and test commercial broadcast equipment, are required to operate only when there is a need therefor.

(e) A supplementary statement shall be filed with and made a part of each application for construction permit for any broadcast station on an experimental basis which specifies any frequency above 300,000 kilocycles or in the bands 162,000 to 168,000, 210,000 to 216,000 and 264,000 to 270,000 kilocycles except television, confirming the applicant's understanding:

1. That all operation upon the frequency is experimental only;
2. That the frequency may not be the best suited to the particular experimental work to be carried on, and
3. That the frequency may not be allocated for the service that may be developed experimentally.

¹ Tolerance may be .01% on equipment installed prior to January 1, 1940, and until January 1, 1941, when all international stations shall maintain frequency within 0.005% of the assigned frequency.

² The phrases "station licensed experimentally" and "experimental station" are used interchangeably and refer to stations listed in Sec. 4.3 when so specified in the instrument of authorization.

Sec. 4.5 *Station records.*

(a) The licensee of each class of broadcast station listed in Sec. 4.1 shall maintain adequate records of the operation, including:

1. Hours of operation.
2. Program transmitted.
3. Frequency check.
4. Pertinent remarks concerning transmission.
5. In case of relay station, an entry giving point of program origination and receiver location shall be included.
6. Research and experimentation conducted in case of an experimental station.
7. And any additional information specified in the regulations governing each class of station or for completing the supplemental report as required.

(b) The above information shall be made available upon request by authorized Commission representatives.

Sec. 4.6 *Equipment changes.* The licensee of each class of broadcast station listed in Sec. 4.1 may make any changes in the equipment that are deemed desirable or necessary, provided:

1. That the operating frequency is not permitted to deviate more than the allowed tolerance;
2. That the emissions are not permitted outside the authorized band;
3. That the power output complies with the license and the regulations governing the same, and
4. That the transmitter as a whole or output power rating of the transmitter is not changed.

Sec. 4.7 *Emission authorized.* All classes of broadcast licenses authorize A3 emission only unless otherwise specified in the license. In case A1, A2, A4, A5, or special emission are necessary or helpful in carrying on any phases of experimentation, application setting out fully the needs shall be made to, and authority therefore received from, the Commission.

Sec. 4.8 *Additional orders, as needed.* In case all the general rules and regulations and the specific rules governing each class of broadcast station do not cover all phases of operation or experimentation with respect to external effects, the Commission may make supplemental or additional orders in each case as deemed necessary for operation in the public interest, convenience, and/or necessity.

Sec. 4.9 *Operation.* A licensed operator shall be on duty and in charge of the transmitter of each broadcast station listed in Sec. 4.1. In no case will remote control operation be authorized. A transmitter is not considered as being operated by remote control when the following conditions prevail:

(a) Continuous reading indicating instruments are before the operator as follows:

1. Frequency deviation meter.
2. Percentage modulation indicator.
3. Spurious emission check (receiver).
4. Last radio stage plate voltage.
5. Last radio stage total plate current.
6. Output or antenna current.

(b) The operator has off and on control of the power to the last radio stage.

(c) The operator can reach the transmitter proper in not more than five minutes to make any changes or adjustments necessary to maintain proper operation.

Sec. 4.10 *Rebroadcasts.*³

(a) The licensee of an international or non-commercial educational broadcast station may, without further authority of the Commission, rebroadcast the program of a United States standard broadcast station, provided the Commission is notified of the call letters of each station rebroadcast and the licensee certified that express authority has been received from the licensee of the station originating the program.² (See Secs. 4.43 and 4.132 (c) concerning commercial announcements.)

(b) No licensee of an international or non-commercial educational broadcast station shall rebroadcast the program of any other class of United States radio station without written authority having first been obtained from the Commission.⁴

(c) No licensee of any other class of broadcast station listed in Sec. 4.1 (television, facsimile, high frequency or developmental) shall rebroadcast the program of any radio station without written authority first having been obtained from the Commission.⁴

(d) Authority will not be granted to rebroadcast in the United States the program of an international broadcast station located within the limits of the North American continent, except upon a satisfactory showing that no other facilities exist for transmitting the program to the area served by the station proposing the rebroadcast.

¹ For definition of "rebroadcast" see Sec. 3.94 (a).

² The notice and certification of consent must be given within three (3) days of any single rebroadcast, but in case of the regular practice of rebroadcasting certain programs of a standard broadcast station several times during a license period, notice and certification of consent must be given for the ensuing license period with the application for renewal of license, or at the beginning of such rebroadcast practice if begun during a license period.

³ The broadcasting of a program relayed by a relay broadcast station (Sec. 4.21) is not considered a rebroadcast.

⁴ Informal application may be employed.

(e) A licensee of an international broadcast station may authorize the rebroadcast of its programs by any station outside the limits of the North American continent without permission from the Commission, provided that the station rebroadcasting the programs cannot be received consistently in the United States.

(f) An application for authority to rebroadcast the program of any radio station shall be accompanied by written consent or certification of consent of the licensee of the station originating the programs.

Sec. 4.11 Equipment and program tests.

(a) A licensee of a broadcast station listed in Sec. 4.1 shall conduct equipment tests in accordance with Sec. 2.42 and program tests in accordance with Sec. 2.43.

(b) In case the transmitter and associated equipment are on hand in complete form and an application for license was filed and granted with the application for construction permit, then the notification of equipment tests and program tests as required by paragraph (a) of this section need not be made.

RELAY BROADCAST STATIONS

Sec. 4.21 Defined.¹ The term "relay broadcast station" means a station licensed to transmit from points where wire facilities are not available, programs for broadcast by one or more broadcast stations or orders concerning such programs.

Sec. 4.22 Licensing and authorizations.

(a) A license for a relay broadcast station will be issued only to the licensee of a standard broadcast station², provided, however, in cases where it is impractical, impossible, or prohibited by laws or regulations for the licensee of a standard broadcast station to install, operate or maintain the necessary equipment under its legal control, the Commission may grant special temporary authority for each event to another person to operate as a relay broadcast station equipment already licensed for another service, or equipment which may be installed under Section 319 (b) of the Communications Act of 1934 without a construction permit and provided further:

(b) The Commission may license a special relay broadcast station to the licensee of another class of broadcast station provided a need therefor is shown and the relay station will be used only for relaying of programs for broadcast by such broadcast station.

(c) The license of a relay broadcast station authorizes the transmission of commercial or sustaining programs, or orders concerning such programs, to be broadcast by its standard broadcast station and other broadcast stations transmitting the same programs simultaneously or a chain program to the network with which the licensee is regularly affiliated. The license of a relay station does not authorize transmission of programs to be broadcast solely by other broadcast stations not aforementioned.

(d) In case a licensee has two or more standard broadcast stations located in different cities, it shall, in applying for a new relay station or for renewal of license of an existing relay station, designate the standard broadcast station or stations in conjunction with which the relay station is to be operated principally, and it shall not thereafter operate the relay station in conjunction with another of its standard broadcast stations located in a different city for more than a total of ten days in any thirty-day period.

(e) Each application for temporary authority to operate a relay broadcast station from a person other than a licensee of a standard broadcast station shall be accompanied by an application for authority to broadcast the program from the licensee of the standard broadcast station proposing the broadcast.

(f) An application for special temporary authority to operate another class of station as a relay broadcast station shall specify a group of frequencies allocated in Sec. 4.23; provided, however, in case of events of national interest and importance which cannot be transmitted successfully to the nearest available wire facilities on these frequencies, other frequencies under the jurisdiction of the Commission may be requested, if it is shown that the operation thereon will not cause interference to established stations.

(g) An application for special temporary authority to operate on frequencies not allocated by Sec. 4.23 or to operate another class of station as a relay broadcast station must be received by the Commission not less than ten days prior to the actual event to be broadcast, and shall contain complete information concerning the frequencies requested and the license of the station to be used. In case of emergencies, which shall be fully explained in the application, the Commission may waive the ten-day requirement specified herein.

Sec. 4.23 Frequency assignment and operation.

(a) The following groups of frequencies are allocated for assignment to relay broadcast stations:

Group A	Group B	Group C	Group D	Group E
1622 kc	1606 kc	1646 kc	30,820 kc	31,220 kc
2058	2022	2090	33,740	35,620
2150	2102	2190	35,820	37,020
2790	2758	2830	37,980	39,260
Group F	Group G	Group H	Group I	Group J
31,620 kc	33,380 kc	132,260 kc	133,030 kc	Any four frequencies above
35,260	35,020	134,080	134,850	300,000 kc excluding band
37,340	37,620	135,480	136,810	400,000 to
39,620	39,820	135,760	138,630	401,000 kc

(h) One of the above groups only, including all four frequencies will be assigned each station. The first application from any metropolitan area for the frequencies in Groups A, B or C shall specify Group A; the second Group B, and the third Group C, the fourth Group A again, etc. and likewise for frequencies in Groups D, E, F or G, first application Group D, second E, third F, etc. Outstanding assignments not following this order will not be changed unless a need therefor develops. Additional applicants shall specify the next unassigned group in sequence or any other group if it appears interference will be avoided thereby.

(c) A station may be licensed for Group H when a need for frequencies of this order may be shown.

(d) Group I will be licensed to stations to operate with frequency modulation only when need for such operation and frequencies of this order may be shown.

¹ See Sec. 4.5 (6) for special log entry requirement.

² See "Number of Relay Broadcast Stations That Will be Licensed to Each Holder of Standard Broadcast Station License" as announced by the Commission.

(c) Any four specific frequencies under Group J will be assigned on experimental operation only and an applicant may apply for the four frequencies which appear most suitable for the experimental work to be conducted.

(f) The licensee of a station on Group J shall carry on research and experimentation for the advancement of the relay broadcast art and development of these ultra high frequencies for relay broadcast services. An application for authority to operate a station on frequencies in Group J shall include a statement concerning the research and experiments to be conducted. The research and experiments shall indicate reasonable promise of substantial contribution to the development of the program relay services.

(g) A license authorizes operation on only one of the four assigned frequencies at any one time. In case it is desired to transmit programs and spoken orders concerning such programs simultaneously, two licenses are required though each may specify the same group of frequencies.

Sec. 4.24 Frequency selection to avoid interference. In case two or more stations are licensed for the same group of frequencies in the same area and in case simultaneous operation is contemplated, the licensees shall endeavor to select frequencies to avoid interference. If a mutual agreement to this effect cannot be reached the Commission shall be notified and it will specify the frequencies on which each station is to be operated.

Sec. 4.25 Power limitations.

(a) A relay broadcast station assigned frequencies in Groups A, B, C and J will be licensed to operate with a power output not in excess of that necessary to transmit the program and orders satisfactorily to the receivers and shall not be operated with a power greater than licensed.

(b) A relay broadcast station assigned frequencies in Groups D, E, F and G will not be authorized to install equipment or licensed for an output power in excess of 100 watts; provided that before using any frequency in these groups with a power in excess of 25 watts, tests shall be made by the licensee to insure that no objectionable interference will result to the service of any government station, and provided, further, that if the use of any frequency may cause interference then the power shall be reduced to 25 watts or another frequency in the licensed group selected which will not cause objectionable interference.

(c) A relay broadcast station assigned frequencies in Groups H and I will be licensed to operate with a power output not in excess of that necessary to transmit the program and orders satisfactorily to the receivers and shall not be operated with a power greater than that licensed. In event interference may be caused to stations on adjacent channels, licensees shall endeavor to make arrangements to reduce power to a point where interference will not be objectionable. If a satisfactory arrangement cannot be agreed upon, the Commission will determine and specify the maximum power or conditions of operation of each such station.

Sec. 4.26 Supplemental report with renewal application. The licensee of a relay broadcast station assigned frequencies under Group J shall submit a supplemental report with and made a part of each application for renewal of license as follows:

1. Number of hours operated for experimental purposes.
2. Developments carried on in the relay broadcast service.
3. Propagation characteristics of the frequencies assigned with regard to relay broadcast service.
4. All developments or major changes in equipment.
5. Any other pertinent developments.

INTERNATIONAL BROADCAST STATIONS

Sec. 4.41 Defined. The term "international broadcast station" means a station licensed for the transmission of broadcast programs for international public reception. (Frequencies for these stations are allocated from bands assigned between 6,000 and 26,600 kilocycles¹ for broadcasting by International Agreement).

Sec. 4.42 Licensing requirements; necessary showing. A license for an international broadcast station will be issued only after a satisfactory showing has been made in regard to the following, among others:

1. That there is a need for the international broadcast service proposed to be rendered.
2. That the necessary program sources are available to the applicant to render an effective international service.
3. That the technical facilities are available on which the proposed service can be rendered without causing interference to established international stations having prior registration and occupancy in conformity with existing international conventions or regulations on the frequency requested.¹
4. That directive antennas and other technical facilities will be employed to deliver maximum signals to the country or countries for which the service is designed.
5. That the production of the program service and the technical operation of the proposed station will be conducted by qualified persons.
6. That the applicant is technically and financially qualified and possesses adequate technical facilities to carry forward the service proposed.
7. That the public interest, convenience and necessity will be served through the operation of the proposed station.

Sec. 4.43 Service; commercial or sponsored programs.

(a) A licensee of an international broadcast station shall render only an international broadcast service which will reflect the culture of this country and which will promote international goodwill, understanding and cooperation. Any program solely intended for, and directed to an audience in the continental United States does not meet the requirements for this service.²

(b) Such international broadcast service may include commercial or sponsored programs provided that,

1. Commercial program continuities give no more than the name of the sponsor of the program and the name and general character of the commodity, utility or service, or attraction advertised.
2. In case of advertising a commodity, the commodity is regularly sold or is being promoted for sale on the open market in the foreign country or countries to which the program is directed in accordance with paragraph (c) of this section.
3. In case of advertising an American utility or service to prospective

¹ See General Radio Regulations annexed to the International Telecommunications Convention, Madrid, 1932, Article 7. Prior to Sept. 1, 1939 and thereafter see Cairo General Radio Regulations, Article 7, annexed to the International Telecommunications Conferences, Cairo, Egypt, 1938. Also, see list of assignments to international channels prepared by the Bureau of the International Telecommunications Union, Berne, Switzerland.

² Suspended indefinitely Sept. 27, 1939.

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(Continued from page 377)

tourists or visitors to the United States, the advertisement continuity is particularly directed to such persons in the foreign country or countries where they reside and to which the program is directed in accordance with subsection (c) of this section.

4. In case of advertising an international attraction (such as a world fair, resort, spa, etc.) to prospective tourists or visitors to the United States, the oral continuity concerning such attraction is consistent with the purpose and intent of this section.
5. In case of any other type of advertising, such advertising is directed to the foreign country or countries and to which the program is directed in accordance with paragraph (c) of this section and is consistent with the purpose and intent of this section.

(c) The areas or zones established to be served by international broadcast stations are the foreign countries of the world, and directive antennas shall be employed to direct the signals to specific countries. The antenna shall be so designed and operated that the signal (field intensity) toward the specific foreign country or countries served shall be at least 3.16 times the average effective signal from the station (power gain of 10).

(d) An international broadcast station may transmit the program of a standard broadcast station or network system provided the conditions in paragraph (b) of this section in regard to any commercial continuities are observed and when station identifications are made, only the call letter designation of the international station is given on its assigned frequency, and provided further that in the case of chain broadcasting, the program is not carried simultaneously by another international station (except another station owned by the same licensee operated on a frequency in a different group to obtain continuity of signal service), the signals from which are directed to the same foreign country or countries.

(e) Station identification, program announcements, and oral continuity shall be made with international significance (language particularly) which is designed for the foreign country or countries for which the service is primarily intended.

Sec. 4.44 Frequency assignment.

(a) The following groups of frequencies are allocated for assignment to international broadcast stations:

Group A	Group B	Group C	Group D
6020 kc	9510 kc	11,710 kc	15,110 kc
6040	9530	11,750	15,150
6060	9570	11,770	15,170
6080	9590	11,790	15,190
6100	9650 ²	11,810	15,210
6140	9670 ²	11,830	15,230
6170 ²		11,850	
6190 ²		11,870	
		11,890	
Group E	Group F	Group G	Group H
15,250 kc	17,760 kc	21,460 kc	25,600 kc
15,270	17,780	21,480	25,625
15,290	17,800	21,520	25,650
15,310	17,830 ²	21,540	25,675
15,330		21,570 ²	25,700
		21,590 ²	25,725
		21,610 ²	25,750
		21,630 ²	25,775
		21,650 ²	25,800
			25,825
			25,850

(b) A separate license and call letter designation will be issued for each frequency except that where frequencies in two or more groups are required to maintain a particular international broadcast service to certain foreign country or countries, one frequency from each of the groups required may be authorized by one license and one call letter designation. In such cases these frequencies shall be used consecutively during a day as required and they shall not be used simultaneously either on the same transmitter or different transmitters.

(c) Not more than one frequency in any one group in paragraph (a) of this section will be assigned to a station.

Sec. 4.45 Power requirement. No international broadcast station will be authorized to install equipment or licensed for operation with a power less than 50 kilowatts.³

Sec. 4.46 Supplemental report with renewal application. A supplemental report shall be filed with and made a part of each application for renewal of license and shall include statements of the following:

1. The number of hours operated on each frequency.
2. A list of programs transmitted of special international interest.
3. Outline of reports of reception and interference and conclusions with regard to propagation characteristics of the frequency assigned.

¹ See Section 3 (p) of the Communications Act of 1934 for the definition of "chain broadcasting".

² Any operation on this frequency prior to September 1, 1939, shall be in compliance with Article 7, Cairo General Radio Regulations as adopted at the International Telecommunications Conferences, Cairo, Egypt, 1938.

³ This provision shall become effective as applying to existing stations July 1, 1940.

Sec. 4.47 Frequency control. The transmitter of each international broadcast station shall be equipped with automatic frequency control apparatus so designed and constructed that it is capable of maintaining the operating frequency within plus or minus 0.005 per cent of the assigned frequency.¹

VISUAL BROADCAST SERVICE

[For recommended new rules and proposed RMA television transmission standards and allocation recommendations, see pages 342 and 343]

TELEVISION BROADCAST STATIONS

[See pages 342 and 343 for proposed rules]

FACSIMILE BROADCAST STATIONS

4.96 Supplemental report with renewal application

Sec. 4.61 Defined. The term "visual broadcast service" means a service rendered by stations broadcasting images for general public reception. There are two classes of stations recognized in the visual broadcast service, namely: television broadcast stations and facsimile broadcast stations.

Sec. 4.71 Defined. The term "television broadcast station" means a station licensed for the transmission of transient visual images of moving or fixed objects for simultaneous reception and reproduction by the general public. The transmission of the synchronized sound (aural broadcast) is considered an essential phase of television broadcast and one license will authorize both visual and aural broadcast as herein set out.

Sec. 4.72 Licensing requirements; necessary showing. A license for a television broadcast station will be issued only after a satisfactory showing has been made in regard to the following, among others:

1. That the applicant has a program of research and experimentation which indicates reasonable promise of substantial contribution to the development of the television broadcast art.
2. That the program of research and experimentation will be conducted by qualified engineers.
3. That the applicant is legally and financially qualified and possesses adequate technical facilities to carry forward the program.
4. That the public interest, convenience and/or necessity will be served through the operation of the proposed station.

Sec. 4.73 Charges prohibited; restrictions and announcements. (a) A licensee of a television broadcast station shall not make any charge, directly or indirectly, for the transmission of either aural or visual programs.

(b) In the case of experimental televising of the production of a commercial standard broadcast program, all commercial announcements not a part of the entertainment continuity shall be eliminated from the television broadcast except the mere statement of the name of the sponsor or product or the televising of the trademark, symbol, slogan or product of the sponsor; provided, however, that when the program transmission is incidental to the experiments being conducted and not featured, and subject to interruptions as the experiments may require, the commercial announcements may be broadcast aurally.

(c) No licensee of a standard broadcast station or network shall make any additional charge, directly or indirectly, for the simultaneous transmission of the aural or visual program by a television broadcast station, nor shall commercial accounts be solicited by the licensee of a standard broadcast station or network, or by others acting in their behalf upon the representation that the commercial program will also be transmitted by a television broadcast station.

(d) The synchronized sound (aural) program of a television broadcast station may be broadcast by a standard broadcast station, provided:

1. That no announcements or references shall be made over the standard broadcast station regarding the operation of the television broadcast station, except the mere statement that the program being transmitted is the sound or aural program of a television broadcast station (identify by call letters).
2. That the call letter designation when identifying the television broadcast station shall be given on its assigned frequency only.

Sec. 4.74 Frequency assignment. (a) The following groups of channels are allocated for assignment to television broadcast stations licensed experimentally:

Group A	Group B	Group C
44,000- 50,000 kc	156,000-162,000 kc	Any 6,000 kc. band above 300,000 kc. excluding band 400,000 to 401,000 kc.
50,000- 56,000	162,000-168,000 ²	
66,000- 72,000	180,000-186,000	
78,000- 84,000	186,000-192,000	
84,000- 90,000	204,000-210,000	
96,000-102,000	210,000-216,000 ²	
102,000-108,000	234,000-240,000	
	240,000-246,000	
	258,000-264,000	
	264,000-270,000 ²	
	282,000-288,000	
	288,000-294,000	

(b) Each television station will be assigned only one 6000-kilocycle fre-

¹ See Section 4.1 page 376. This provision shall become effective as applying to existing stations Jan. 1, 1941.

² See Secs. 4.4 (c) and 4.154 (a).

HIGH FREQUENCY BROADCAST STATIONS

quency band from groups in paragraph (a) of this rule. Both aural and visual carriers with side bands for modulation are authorized but no emission shall result outside the authorized frequency band.

(c) Frequency band in Group A shall be used by stations principally for developing television intended directly for public reception. Frequency bands in Groups B and C may be licensed for the same purposes as those in Group A and in addition for stations to serve auxiliary television purposes, such as television relay stations, developmental mobile service. However, no mobile or portable station will be licensed for the purpose of transmitting television programs to the public directly.

(d) A licensee will not be granted a second television station to operate on a frequency band in Group A which would serve in whole or part the same service area as already served by a station licensed to it for a frequency band in Group A.

Sec. 4.75 *Power*. The operating power of a television broadcast station shall not be in excess of that necessary to carry forward the program of research. The operating power may be maintained at the maximum rating or less, as the conditions of operation may require.

Sec. 4.76 *Supplemental report with renewal application*. A supplemental report shall be filed with and made a part of each application for renewal of license and shall include statements of the following:

1. Number of hours operated for transmission of television programs.
2. Comprehensive report of research and experimentation conducted.
3. Conclusions and program for further developments of the television broadcast service.
4. All developments and major changes in equipment.
5. Any other pertinent developments.

Sec. 4.91 *Defined*. The term "facsimile broadcast station" means a station licensed to transmit images of still objects for record reception by the general public.

Sec. 4.92 *Licensing requirements*. A license for a facsimile broadcast station will be issued only after a satisfactory showing has been made in regard to the following, among others:

1. That the applicant has a program of research and experimentation which indicates reasonable promise of substantial contribution to the development of the facsimile broadcast service.
2. That sufficient facsimile recorders will be distributed to accomplish the experimental program proposed.
3. That the program of research and experimentation will be conducted by qualified engineers.
4. That the applicant is legally and financially qualified and possesses adequate technical facilities to carry forward the program.
5. That the public interest, convenience and/or necessity will be served through the operation of the proposed station.

Sec. 4.93 *Charges prohibited; restriction*. (a) A licensee of a facsimile broadcast station shall not make any charge, directly or indirectly, for the transmission of programs.

(b) No licensee of any standard broadcast station or network shall make any additional charge, directly or indirectly, for the transmission of some phase of the programs by a facsimile broadcast station, nor shall commercial accounts be solicited by any licensee of a standard broadcast station or network, or others acting in their behalf, upon representation that images concerning that commercial program will be transmitted by a facsimile station.

Sec. 4.94 *Frequency assignment*. (a) The following groups of frequencies are allocated for assignment to facsimile broadcast stations which will be licensed experimentally only:

Group A	Group B	Group C	Group D
25,025 kc	43,540 kc	116,110 kc	Any frequency
25,050	43,580	116,230	above 300,000 kc.
25,075	43,620	116,350	excluding band
25,100	43,660	116,470	400,000 to
25,125	43,700		401,000 kc.
25,150	43,740		
25,175	43,780		
25,200	43,820		
25,225	43,860		
25,250	43,900		
	43,940		

(b) Other broadcast or experimental frequencies may be assigned for the operation of facsimile broadcast stations on an experimental basis provided a sufficient need therefor is shown and no interference will be caused to established radio stations.

(c) One frequency only will be assigned to a facsimile station from the Groups in paragraph (a) of this section. More than one frequency may be assigned under provisions of paragraph (b) of this section if a need therefor is shown.

(d) Each applicant shall specify the maximum modulating frequencies proposed to be employed.

(e) The operating frequency of a facsimile broadcast station shall be maintained in accordance with the frequency tolerance given in Sec. 40.01 provided, however, where a lesser tolerance is necessary to prevent interference, the Commission will specify the tolerance.

(f) A facsimile broadcast station authorized to operate on frequencies regularly allocated to other stations or services shall be required to abide by all rules governing the stations regularly operating thereon, which are applicable to facsimile broadcast stations and are not in conflict with Secs. 4.1 to 4.11, inclusive, of these rules.

Sec. 4.95 *Power*. The operating power of a facsimile broadcast station shall not be in excess of that necessary to carry forward the program of research, provided, however, not more than 1000 watts will be authorized on a frequency in Group A. The operating power may be maintained at the maximum rating or less, as the conditions of operation may require.

Sec. 4.96 *Supplemental report with renewal application*. A supplemental report shall be filed with and made a part of each application for renewal of license and shall include statements of the following:

1. Number of hours operated for transmission of facsimile programs.
2. Comprehensive report of research and experimentation conducted.
3. Conclusions and programs for further developments of the facsimile broadcast service.
4. All developments and major changes in equipment.
5. Any other pertinent developments.

Sec. 4.111 *Defined*. The term "high frequency broadcast station" means a station licensed on frequencies above 25,000 kilocycles for transmission of aural programs for general public reception.

Sec. 4.112 *Licensing requirements; necessary showing*. A license for a high frequency broadcast station will be issued only after a satisfactory showing has been made in regard to the following, among others:

1. That the applicant has a program of research and experimentation which indicates reasonable promise of substantial contribution to the development of high frequency broadcasting.
2. That substantial data will be taken on the propagation characteristics of these frequencies; on the noise level in different parts of the city; on the field intensity necessary to render good broadcast service; on antenna design and characteristics with respect to propagation; and on other allied phases of broadcast coverage.
3. That the research and experimentation will be conducted by qualified engineers.
4. That the applicant is legally and financially qualified and possesses adequate technical facilities to carry forward the program.
5. That the public interest, convenience and necessity will be served through the operation of the proposed station.

Sec. 4.113 *Charges prohibited; restriction and announcements*. (a) A licensee of a high frequency broadcast station shall not make any charge, directly or indirectly, for the transmission of programs, but may transmit the programs of a standard broadcast station or network including commercial programs, if the call letter designation when identifying the high frequency broadcast station is given on its assigned frequencies only and the statement is made over the high frequency broadcast station that the program of a standard broadcast station or network (identify by call letters or name of network) is being broadcast. Immediately following any announcement of the call letter designation of a standard broadcast station, the program from which is being broadcast over a high frequency broadcast station, the call letter designation of the high frequency broadcast station shall be given. In case of the reassignment of the program of any broadcast station, Sec. 4.10 applies.

(b) No licensee of any standard broadcast station or network shall make any additional charge, directly or indirectly, for the simultaneous transmissions of programs by the high frequency broadcast station, nor shall commercial accounts be solicited by a licensee of a standard broadcast station or network, or by others acting in their behalf upon representation that the commercial program will also be transmitted by a high frequency broadcast station.

Sec. 4.114 *Frequency assignment*.

(a) The following groups of frequencies are allocated for assignment to high frequency broadcast stations:

Group A	Group B	Group C	Group D
25,300 kc	25,900 kc	26,300 kc	42,060 kc
25,325	25,925	26,500	42,100
25,350	25,950	26,700	42,140
25,375	25,975	26,900	42,180
25,400	26,000		42,220
25,425	26,025		42,260
25,450	26,050		42,300
25,475	26,075		42,340
25,500	26,100		42,380
25,525	26,125		42,420
25,550	26,150		42,460

Group E	Group F	Group G	Group H
42,000 kc	116,590 kc	117,190 kc	Any frequency
42,800	116,710	117,430	above 300,000 kc.
43,000	116,830	117,670	excluding band
43,200	116,950	117,910	400,000 to
43,400	117,070		401,000 kc.

(b) A station assigned a frequency in Group A, B, D or F is authorized to operate exclusively with amplitude modulation (maximum band width of emission 30 kc.). A station assigned a frequency in Group C, E or G is authorized to operate exclusively with frequency modulation (maximum band width of emission 200 kc.). A station assigned a frequency in Group H is authorized to operate with either amplitude or frequency modulation with the above band widths of emission as applicable.

(c) Stations serving the same area will not be assigned frequencies separated less than the following:

Group A or B	Group D	Group C, E, F, G or H
100 kc	160 kc	To be determined

(d) One frequency only in a Group will be assigned to a station. A station assigned a frequency in Group A, B or C will not be assigned another frequency. A station assigned a frequency in Group D may also be assigned a frequency in Group F, and in Group E, also in Group G. In case more than one frequency is assigned to a station, the license authorizes operation on only one of the frequencies at one time.

(e) A licensee of a station assigned a frequency in Group A or one of the last two frequencies in Group C shall make the necessary observations to determine that no interference is caused to international mobile service and international fixed service respectively; and that the operation is in accordance with international agreements on the assignments of stations to this band. If interference is caused to such services the licensee may be required to reduce the operating power of the station or cease operation until the Commission deems no further interference will result.

Sec. 4.115 *Power*.

(a) No high frequency broadcast station will be licensed for an output power rating greater than 1000 watts unless the applicant can show that greater power is needed to carry on a special program of research, provided, however, in no case will an operating power greater than 1000 watts be authorized to a station assigned a frequency in Group A or one of the last two frequencies in Group C.

(b) While conducting apparatus experiments and in case adequate signal for reliable service can be delivered with less power, the operating output may be reduced accordingly.

Sec. 4.116 *Frequency control*. Each high frequency broadcast station transmitter shall be equipped with automatic frequency control apparatus so de-

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signed and constructed that it is capable of maintaining the operating frequency within plus or minus 0.01% of the assigned frequency.

Sec. 4.117 *Supplemental report with renewal application.* A supplemental report shall be filed with each and made a part of the application for renewal of license and shall include statements of the following, among others:

1. The number of hours operated.
2. Data taken in compliance with Sec. 4.112 (2).
3. Outline of reports of reception and interference and conclusions with regard to propagation characteristics of the frequency assigned.
4. Research and experiments being carried on to improve transmission and to develop broadcasting on the very high frequencies.
5. All developments or major changes in equipment.
6. Any other pertinent developments.
7. Comprehensive summary of all reports received. See Sec. 4.114 (e).

NON-COMMERCIAL EDUCATIONAL BROADCAST STATIONS

Sec. 4.131 *Defined.* The term "non-commercial educational broadcast station" means a station licensed to an organized non-profit educational agency for the advancement of its educational work and for the transmission of educational and entertainment programs to the general public.

Sec. 4.132 *Operation and service.* The operation of, and the service furnished by, non-commercial educational broadcast stations shall be governed by the following regulations:

(a) A non-commercial educational broadcast station will be licensed only to an organized non-profit educational agency and upon a showing that the station will be used for the advancement of the agency's educational program particularly with regard to use in an educational system consisting of several units.

(b) Each station may transmit programs directed to specific schools in the system for use in connection with the regular courses as well as routine and administrative material pertaining to the school system and may transmit educational and entertainment programs to the general public.

(c) Each station shall furnish a non-profit and non-commercial broadcast service. No sponsored or commercial program shall be transmitted nor shall commercial announcements of any character be made. A station shall not transmit the programs of other classes of broadcast stations unless all commercial announcements and commercial references in the continuity are eliminated.

Sec. 4.133 *Power.* The operating power of non-commercial educational broadcast stations shall be not less than 100 watts or greater than 1000 watts unless a definite need for greater power is shown.

Sec. 4.134 *Frequency control.* The transmitter of each non-commercial educational broadcast station shall be equipped with automatic frequency control apparatus so designed and constructed that it is capable of maintaining the operating frequency within plus or minus 0.01 percent of the assigned frequency.

Sec. 4.135 *Operating schedule.* Non-commercial educational broadcast stations are not required to operate on any definite schedule or minimum hours.

Sec. 4.136 *Equipment requirements.* The transmitting equipment, installation, and operation as well as the location of the transmitter shall be in conformity with the requirements of good engineering practice as released from time to time by the Commission.

Sec. 4.137 *Frequencies.*

(a) The following frequencies are allotted for assignment to non-commercial educational broadcast stations:

41.020 kc	41.220 kc	41.420 kc	41.620 kc	41.820 kc
41.060	41.260	41.460	41.660	41.860
41.100	41.300	41.500	41.700	41.900
41.140	41.340	41.540	41.740	41.940
41.180	41.380	41.580	41.780	41.980

(b) Stations serving the same area will not be assigned frequencies separated less than 160 kilocycles.

(c) Amplitude modulation shall be employed exclusively unless it can be shown that frequency modulation will better serve the purpose of the station in which case such modulation may be authorized provided sufficient frequencies can be grouped so as to obtain the required band width without causing interference to established stations or preventing the full expansion of the service.

(d) Only one frequency will be assigned to a station.

DEVELOPMENTAL BROADCAST STATIONS

Sec. 4.151 *Defined.* The term "developmental broadcast station" means a station licensed to carry on development and research for the advancement of broadcast services along lines other than those prescribed by other broadcast rules or a combination of closely related developments that can be better carried on under one license.

Sec. 4.152 *Licensing requirements; necessary showing.*

(a) Licenses for developmental broadcast stations will be issued only after a satisfactory showing has been made in regard to the following, among others:

1. That the applicant has a program of research and development which cannot be successfully carried on under any of the classes of broadcast stations already allocated, or is distinctive from those classes, or combination of closely related developments that involve different phases of broadcasting which can be pursued better under one license.
2. That the program of research has reasonable promise of substantial contribution to the development of broadcasting, or is along lines not already thoroughly investigated.
3. That the program of research and experimentation will be conducted by qualified persons.

4. That the applicant is legally and financially qualified and possesses adequate technical facilities to carry forward the program.

5. That the public interest, convenience and necessity will be served through the operation of the proposed station.

(b) A separate developmental broadcast station license will be issued for each major development proposed to be carried forward. When it is desired to carry on several independent developments, it will be necessary to make satisfactory showing and obtain a license for each.

Sec. 4.153 *Program service; charges prohibited; announcements.*

(a) A license of developmental broadcast stations shall broadcast programs only when they are necessary to the experiments being conducted. No regular program service shall be broadcast unless specifically authorized by the license.

(b) A license of a developmental broadcast station shall not make any charge, directly or indirectly, for the transmission of programs, but may transmit the programs of a standard broadcast station or network including commercial programs, if the call letter designation when identifying the developmental broadcast station is given on its assigned frequency only and the statement is made over the developmental broadcast station that the program of a broadcast station or network (identify by call letters or name of network) is being broadcast in connection with the developmental work. In case of the rebroadcast of the program of any broadcast station, Sec. 4.10 applies.

Sec. 4.154 *Frequency assignment.*

(a) The following frequencies are allocated for assignment to developmental broadcast stations:*

2,396	1,614	12,855	12,862.5	37,140
2,400	2,398	12,870		37,540
				39,140
				39,460
3,490	3,492.5	17,300	17,310	39,540
3,495		17,320		132,400
				132,680
				133,380
				134,360
4,795	4,797.5	23,100		135,340
4,800		30,660		137,440
				137,860
				138,140
6,420	6,425	31,180		138,840
6,430		31,540		139,540
				139,960
				162,000 to 168,000
8,650	8,655	33,620		210,000 to 216,000
		35,060		264,000 to 270,000
8,660		35,460		300,000 to 400,000
				401,000 and above
9,130	9,135	37,060		
9,140				

* Also available for assignment to all other stations in the experimental service.

(b) A license will be issued for more than one of these frequencies upon a satisfactory showing that there is need thereof.

(c) The frequencies suited to the purpose and in which there appears to be the least or no interference to established stations shall be selected.

(d) In cases of important experimentation which cannot be conducted successfully on the frequencies allocated in subsection (a) of this Rule, the Commission may authorize developmental broadcast stations to operate on any frequency allocated for broadcast stations or any frequencies allocated for other services under the jurisdiction of the Commission upon satisfactory showing that such frequencies can be used without causing interference to established services.

Sec. 4.155 *Frequency tolerance.*

(a) The operating frequency of a developmental broadcast station shall be maintained in accordance with the frequency tolerance given in Sec. 4.1, provided, however, where lesser tolerance is necessary to prevent interference, the Commission will specify the tolerance.

(b) The operating power of a developmental broadcast station shall not be in excess of that necessary to carry on the program of research. The operating power may be maintained at the maximum rating or less, as the conditions of operation may require.

Sec. 4.156 *Supplemental report with renewal application.* A supplemental report shall be filed with and made a part of each application for renewal of license and shall include statements of the following, among others:

1. The number of hours operated.
2. Comprehensive report on research and experiments conducted.
3. Conclusions and program for further development of the broadcast service.
4. All developments and major changes in equipment.
5. Any other pertinent developments.

Sec. 4.157 *Frequency restrictions.* A developmental broadcast station authorized to operate on frequencies regularly allocated to other stations or services, shall be required to abide by all rules governing the stations operating regularly thereon which are applicable to developmental broadcast stations and are not in conflict with Secs. 4.1 to 4.11, inclusive, and Secs. 4.151 to 4.156, inclusive, of these rules.

* This frequency will not be available for the experimental service after October 1, 1939.