AN AGREEMENT

BETWEEN

THE

UNITED STATES

AND

MEXICO

1986

AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED STATES OF AMERICA AND THE GOVERNMENT OF THE UNITED MEXICAN STATES AND RELATING TO THE AM BROADCASTING SERVICE IN THE MEDIUM FREQUENCY BAND

AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED STATES OF AMERICA AND THE GOVERNMENT OF THE UNITED MEXICAN STATES RELATING TO THE AM BROADCASTING SERVICE IN THE MEDIUM FREQUENCY SAND

The Government of the United States of America and the Government of the United Mexican States, desiring to continue their mutual understanding and cooperation concerning AM Broadcasting and recognizing the sovereign right of both countries in the management of their own services, taking into account the provisions of Article 31 of the International Telecommunication Convention, Nairobi, 1982 and Articles 6 and 7 of the Radio Regulations, 1982, annexed to the Convention, in order to protect the broadcasting stations in the two countries and to improve the utilization of the frequency band 535-1605 kHz allocated to this service, have agreed as follows:

ARTICLE 1

Definitions

For the purpose of this Agreement, the following terms shall have the meanings defined below:

Administration:	The Federal Communications Commission of the United States of America and the General Directorate of Concessions and Permits of Telecommunications of the Secretariat of Communications and Transportation of the United Mexican States, respectively:
Agreement:	This Agreement and its Annexes:
I.F.R.B.:	The International Frequency Registration Board;
Assignment in Conformity with the Agreement:	A frequency assignment appearing in the Plan;

Objectionable Interference: The interference caused by a signal that exceeds the maximum permissible field strength within the protected contour, in accordance with the values determined according to the provisions of Annex 2 to the Agreement;

Plan: The frequency assignment Plan as contained in Annex 1 to the Agreement and the modifications introduced as a result of the application of the procedures of Article 3 of the Agreement:

Rio de Janeiro Plan: The frequency assignment Plan as defined in the Regional Agreement for the Medium Frequency Broadcasting Service in Region 2 (Rio de Janeiro, 1981).1/

1/ Any reference in this Agreement to the Regional Agreement of Rio de Janeiro does not prejudge the legal status of the Regional Agreement for either contracting party.

ARTICLE 2

Adoption of the Plan

The Plan set forth in Annex 1 to this Agreement consists of a list of assignments with technical parameters agreed upon by the two administrations. Broadcasting stations shall be brought into service only when in conformity with Annex 1 or any modification of it resulting from application of Article 3.

ARTICLE 3

Procedure for Modifications to the Plan

3.1 When an Administration proposes to modify the Plan, i.e.,

- to modify the characteristics of a frequency assignment to a station shown in the Plan, whether or not the station has 'been brought into use, or

- to introduce a new assignment into the Plan, or

- to cancel a frequency assignment to a station,

the following procedure shall be applied simultaneously with or prior to the notification to the I.F.R.B. (for modification to the "Rio de Janeiro Plan").

3.2 Proposals for modifications in the characteristics of an assignment and for the introduction of a new assignment.

3.2.1 The administration proposing to modify the characteristics of an assignment in the Plan or introduce a new assignment shall seek the agreement of the other Administration and shall send in accordance with Article 4 the necessary information via registered mail.

3.2.2 Any assignment in conformity with the Agreement shall be considered as adversely affected when calculations, based on Annex 2, indicate that objectionable interference would occur as a result of the proposed modification to the Plan.

3.2.3 If an Administration which received a notification considers that a proposed modification to the Plan is acceptable, it shall communicate its agreement to the other Administration as soon as possible and shall inform the I.F.R.B. accordingly. If the notified Administration considers that . the proposed modification to the Plan is unacceptable, it shall communicate its reasons to the notifying Administration within 90 days from the date on which the notification by registered mail is received. If no comment has been received within the 90 day period, the notifying Administration may proceed with its modification and advise the I.F.R.B. that the agreement of the other Administration has been obtained. On those exceptional occasions when the period for responding to a notification is found to be insufficient the Administration which receives a notification may request an extension of such period.

3.2.4 The agreement referred to in 3.2.1 is not required for a proposed change in the characteristics of an assignment in conformity with the Agreement if it entails no increase in the radiated field strength in any direction, and if a change in site of the station is involved, this change is limited to 3 km or 5% of the distance to the nearest point on the border of the other country, whichever is larger, up to maximum of 10 km. The distance is 'calculated from the site first registered *in* the Plan or subsequently registered in the Plan as a result of the application of the provisions of 3.2.1. In any event, such site change shall not produce a groundwave contour overlap prohibited under 4.9.4.2 of Annex 2 to this Agreement. However, no protection will be required beyond the level of protection which was already accepted before the proposed modification.

3.2.5 All Modifications to the Plan will be registered in it when the agreement of the other Administration has been obtained or when the time period for responding to the Notification established in 3.2.3 has expired and no such response has been received.

3.3 Cancellation of an Assignment

When an administration decides to cancel an Assignment in Conformity with the Agreement, it shall immediately notify the other Administration. Any such notification of cancellation of an Assignment in Conformity with the Agreement will be considered an abandonment by the notifying Administration of any right arising from that assignment unless, simultaneously with such cancellation, the Administration notifies a new assignment of the same frequency to substitute for the cancelled assignment. In such case, the Administration shall retain, with respect to the substituting assignment, the rights and obligations of the cancelled assignment, including priority. However, such new assignment will not be permitted to cause objectionable interference to existing stations in the other country at a level in excess of that caused by the cancelled assignment, and which has been previously accepted.

ARTICLE 4

Notification Procedure

4.1 The date of a notification will be determined by the date on which the required information submitted in conformity with this Article is received by the other Administration. If a conflict exists between two or more valid notifications, priority will be given to the notification which has the earlier date of receipt.

4.2 The information required for the notifications referred to in Article 3 shall be provided in conformity with Annex 1 to this Agreement. In the case of a modification of technical characteristics, there shall be an indication of which parameter(s) are modified. . In order to facilitate the verification of the data, directional antenna parameters shall be supplemented by sample radiation values calculated in five azimuths using the corresponding vertical angles, preferably in directions in which there is maximum and minimum radiation.

4.3 Any notification of the bringing into use of the modification of an Assignment in Conformity with the Agreement which involves a change in frequency shall have the effect of cancelling the former assignment and will constitute the simultaneous notification of a new assignment which shall be given the priority corresponding to the notification of a new assignment.

4.4 Each Administration shall notify the date that an Assignment in Conformity with the Agreement or a modification of an Assignment in Conformity with the Agreement begins or ceases operation. Such notification shall be made within sixty days following such date, and the I.F.R.B. shall be notified accordingly.

4.5 Any Assignment in Conformity with the Agreement shall be deleted from the Plan and cease to be protected from interference unless it is brought into use within five years from the date on which the respective station has been notified and accepted. This is without prejudice to the provisions of paragraph 4.7 of this Article.

4.6 Any modification of any Assignment in Conformity with the Agreement shall be deleted from the Plan and cease to be protected from interference unless it is brought into use within five years from the date on which the respective modification had been accepted.

4.7 For the purposes of paragraphs 4.5 and 4.6 the aforementioned periods may, in special cases, be extended for successive periods of one year upon notice to the other Administration within the effective period of the notification in question. Such notice must include a detailed description of the extraordinary circumstances which would justify such extension.

4.8 Any notification of a new or modified Assignment in Conformity with the Agreement which does not include all the required information set forth in Annex 1, shall be returned by the receiving Administration, and the assignment involved shall receive no protection or priority date. Nevertheless, if the Administration notifies a directional antenna and the complete information is not provided, the notifying Administration shall submit Section II, Part II of Annex 1 with its initial notification. The receiving Administration may return this notification if the supplementary information is not received within 6 months after receiving the initial notification.

4.9 Wnen an Administration notifies a modification to an Assignment in conformity with the Agreement which has 'been brought into use, the new notification will be protected from subsequent objectionable interference but will not supersede the previous Assignment in the Plan until it is brought into use.

4.10 When an Administration notifies a modification to an Assignment in conformity with the Agreement which has not 'been brought into use, the new notification will supersede the previous notification when it is accepted.

ARTICLE 5

Technical Criteria

5.1 The Administrations shall apply in carrying out this Agreement, the technical criteria contained in Annex 2, as may 'be amended from time to time pursuant to Article 9.

5.2 Notwithstanding the requirements of paragraph 4.9 of Annex 2, the Administrations agree to consider and analyze all reasonable measures to accommodate modifications of technical parameters agreed upon, of existing or authorized stations in order to ameliorate the impact of objectionable interference received from Administrations not parties to this agreement which seriously affect one or both parties to this agreement.

ARTICLE 6

Extended Hours of Operation

6.1 **Scope**

"Stations with extended hours of operation" are Class B and C stations operating during a period starting two hours before sunrise and ending two hours after sunset, local time, with protection requirements determined in accordance with Appendix 7 to Annex 2.

6.2 **Protection**

A notified and accepted station operating at nighttime shall have priority over extended hours of operation and shall be protected in accordance with 4.9 of Annex 2.

6.3 Notification

"Stations with extended hours of operation" that comply with the provisions of this Article shall be considered acceptable. Stations later found to be operating in a manner inconsistent with the protection requirements of this Agreement must make the necessary changes in their extended hours of operation to afford the required protection. Proposals for stations with extended hours of operation shall be notified in accordance with the applicable procedures established in Annex 1. Notification shall include the exact operating characteristics of each proposed station.

ARTICLE 7

Termination of Previous Agreements

This Agreement supersedes the existing Agreement between the United States of America and the United Mexican States Concerning Broadcasting in the Standard Broadcasting Band (535-1605kHz) and the existing Agreement between the United State-' of America and the United Mexican States Concerning the Operation of Broadcasting Stations in the Standard Band (535-1605 kHz), During a Limited Period Prior to Sunrise and After Sunset, both signed on *December* 11, 1968.

ARTICLE 8

Resolution of Conflicts

In the case of any discrepancy between the provisions of this Agreement and the provisions of another bilateral or regional agreement relating to broadcasting in the frequency band 535-1605 kHz, the provisions of this Agreement will prevail insofar as mutual relations between the United States of America and the United Mexican States are concerned.

ARTICLE 9

Amendment of the Agreement and the Annexes

Except for modifications to the Plan, which are governed by Article 3, the Agreement and the annexes hereto may be amended by cooperative efforts of the two Administrations. These amendments would become effective when an exchange of Diplomatic Notes takes place between the Department of State of the United States of America and the Secretariat of External Relations of the United Mexican States.

ARTICLE 10

Coming into Force and Duration

This Agreement shall come into force on the date on which both parties notify each other through diplomatic channels that they have concluded their respective constitutional procedures and shall continue in force until a new agreement is substituted or until it is denounced by either party.

ARTICLE 11

Termination of the Agreement

Either Government may terminate this Agreement by written notice of denunciation to the other Government throug diplomatic channels. The denunciation will be effective one yea after receipt of the notice.

IN WITNESS WHEREOF, the respective Plenipotentiarie have signed this Agreement.

DONE in duplicate, in the English and Spanish languages, each having equal authenticity, at Mexico City, District< Federal this ____ day of 1986.

For the Government of the United States of America

For the Government of the United Mexican States

ANNEX 1

to the Agreement

INFORMATION TO BE CONTAINED IN LISTINGS AND IN FORMS FOR NOTIFICATION PURPOSES

For the purposes of this Agreement the forms to be used in accordance with Article 3 will be the same as those referred to in Annex 3 of the Regional Agreement Concerning Radio Service in the Broadcast Band in Region 2, signed at Rio de Janeiro, 1981.

As an exception, in the case of notification of stations operating during extended hours the form from Part V of this Annex will be used.

1. Parts I through V describe the data to be notified and the forms to be used in notification. Part VI describes the Plan.

2. An administration wishing to submit the equivalent information on magnetic tape or by other electronic means, shall submit such data only in the format accepted by the other administration.

3. Five forms and a List are adopted; each of which corresponds to the following information:

PART I	:	General information on the transmitting station.
PART II	:	Section I: Characteristics of directional antennas (when the antenna design is known). Section II: Radiated field in various sectors (for use when the antenna design is not yet known).
PART III	:	Additional information for directional antennas with augmented (modified expanded) patterns.
PART IV	:	Supplementary information for top-loaded or sectionalized towers used for directional and omnidirectional antenna systems.
PART V	:	Supplementary information for extended hours of operation.
PART VI	:	The Plan.

4. The Administration receiving the notification may return forms which have not been completed correctly.

5. When known, the IFRB Serial Number shall be inserted on each form by the notifying Administration. Otherwise, the space provided shall be left blank.

PART I

General Information

Instructions for completing the forms

Box No.

01 *Administration*

Indicate the name of the administration. the sheet number and the dare on which the form was completed;

02 *Assigned frequency (kHz)*

03 *Name of the transmitting sration*

indicate the name of the locality or the name by which the station is known. Limit the number of letters and *numerals to a* total of 14:

04 *Call sign*

This information is optional. Limit the number of letters and numerals to a total of 7;

05 *Additional identification*

Indicate any additional information which may be considered essential for complete identification. Where this information is not essential, this box may be left blank:

06 *Station Class (A. B or C)*

Insert A. B or C according to the station classes defined in Chapter 1 of Annex 2 to the Agreement:

07 *Operational status*

Enter 0 for a station already in operation and enter P for a station to be brought into operation:

08 *Country*

Indicate the name of the country or geographical area in which the station is located. Use the symbols in Table 1 of the Reface to the International Frequency List;

09 *Geographical coordinates of the transmirring sration*

Indicate the geographical coordinates (longitude and latitude) of the transmitting antenna site in degrees, minutes and seconds. Seconds need to be entered only if available. Delete the letter N or S, as appropriate. If no seconds are indicated, the IFRB will use a value of 0 in its calculations:

II *Indicate the reason for the application of Article 4 :*

a) New assignment:

b) Modification of the characteristics of an assignment recorded in the Plan:

c) Cancellation of an assignment:

12 Indicate whether the modification is of the type specified in section 4.2.14 of Article 4 of the Agreement:

13 In the case of a new station, indicate the date of bringing into service. In the case of a change in the characteristics of a station already recorded in the Plan. indicate the date of start of operation with the modified characteristics or the date of cessation of operation;

DAYTIME OPERATION

21 *Station power (kW)*

Indicate the carrier power supplied to the antenna for daytime operation (to the second decimal position for powers less than 1 kW):

25 r.m.s. value of ndiation (mV/m at I km) **for daytime station power;**

26 ***Antenna type***

Indicate here the **type** of **antenna** used for daytime operation- Use the symbols **as** follows:

A – Simple omnidirectional antenna:

B – Directional antenna when the design is known (complete **Part** II, **Section I);**

C – Directional antcnnr where the design is not known. indicated by sectors of radiation (complete Part II. Section **II);**

1 – Top-loaded **omnidirectional** antenna (complete Part IV);

2 – Sectionalized omnidirectional antenna (complete Part **IV);**

27 ***Simple vertical antenna electrical height***

indicate here the **electrical** height. in degrees, for a simple vertical antenna in use for daytime **operation.** In the case of an antenna **type** ocher than A, this box should be left blank;

NIGHT-TIME OPERATION

31 ***Station power (k W)***

Indicate the carrier power supplied to the antenna for night-time operation (to the second decimal position for powers **less** than **1 kW);**

35 ***r.m.s. value of radiation (m V/m at 1 km) for night-rime station power***

36 ***Antenna type***

Indicate the type of antenna used for night-time operation (use the symbols in Box No. 26);

37 (See Box No. 27);

44 ***Remarks***

Indicate here any necessary additional information, such as. the identification of **the** synchronized network to which the station belongs. If **shared** time operation is intended, indicate in this box and identify the other assignment involved;

Coordination under article 4

Country – Indicate the name of the countries which may be affected and with which coordination is considered necessary, using the symbols in Table **1** of the Preface to the International Frequency List:

In progress – Add an "X" if coordination is under way with **these countries;**

Acceptance
obtained – Indicate with *an* "X" if coordination has been successful.

IFRB Serial No.

FORM

TO BE USED IN APPLICATION OF ARTICLE 4 OF THE MF BROADCASTING AGREEMENT.
(BAND 535 – 1 605 kHz)

CHARACTERISTICS OF A BROADCASTING STATION

PART I GENERAL INFORMATION

01 Administration | Form No. | Date

Assigned frequency (kHz)		02	
Transmitting station	Name of the station	03	
	Call sign	04	
	Additional identification	05	
	Station class (A, B or C)	06	
Country		07	
Geographical coordinates of the transmitting station		08	E/W : N/S :

11 a) New assignment ☐ b) Modification of the characteristics of an assignment recorded in the Plan ☐ c) Cancellation of an assignment ☐

12 Modification under Section 4.2.14 Yes ☐ No ☐

13 Date of bringing into service or cessation of operation Day Month Year

Station parameters	Daytime operation	Night-time operation
Status of the station (O or P)	20	30
Station power (kW)	21	31
r.m.s. value of radiation (mV/m à 1 km) (except when symbol B or C appears in box 26 or 36)	25	35
Antenna type	26	36
Simple vertical antenna electrical height (degrees)	27	37

44 Remarks

Coordination under Article 4								
Country								
In progress	☐	☐	☐	☐	☐	☐	☐	☐
Agreement	☐	☐	☐	☐	☐	☐	☐	☐

PART II

Description of the directional antenna

Radiation characteristics of the transmitting antenna

1. The form for Pan II Section I is used when the design of the directional antenna -is known. When a directional antenna is intended to be used. but the design is not yet known. the form Part II Section II should be used. The latter form should be replaced by a completed Pan II Section I form as soon as the design parameters are determined.

2. Administrations are invited to use Part II of the form to furnish the electrical characteristics of the antenna. From the information thus furnished. the IFRB will determine the radiation pattern.

3. When Pan II of the form is not suitable for describing a particular type of antenna. administrations may communicate the particulars of the antenna in question on a separate sheet, taking care that all the parameters necessary for the calculation of the radiation diagram have been included.

4. Radiation diagrams shall be used only when the information requested in Pan II is not available. See Appendix 3 to Annex 2 to the Agreement

PART II - SECTION I

Description of the directional antenna consisting of vertical conductors

Instructions for completing the form

Box No.

01 Indicate the name of the transmitting station:

02 Country

Indicate the country or geographical area in which the station is located. Use the symbols in Table I of the Reface co the international Frequency List:

03 Indicate the hours of operation for which the given characteristics of the antenna are applicable, The symbols D or N shall be used to indicate chat the station operates for the daytime or night-time period respectively. When the same operation is used for both daytime and night-time, enter the two symbols "D" and "N":

04 Indicate the total number of towers constituting the array.

Column No.

05 This *column* shows the serial number of towers. as they will be described in columns 06 to 12:

06 Indicate here the ratio of the tower field to the field from the reference tower:

07 Indicate here, in degrees, the positive or negative difference in the phase angle of the field from the tower with respect to the field from the reference tower:

08 Indicate. in degrees. the electrical spacing of the tower from the reference point, defined in column. 10:

09 Indicate. in degrees from True North, the angular orientation of the tower from the reference point indicated in column 10:

10 Define the reference point as follows:

0 : where the spacing and orientation are shown with respect to a common reference point which is generally the first tower;

I : where the spacing and orientation are shown with respect *to* the previous tower:

11 Indicate the electrical height (degrees) of the tower under consideration:

12 Tower *structure*

This column should contain a code from 0 to 2 to indicate the structure of each tower:

0 - simple vertical antenna
I - top-loaded antenna
2 - sectionalized antenna

Codes I and 2 are used in Parr IV to indicate the characteristics of the various structures. They are also used for the identification of the appropriate formula for vertical radiation in Appendix 4 co Annex 2.

Note: **In the absence of a specific code to refer to** other **types of sectionalized antennas.** administrations may use the codes **indicated in Appendix 6 to Annex 2.**

Box No.

14 r.m.s. value of radiation (mV/m at I km):

IS Type of pattern:

T - theorctial

E - expanded

M - augmented (modified expanded):

16 Special quadrature factor for expanded and augmented (modified expanded) patterns in mV/m at I km (to replace the normal expanded pattern quadrature factor when special precautions are taken to ensure pattern stability):

FORM

IFRB Serial No.

TO BE USED IN APPLICATION OF ARTICLE 4 OF THE MF BROADCASTING AGREEMENT

(BAND 535 – 1 605 kHz)

CHARACTERISTICS OF A BROADCASTING STATION

PART II – section I

DESCRIPTION OF A DIRECTIONAL ANTENNA CONSISTING OF VERTICAL CONDUCTORS

Form No. ______ Date ______

(01) Name of transmitting station

(02) Country

(03) Hours of operation (D, N or DN)

(04) Total number of towers

(05) Tower No.	(06) Tower field ratio	(07) Phase difference of the field (± degrees)	(08) Electrical tower spacing (degrees)	(09) Angular tower orientation (degrees)	(10) Definition point indicator	(11) Electrical height of tower (degrees)	(12) Tower structure
1	•	•	•	•		•	
2	•	•	•	•		•	
3	•	•	•	•		•	
4	•	•	•	•		•	
5	•	•	•	•		•	
6	•	•	•	•		•	
7	•	•	•	•		•	
8	•	•	•	•		•	
9	•	•	•	•		•	
10	•	•	•	•		•	

(Use a supplementary that in cases what there are more than 10 towers.)

(14) r.m.s. value of theoretical radiation	(15) Type of pattern (T, E or M)	(16) Special quadrature factor
• mV/m at 1 km		• mV/m at 1 km

(17) SUPPLEMENTARY INFORMATION

PART II – SECTION II

Radiated field limitations in specific sectors in the absence of information on directional antennas

1. In the absence of a detailed description of the directional antenna system, an indication of the radiated field limitations in specific sectors is required. In these cases, the radiation pattern (0°-360°) is subdivided in sectors'with an indication of the maximum radiated field for each sector.

2 This form is to be used for a proposed station only ("P" entered in Pan I. Box 07).

3. The Sheet No. box is for the convenience of administrations. Indicate the date on which the form was completed.

Instructions for completing the form

Box No.

01 Name (usually town or locality) of transmitting station;

02 Country

indicate the country or geographical area in which the transmitting station is located. using the symbols in Table 1 of the Preface to the International Frequency List:

03 Indicate the hours of operation for which the given characteristics of the antenna are applicable. The symbols D or N shall be used to indicate that the station operates: for the daytime or night-time period respectively. When the same operation is used for both daytime and night-time. enter the two symbols "D" and 'N".

Column No.

DAYTIME OPERATION

18 Sectors of radiation in degrees from True North for daytime operation. The entire circumference from 0 to 360 degrees shall be specified;

19 Maximum radiated field strength in the sector indicated in column 18, in the horizontal plane in mV/m at 1 *km:* (see Appendix to this Annex):

NIGHT-TIME OPERATION

28 Sectors of radiation in degrees from True Nonh for night-time operation. The entire circumference from 0 to 360 degrees shall be specified:

29 Maximum radiated field strength in the vertical plane in the sector indicated in column 28. in mV/m at 1 km.

Box No.

20 Any further information which should be included in the IFRB weekly circular. Any further explanatory notes for the information of the IFRB may be attached.

Note: This form should be replaced by the form corresponding to Pan II. Section I, duly completed. as soon as the antenna design is known.

IFRB Serial No.

FORM

TO BE USED IN APPLICATION OF ARTICLE 4 OF THE MF BROADCASTING AGREEMENT

(BAND 535 – 1 605 kHz)

CHARACTERISTICS OF A BROADCASTING STATION

PART II – Section 2

DESCRIPTION OF RADIATION CHARACTERISTICS IN THE ABSENCE OF ANY INFORMATION ON THE DIRECTIONAL ANTENNA DESIGN

Form No. | Date

01 Name of transmitting station

02 Country

NOTE: This form should only be used for planned stations (Symbol P in box 20 or 30 in part I).

Daytime operation	
18 Sector of radiation (degrees)	19 Maximum field strength in the horizontal plane (mV/m at 1 km)
0 | – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |

Night-time operation	
28 Sector of radiation (degrees)	29 Maximum field strength in any vertical plane in the sector (mV/m at 1 km)
0 | – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |
| – |	| ● |

20 SUPPLEMENTARY INFORMATION

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PART III

Description of the parameters of directional antennas with augmented (modified expanded) patterns

1. Part II of this Annex contains the information for directional antenna systems operating with theoretical and expanded patterns. However. some stations operate with augmented (modified expanded) directional antenna patterns. In these cases, additional calculations arc performed., once the expanded radiation is calculated. to determine the radiation from the augmented (modified expanded) directional antenna pattern. This Part contains the additional parameters requited for augmented (modified expanded) patterns.

2. If Part III is submitted. a corresponding Part II must also be submitted.

3. Part III should be submitted only if Box 15 of Section I of Part II contains the symbol "M" for "augmented (modified expanded)".

Box No.

01 **Indicate** the **name** of transmitting station:

02 **Country**

Indicate the country **or** geographical **area in which the station** is located, using the symbols **in Table 1 of the** Preface **to the International** Frequency List;

03 **Indicate** the **hours** of operation for which the antenna **characteristics** given are applicable. **The** symbols **D or N shall be used to indicate that the station** operates for the daytime and night-time. enter the two **symbols "D"** and **"N";**

04 Indicate the total number of **augmentations which are used. It must be 1 or** greater **than 1.**

Column No

05 indicate the **serial** number of the augmentations. as they will be described in columns **06, 07** and 0% **(see section 27** of Appendix 3 to **Annex** 2):

06 Indiatc the radiation at the **central** azimuth of augmentation. This value should always be equal to or greater than the **value** from the theoretical pattern :

07 Indicate **the central azimuth of augmentation. This is** the **centre** of the span:

08 **Indicate the total span** of **the** augmentation. **Half of** the span will be on each **side of the central azimuth** of **augmentation. Spans** may **overlap:** if so. augmentations arc processed clockwise according to **the central azimuth** of augmentations.

Box *No.*

09 Supplementary **information. Indicate** any supplementary information conctming **augmented (modified** expanded) **patterns.** If a supplementary sheet has been used for further **augmentations, please** indicate in this box.

FORM

TO BE USED IN APPLICATION OF ARTICLE 4 OF THE
MF BROADCASTING AGREEMENT

CHARACTERISTICS OF A BROADCASTING STATION

PART III

DESCRIPTION OF THE PARAMETERS OF DIRECTIONAL ANTENNAS AUGMENTED (MODIFIED EXPANDED) PATTERNS. TO BE SUBMITTED WHENEVER THE SYMBOL M IS ENTERED IN PART II SECTION I BOX 15

Form No. ____ Date ____

01 Name of transmitting station

02 Country

03 Hours of operation (D, N or DN)

04 Total number of augmentations

05 Augmentation No.	06 Radiation at central azimuth of augmentation (mV/m at 1 km)	07 Central azimuth of augmentation (degrees)	08 Total span of augmentation (degrees)
01			
02			
03			
04			
05			
06			
07			
08			
09			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

(Use a supplementary sheet in cases where there are more than 20 augmentations.)

09 SUPPLEMENTARY INFORMATION

PART IV

Supplementary information for top-loaded or sectionalized towers used for omnidirectional and directional antennas

1. Where an omnidirectional antenna is top-loaded or sectionalized. the figures 1 or 2 will have been entered in Parr I. Box 26 and/or 36. Proceed as for a single tower of a directional antenna.

2. When an antenna tower of a directional antenna is. either top-loaded or sectionalized. column 12. Section 1 of Part II will contain either *a* figure 1 or a figure 2. These numerals describe the particular type of top-loaded or sectionalized antenna used, as described below:

Box No.

01 Name of the station:

02 Country

Indicate the country or geographical area in which the station is located. using the symbols in Table 1 of the Reface to the International Frequency List:

03 Indicate the hours of operation for which the given characteristics of the antenna are applicable. The symbols D or N shall be used to indicate that the station operates for the daytime or night-time period respectively. When the same operation is used for both daytime and night-time, enter the **two** symbols "D" and "N".

Column No.

04 Tower number:

Columns 5 to 8 show the values of four characteristics of the elements constituting a top-loaded or sectionalized antenna. Each of these columns may contain a figure representing the value of a given characteristic as described below:

05	***Code used in Col. 12 .*** (Part II – Section I)	***Description of the characteristic the value of which is given in tht column (these values are used in the equations given in Appendix 4 to Annex 2)***
	1	Electrical. height of the antenna tower (degrees):
	2	Height of lower section (degrees):
06	***Code used in Col. 12 •*** (Part II – Section I)	Description ***of the characteristic the value of which is given in the column (these values are used in the equations*** given ***in Appendix 4 to Annex 2)***
	1	Difference between apparent electrical height (based on cuncnt distribution) and actual height (degrees);
	2	Difference between apparent electrical height of lower section (based on current distribution) and actual height of lower section (degrees):
07	***Code used in Col. 12 •*** (Part II – Section I)	***Description of the characteristic the value of which is indicated in the column (these values are used in the equations contained in Appendix 4 to Annex 2)***
	1	**Blank:**
	2	Total height of antenna (degrees);

Column No.

08	*Code used in Col. 12 . (Part 11 – Section I)*	*Description of the characteristic the value of which is indicated in the column (these values are used in the equations entered in Appendix 4 to Annex 2)*
	1	**Blank:**
	2	**Difference between apparent electrical** height (based on current distribution) of the total tower and the actual-height of the total tower (degrees).

FORM

IFRB Serial No.

TO BE USED IN **APPLICATION OF ARTICLE 4 OF THE MF BROADCASTING AGREEMENT**

CHARACTERISTICS OF A BROADCASTING STATION

PART IV

DESCRIPTION OF TOP-LOADED OR SECTIONALIZED TOWERS USED FOR DIRECTIONAL OR OMNIDIRECTIONAL **ANTENNA SYSTEMS**

Form No. I I **Date** I- -1

01 Name of transmitting station

02 Country

03 Hours of operation (D, N or DN)

04 Tower number	05 A	06 B	07 C	08 D
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●
	●	●	●	●

PART V

SUPPLEMENTARY INFORMATION FOR EXTENDED HOURS OF OPERATION

FORM

TO BE USED IN APPLICATION OF ARTICLE 4 OF THE MF BROADCASTING AGREEMENT
(BAND 535 – 1605 kHz)

CHARACTERISTICS OF A BROADCASTING STATION

PART I — GENERAL INFORMATION

(01) Administration ______ Form No. ______ Date ______

Assigned frequency (kHz)		02	
Transmitting station	Name of the station	03	
	Call sign	04	
	Additional identification	05	
	Station class (A, B or C)	06	
Country		07	
Geographical coordinates of the transmitting station		08	E/W ; N/S

11	a) New assignment ☐	b) Modification of the characteristics of an assignment recorded in the Plan ☐	c) Cancellation of an assignment ☐
12	Modification under Section 4.2.14	Yes ☐	NO ☐
13	Date of bringing into service or cessation of operation	Day Month Year	

Station parameters	Daytime operation	Night-time operation
Status of the station (0 or P)	(20)	(30)
Station power (kW)	(21)	(31)
r.m.s. value of radiation (mV/m at 1 km) (except when symbol B or C appears in box 26 or 36)	(25)	(35)
Antenna type	(26)	(36)
Simple vertical antenna electrical height (degrees)	(27)	(37)

(44) Remarks

Extended Hours of Operation

Coordination under Article 4

Country								
In progress	☐	☐	☐	☐	☐	☐	☐	☐
Acceptance	☐	☐	☐	☐	☐	☐	☐	☐

PART VI

THE PLAN

1.- The Plan in its entirety consists of the assignments duly notified, coordinated and accepted by both 'Administrations.

2.- Both Administrations shall exchange lists periodically, as follows:

List 1: Every six months modifications to the Plan notified during such period shall be exchanged.

List 2: Every twelve months an amended Plan shall be exchanged which includes all accepted modifications to the Plan up to that date and shall supersede the Plan then in force.

APPENDIX

(to Annex 1)

Typical radiation values of a directional antenna

1. Introduction

When an administration intends co propose a new station under Article 4, using a directional antenna, and the antenna design is not known, the form in Annex 3, Part IL, Section IL, is to be used. This form requires information on the arcs of suppression.

The following information may be used as a guide for determining realistic values which might be entered on the form.

2. Minimum radiation

When the radiated field is suppressed in one or more directions so as to afford protection to other stations, the minimum level of radiation achievable in practice (E_{min}) over arcs up to about 30 degrees, is given by the following equation:

$$E_{min} = 10\sqrt{P} \text{ mV/m at 1 km}$$

where P is the station power in kW. Thus the degree of suppression required by a planned scacion necessarily limits the station power to a practical value. When the maximum suppression is required over wide spans exceeding 30 degrees, a considerably more complex antenna array or lower power is usually required.

3. Maximum radiation .

The radiated field in the direction generally opposite co the direction of suppression tends to increase such that the maximum field achieves an approximate value of 1.35 x the r.m.s. value of the theoretical radiation in mV/m ac 1 km.

4. Radiation in the other directions

In the directions other than in the spans of E_{min} and E_{max}, the radiated field may exceed the r.m.s. value of the radiation by more than 10 Percent.

5. **Table of typical values**

Station power (kW)	Typical values of E (mV/m at 1 km)		
	E_{min}	r.m.s. value + 10%	E_{max}
1	10	330	405
2.5	16	520	640
3	22	735	900
10	32	1040	1280
25	50	1650	2030
50	71	2330	2860

ANNEX 2

co the

AGREEMENT BETWEEN THE GOVERNMENT OF THE

UNITED MEXICAN STATES AND THE GOVERNMENT

OF THE UNITED STATES OF AMERICA RELATING

TO THE AM BROADCASTING SERVICE IN THE

MEDIUM FREQUENCY BAND

TECHNICAL CRITERIA

To be used in the application of the Agreement

CHAPTER 1

Definitions and symbols

1. Definitions

In addition to the definitions given in the Radio Regulations (1982), the following defialcloas and symbols apply to this Agreement.

1.1 Broadcasting channel (AM)

A part of the frequency spectrum, equal to the necessary bandwidth of AM sound broadcasting statloas, and characterlred by the nominal value of the carrier frequency located at its center.

1.2 Objectionable interference

Interference caused by a signal exceeding the maximum permissible field strength within the protected contour, in accordance with the values derived from this Annex-

1.3 Protected contour

Continuous line that delimits the area of primary or secondary service which is protected from ob jeccioaable interference.

1.4 Primary service area

Service area delimited by the contour within which the calculated level of the groundwave field strength is protected from objectfoaable interference in accordance with the provisions of Chapter 4.

L.5 Secondary service area

Service area delimited by the contour within which the calculated level of the field strength due to the skywave field strength 50% of the time is protected from objectionable interference in accordance vith the provisions of Chapter 4.

1.6 Nominal usable field strength (E_{nom})

Agreed minimum value of the field strength required *to* provide satisfactory reception, under specified conditions, in the presence of a tmospheric noise, man-made noise and interference from other transmitters. The value of nominal usable field strength has been employed as the reference for planning.

1.7 Usable field strength (E_u)

Minimum value of the field strength required co provide satisfactory reception under specified conditions in the presence of atmospheric noise, man-made noise, and interference in a real situation (or resulting from a frequency assignment plan).

1.8 Audio-frequency protection ratio (or AF protection ratio)

Agreed minimum value of the audio-frequeacy signal-to-interference ratio corresponding to a subjectively defined reception quality. This ratio may have different values according to the type of service desired.

1.9 Radio-frequency protection ratio (or RF protection ratio)

The deslred radlo-frequency signal-to-interference ratio which, in well-defined conditions, makes it possfble to obtain the audio-frequency protection ratio at the output of a receiver. These specif led conditions include various parameters such as the frequency separation between the desired carrier and the interfering carrier, the emission characteristics (type and percent 'modulation etc .) , Levels of input and output of the receiver and i ts characteristics (selectivity, sensitivity to intermodulation, etc.).

1.10 Class A station (see Note L to Section 4.6)

A station intended to provide coverage over extensive primary and secondary service areas and which is protected against objectionable interference, accordingly.

1.11 Class B station

A station lntended to provide coverage over ooe or more population centers and the contiguous rural areas located in Fts primary service area and which is protected against objectionable interfereace, accordingly.

1.12 Class C station

A station intended to provide coverage over a city or town and the contiguous suburban areas located in its primary service area and which is protected against objectionable interference, accordingly.

1.13 Daytime operation

Operation betueen the times of local sunrise and local sunset.

1.14 Nighttime operation

Operation between the times of local sunset and local sunrise.

1.15 Synchronized *network*

Tvo or more broadcasting stations whose carrier frequencies are identical and which broadcast the same program simultaneously.

In a synchronized network the difference in carrier frequency between any two traasmttters in the network shall aot exceed 0.1 Hz. The modulation delay between any two transmitters in the network shall not exceed 100 microseconds, when measured at either transmitter site.

1.16 <u>Station power</u>

Unmodulated carrier power supplied to the antenna.

1.17 <u>Groundwave</u>

Electromagnetic wave vhfch is propagated along the surface of the Earth or near it and which has not been reflected by the ionosphere.

1.18 <u>Skywave</u>

Electromagnetic wave which has been reflected by the ionosphere=

1.19 <u>Skywave field strength, 10% of the time</u>

The value of a skywave signal vhlch is not exceeded for more than 10% of the period of observation.

1.20 <u>Skywave field strength, 50% of the time</u>

The value of a skyvave signal which is not exceeded for more than SO% of the period of observation.

1.21 <u>Characteristic field strength (E_c)</u>

The field strength, at a reference distance of 1 km in a horizontal direction, of the groundvave signal propagated along perfectly conducting ground for L kW station power, taking into account losses in a real antenna.

1.22 <u>symbols</u>

Hz	:	hertz
kHz	:	kilohertz
W	:	watt
kW	·	kilowatt
mV/m	:	millivolt/meter
µV/m	:	microvolt/meter
mS/m	:	millisiemens/meter
km		kilometer

CHAPTER 2

Groundwave propagation

2.1 Ground conductivity

2.1.1 The maps of ground conductivity for Mexico and the U.S.A. are contained in Appendix 1.

2.1.2 Either Administration may modify its ground conductivity map at any time by notifying changes co the other Administration.

2.1.3 No assignment in the Plan shall at any time be required to be modified as a result or' the incorporation of these changes.

2.2 Field strength curves for groundwave propagation

The curves shown in Appendix 2 are to be used for determining groundwave propagation in the following frequency ranges:

Graph No.	kHz
1	540 - 560
2	570 - 590
3	600 - 620
4	630 - 650
5	660 - 680
6	690 - 710
7	720 - 760
8	770 - 810
9	820 - 860
10	870 - 910
11	920 - 960
12	970 - 1030
13	1040 - 1100
14	1110 - 1170
15	1180 - 1240
16	1250 - 1330
17	1340 - 1420
18	1430 - 1510
19	1520 - 1610

2.3 Calculation of groundwave field strength

2.3.1 Homoneneous ground conductivity paths

The vertical component of the field strength for a homogeneous path is represented as a function of distance, for various values of ground conductivity and is shown on graphs 1 to 19 which are standardized for a Characteristic field strength of 100 mV/m a; 1 km.

The distance in kilometers is shown on a logarithmic scale on the abscissa. The field strength is shown on a logarithmic scale on the ordinate in mV/m. The straight line marked "100 mV/m at 1 km" is the field strength on the assumption that the antenna is erected on a surface of perfect conductivity.

For omnidirectional antenna systems having a different characteristic field strength, correction must be made according to the following equations:

$$E = E_0 \frac{E_R}{100}$$

where: $E_R = E_c\sqrt{P}$ for omnidirectional antenna systems

Note: For a directional antenna system, E_R is determined in accordance with Appendix 3.

where E : resulting field strength in mV/m

E_0 : field strength read from graphs 1 to 19 in mV/m

E_R : actual radiated field strength at a particular azimuth at 1 km in mV/m

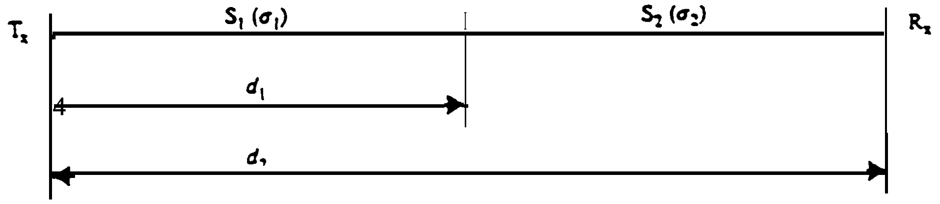
E_c : characteristic field strength in mV/m

P : station power in kW.

2.3.2 Non-homogeneous ground conductivity paths

In this case, the equivalent distance or Kirke method is to be used. To apply this method, graphs 1 to 19 are used.

Consider a path whose sections S_1 and S_2 have endpoint lengths corresponding to d_1 and $d_2 - d_1$, and conductivities σ_1 and σ_2 respectively, as shown on the following figure:



The method is applied as follows:

a) Taking section S_1 first, we read the field strength corresponding to conductivity σ_1 at distance d_1 on the graph corresponding to the operational frequency.

b) As the field Strength remains constant at the soil discontinuity, the value immediately after the point of discontinuity must be equal to that obtained in a) above. As the conductivity of the second section is σ_2, the curve corresponding to conductivity σ_2 gives the equivalent distance to that which would be obtained at the same field strength arrived at in a). This equivalent distance is d. Distance d is larger than d_1 when σ_2 is larger than σ_1. Otherwise d is less than d_1.

c) The field strength at the real distance d_2 is determined by taking note of the corresponding curve for conductivity σ_2 similar to that obtained at equivalent distance $d + (d_2 - d_1)$.

d) For successive sections with different conductivities, procedures b) and c) are repeated.

CHAPTER 3

Skywave propagation

3. The calculation of skyvave field strength shall be conducted in accordance with the provisions vhlch follow. (No account is taken in this Agreement of sea gala or of excess polarization coupling loss.)

3.1 List of symbols

d : short great-circle path distance (km)

E_c : characteristic field strength (mV/m at 1 km for I kW)

f(θ) : radiation as a fraction of the value θ = 0 (when θ = 0, f(θ) = 1)

f : frequency (kHz)

F : ad justed annual median skyvave f ield strength (μV/m)

F_c : field streagth read from Figure 4 or Table III for a characteristic field strength of 100 mV/m at 1 km

F(50): skywave field strength, 50% of the time (μV/m)

F(10): skywave field strength, 10% of the time (μV/m)

3 : station power (kW)

θ : elevation angle from the horizontal (degrees)

$E_{exp}(\phi, \theta)$: expanded pattern radiation at a particular azimuth, φ, and a particular elevation angle, θ (mV/m)

3.2 Geaeral procedure

Radiation in the horizontal *plane* of an omnidirectional antenna fed with 1 kW (characteristic field strength, E_c) is known either from design data or, if the actual deslgn data are not available, from Figure 1.

The angle of elevation, θ, can be determined from Table I or Figure 2.

Note: Table I and Figure 2 is derived from the formula:

$$\theta = \arc\tan\left(0.00752 \cot \frac{d}{444.54}\right) - \frac{d}{444.54} \quad \text{degrees} \qquad (1)$$

$0 \leq \theta \leq 90°$

The radiation f (8) expressed as a fraction of the value at θ = 0 at a pertinent elevation angle θ can be determlaed from Figure 3 or Table II.

The adjusted skywave field strength F is given by:

$$F = F_c \frac{E_R}{100} \quad (\mu V/m) \qquad (2)$$

vhere F_c is the direct reading from the field strength curve in Figure 4 or Table III.

The formula $E_R = E_c F(\theta) \sqrt{P}$ is used for omnidirectional systems. For a directional antenna system, E_R is calculated la accordance with Appendix 3.

Note: Values of F_c in Figure 4 and Table III are normalized to LOO mV/m a: 1 km.

For distances greater than 4,250 km, it should be noted that F_c can be expressed by:

$$F_c = \text{antilog}\left(\frac{231}{60+d/50} - 1.773\right) (\mu V/m) \qquad (3)$$

3.3 Skywave field strength, 50% of the time

The skyvave field strength not exceeded 50% of the time:

$$F(50) = F \quad (\mu V/m) \qquad (4)$$

3.4 Skywave field strength, 10% of the time

This factor is given by:

$$F(10) = F(50)(2.5) \quad (\mu V/m) \qquad (5)$$

3.5 Nocturnal variaton of skywave field strength

Hourly median skywave field strengths vary during the night and at sunrise and sunset. The diurnal factor is determined using the time of day at the midpoint of the path between the site of the iaterferlng statioa and the point at which interference is being calculated.

Diurnal factors are computed using the formula:

$$Df = a + bF + cF^2 + dF^3 \qquad (6)$$

Where: Df represents the diurnal factor,

F is the frequency in MHz,

a, b, c, and d are constants used in calculating the diurnal factors.

For the pre-sunrise and post-sunset periods, the constants are obtained from Figures Sc and 5d. The columns labeled T_{mp} represent the number of hours before and after sunrise and sunset at the path midpoint. Figures 5a and 5b depict the skywave diurnal factors with respect co sunrise and sunset at the midpoint of the transmission path.

Figures 5a and Sb or Formula 6 shall be applied in determining field strengths of signals of stations engaging in extended hours of operation. However, the calculations made according to Formula 6 are controlling.

Diurnal factors greater than 1 will not be used in calculations, and interpolation is to be used beeveen calculated values where necessary.

3.6 Sunrise and sunset time

To facilitate the determination of the Local. time of sunrise and sunset , Figure 6 gives the times for various geographical latitudes and for each month of the year. The time is the local meridian time at the point concerned and should be converted to the appropriate standard time.

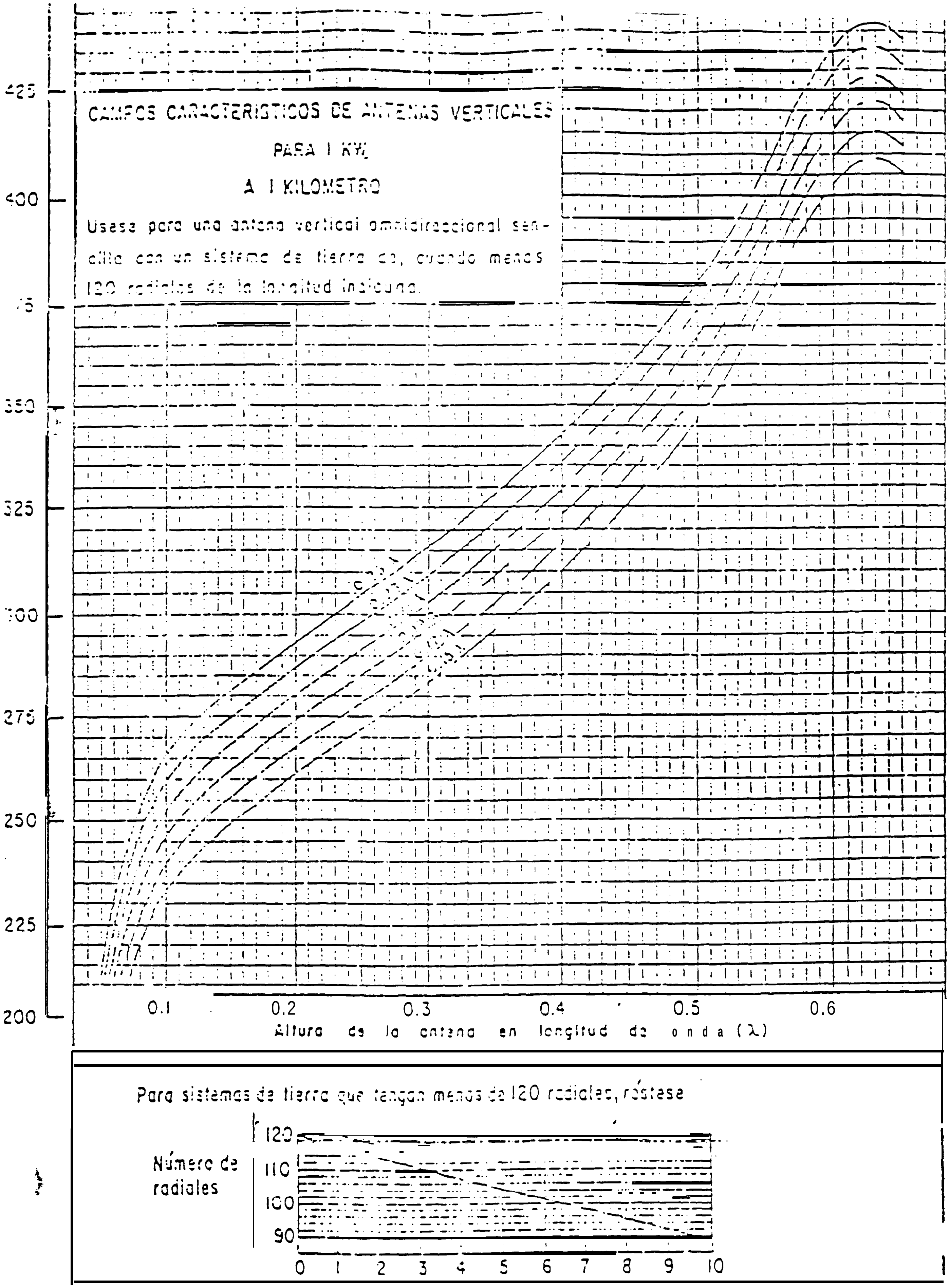
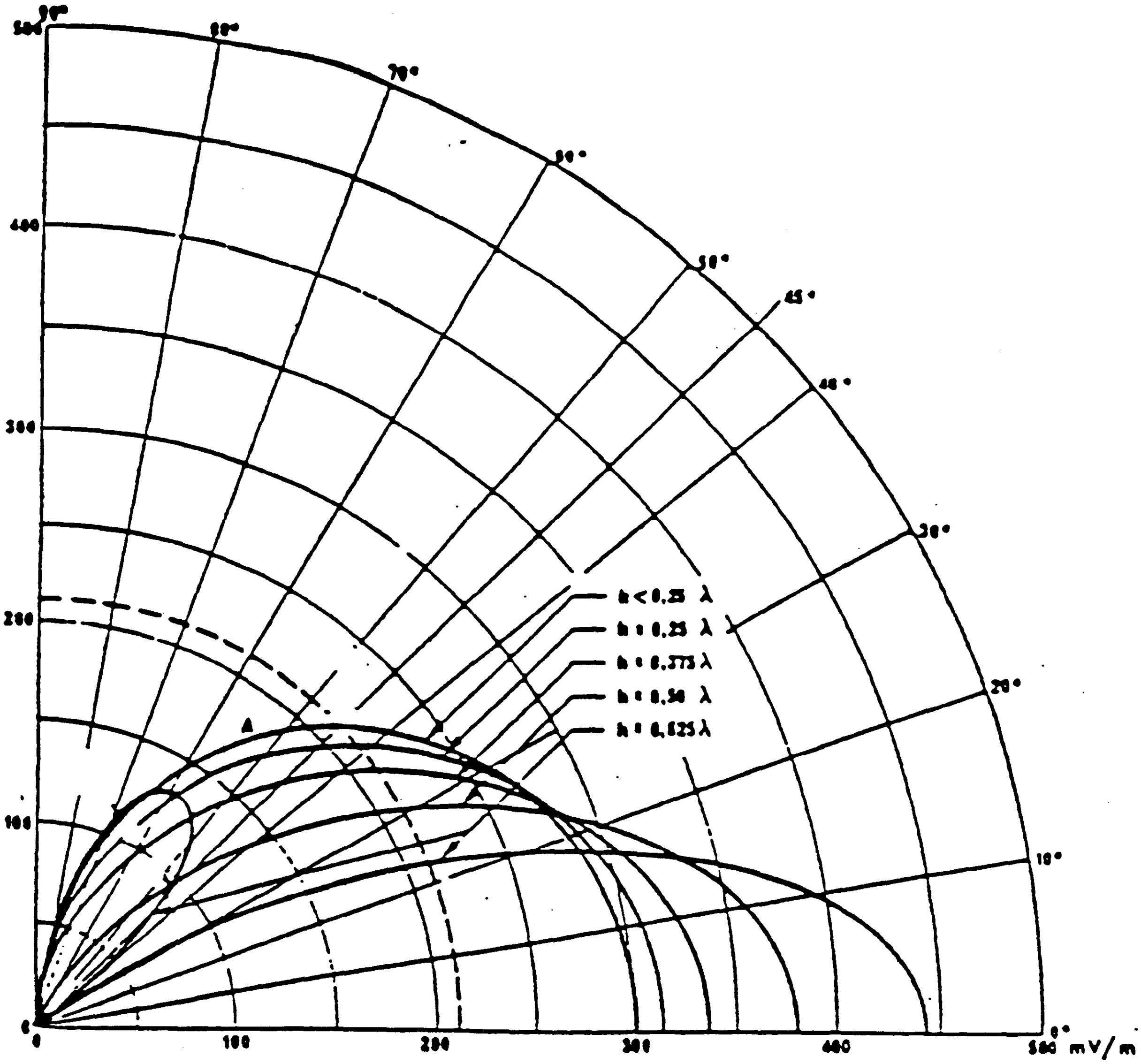

CAMPOS CARACTERISTICOS DE ANTENAS VERTICALES
PARA 1 KW
A 1 KILOMETRO
Usese para una antena vertical omnidireccional sencilla con un sistema de tierra de, cuando menos 120 radiales de la longitud indicada.
425
400
350
325
300
275
250
225
200
0.1
0.2
0.3
0.4
0.5
0.6
Altura de la antena en longitud de onda (λ)
Para sistemas de tierra que tengan menos de 120 radiales, réstese
Número de radiales
120
110
100
90
0
1
2
3
4
5
6
7
8
9
10

FIG. 1

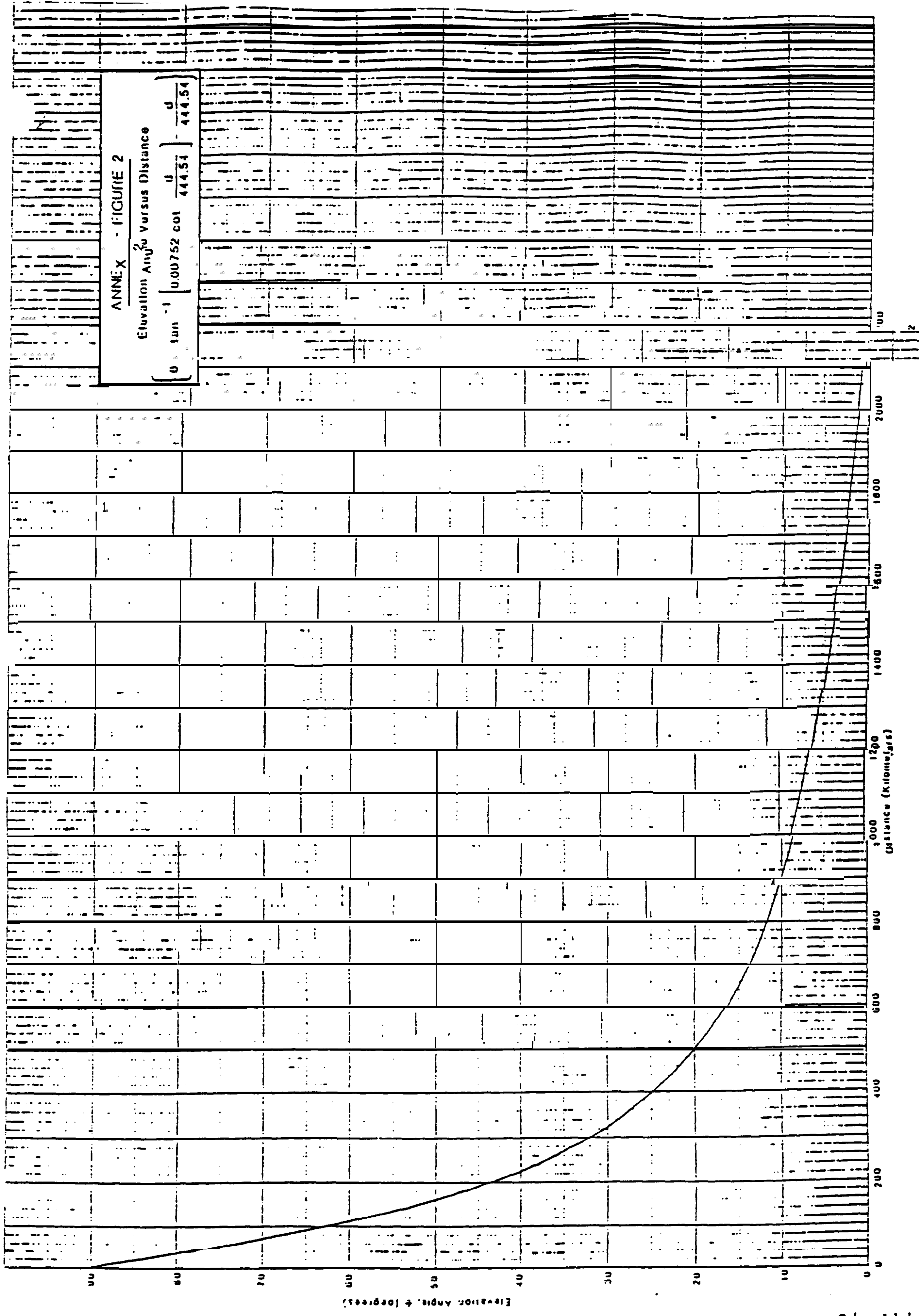


A: Short vertical antenna

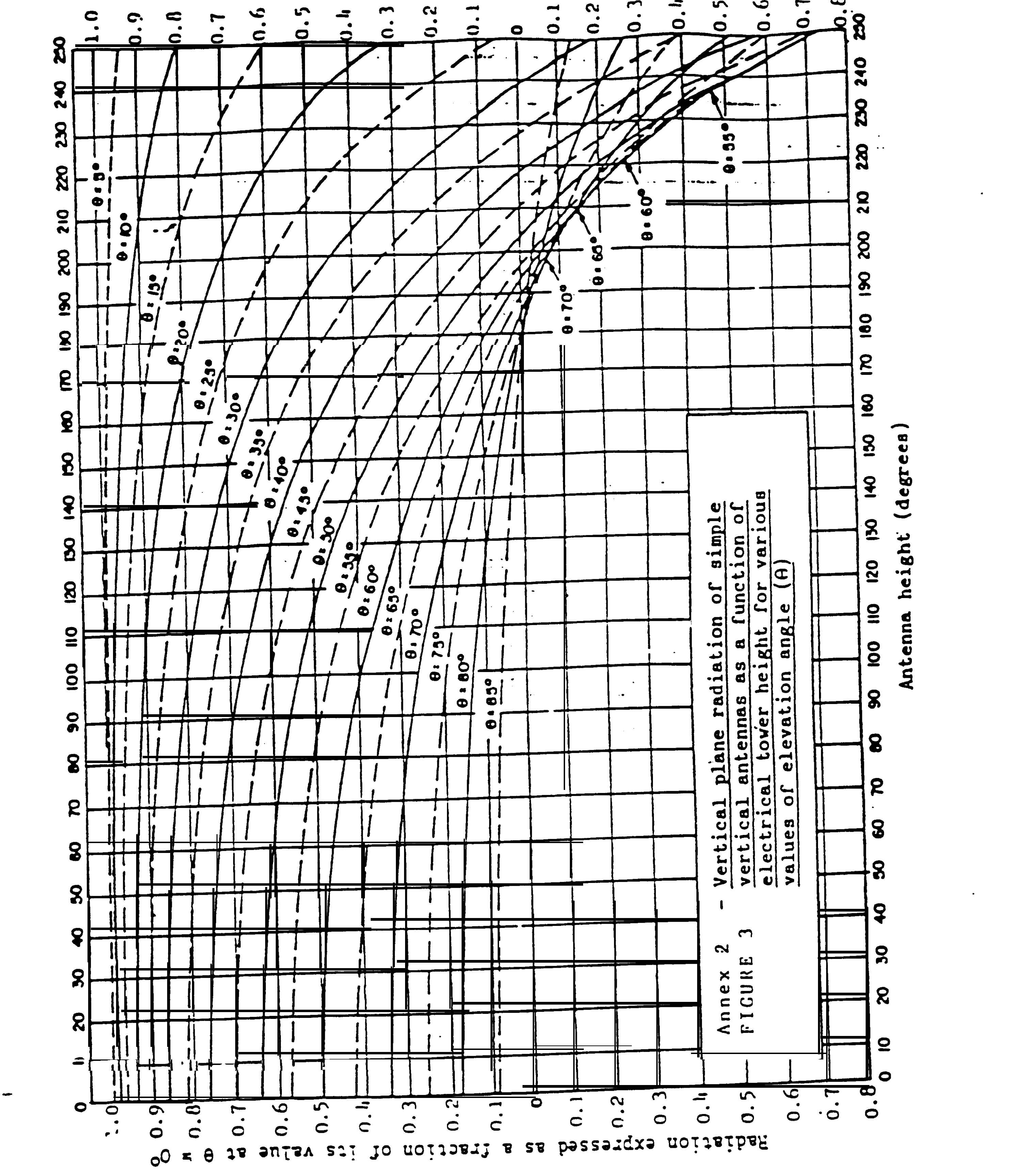
FIGURE la - Field strength at a distance of 1 km as a function of elevation angle, for different heights of vertical antenna assuming a transmitter power of 1 kW

TABLE I - Elevation angle vs distance

Distance (km)	Elevation angle (degrees)
50	75.3
100	62.2
150	51.6
200	43.3
250	36.9
300	31.9
350	27.9
400	24.7
450	22.0
500	19.8
550	18.0
600	16.3
650	14.9
700	13.7
750	12.6
800	11.7
850	10.8
900	10.0
950	9.3
1000	8.6
1050	8.0
1100	7.4
1150	6.9
1200	6.4
1250	5.9
1300	5.4
1350	5.0
1400	4.6
1450	4.3
1500	3.9
1550	3.5
1600	3.2
1650	2.9
1700	2.6
1750	2.3
1800	2.0
1850	1.7
1900	1.5
1950	1.2
2000	1.0
2050	0.7
2100	0.5
2150	0.2
2200	0.0
2250	0.0
2300	0.0
2350	0.0
2400	0.0



ANNEX - FIGURE 2
Elevation Angle θ Versus Distance
$\theta = \tan^{-1}\left[0.00752 \cot\left(\frac{d}{444.54}\right)\right] - \frac{d}{444.54}$
Distance (Kilometers)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Elevation Angle, θ (degrees)
90
80
70
60
50
40
30
20
10
0



Annex 2
FIGURE 3 - Vertical plane radiation of simple vertical antennas as a function of electrical tower height for various values of elevation angle (θ)

TABLE II - f(θ) values for simple vertical antennas

Elevation angle (degrees)	f(θ)					
	0.11λ	0.13 λ	0.15λ	0.17λ	0.19λ	0.21λ
0	1.000	1.000	1.000	1.000	1.000	1.000
1	0.999	1.000	1.000	1 .000	1 .000	1 .000
2	0.999	0.999	0.999	0-999	0.999	0.999
3	[illegible]	0.998	0.998	0.998	0.998	0.998
4	0.997	0.997	0.997	0.997	0.997	0.997
5	0.996	0.996	0.996	0.995	0.995	0.995
6	0.994	0.994	0.994	0.993	0.993	0.993
7	0.992	0.992	0.991	0.991	0.991	0.990
8	0.989	0.989	0.986	0.988	0.988	0.987
9	0.987	0.986	0.983	0.985	0.985	0.984
10	0.984	0.983		0.982	0.981	0.980
11	0.980	0.980	0: 979	0.978	0.977	0.976
12	0.976	0.976	0.975	0.974	0.968	0.971
13	0.972	0.972	0.971	0.969	0.963	0.967
14	0.968	0.967	0.966	0.965	[illegible]	0.961
15	0.963	0.962	0.961	0.959	0.958	0.956
16	0.958	0.957	0.950	0.954	0.952	0.950
17	0.953	0.952	0.944	0.948	0.945	0.943
18	0.947	0.946	[illegible]	0.942	0.940	0.937
19	0.941	0.940	0.938	0.935	0.933	0.930
20	0.935	0.933	0.931	0.929	0.926	0.923
22	0.922	0.920	0.917	0.914	0.911	0.907
24	0.907	0.905	0.902	0.898	0.894	0.890
26	0.892	0.889	0.885	0.882	0.877	0.872
28	0.875			0.864		0.852
		[illegible]	0.868		0.858	0.832
32	0.838	0.834	0.830	0.824	0.818	0.811
34	0.798	0.814	0.809	0.803	0.774	0.789
36	0.776	0.793	0.788	0.781	0.751	0.766
38	[illegible]	0.771	0.765	0.758	[illegible]	0.742
40	0.753	0.748	0.742	0.735	0.726	0.717
42	0.730	0.724	0.718	0.685	0.702	0.692
44	0.705	0.700	0.693	0.659	0.676	0.666
46	0.680	0.674	0.667	[illegible]	0.650	0.639
48	0.654	0.648	0.641	0.633	0.623	0.612
50	0.628	0.621	0.614	0.606	0.596	0.585
52	0.600	0.594	0.587	0.578	0.568	0.557
54	0.572	0.565	0.559	0.550	0.540	0.529
56	0.544	0.537	0.530	0.521	0.512	0.501
58	0.515	0.508	0.501	0.493	0.483	0.472
60	0.485	0.479	0.472	0.463	0.454	0.443

Elevation angle (degrees)	f(θ)					
	0.23 λ	0.25 λ	0.27 A	0.29 λ	0,311 λ	0.35 λ
0	1.000	1.000	1.000	1.000	1.000	1.000
1	1.000	1.000	1.000	1.000	1.000	1.000
2	0.999	0.999	0.999	0.999	0.999	0.999
3	0.998				0.998	
4	0.997	0.998	0.998	0.996	0.996	0.997 0.995
	[illegible]	0.996	0.996		[illegible]	0.992
5 6	0.995 0.992	0.992	0.994 0.991	0.988	0.990	0.989
7	0.990	0.989	0.988	0.984	0.987	0.985
8	0.987	0.986	0.985	[illegible]	0.983	0.980
9	0.983	9.932	0.981	0.980	0.978	0.975
10	0.979	0.978	0.972	0.970	0.973	0.969
11	0.975	0.973	0.966	0.964	0.968	0.963
12	0.970	0.968	[illegible]	[illegible]	0.962	0.955
13	0.959	0.963	0.961	0.958	0.955	0.949
14	0.953	0.957	0.955	0.952	0.948	0.941
15	[illegible]	0.951	0.948	0.945	0.941	0.932
16	0.947	0.944	0.941	0.937	0.933	0.924
17	0.941	0.937	0.934	0.930	0.925	0.914
18	0.934	0.930	0.926	0.921	0.916	0.904
					0.907	0.894
19 20	0.919	0.914 0.922	0.909	0.904 0.913	0.898	0.883
22	0.902	0.897	0.891	0.885	[illegible]	0.851
24	0.885	0.879	0.872	0.865	0.877	0.837
26	0.866	0.859	0.852	0.843	0.833	0.811
28	0.846	0.833	0.830	0.820	0.809	0.785
30	0.825	0.816	0.807	0.797	0.784	0.768
			0.784	0.772		0.729
32 34	0.808 0.780	0.794 0.770	0.759	0.747	0.759 0.732	0.701
36	0.732	0.720	0.708	0.721	0.677	0.671
38	0.706	0.695	0.681	0.694	0.649	0.642
40	[illegible]	[illegible]	[illegible]	0.667	[illegible]	0.612
42	0.681	0.668	0.654	0.639	0.621	0.582
44	0.654	0.641	0.627	0.611	0.593	0.552
46	0.628	0.614	0.600	0.583	0.564	0.523
48	0.600	0.587	0.572	0.555	0.536	0.494
so	0.573	0.559	0.544	0.527	0.507	0.465
52	0.545	0.531	0.516	0.498	0.479	0.436
54	0.517	0.503	0.487	0.470	0.451	0.408
56	0.488	0.474	0.459	0.442	0.423	0.381
58	0.460	0.446	0.431	0.414	0.395	0.354
60	0.431	0.418	0.403	0.387	0.368	0.328

Elevation angle (degrees)	f(θ)					
	0.40λ	0.45λ	0.50λ	0.528λ	0.55λ	0.625λ
0	1.000	1.000	1.000	1.000	1.000	1.000
1	1.000	1.000	0.999	0.999	0.999	0.999
2	0.998	0.998	0.998	0.997	0.997	0.996
3	0.997	0.996	0.996	0.994	0.993	0.989
4	0.994	0.992	0.990	0.989	0.988	0.981
5	0.981	0.988	0.986	0.983	0.981	0.970
6	0.906	0.983	0.979	0.976	0.972	0.957
7	0.932	0.977	0.971	0.967	0.962	0.941
8	0.976	0.970	0.982	0.957	0.951	0.924
9	0.970	0.963	0.953	0.945	0.938	0.904
10	0.963	0.954	0.942	0.933	0.924	0.882
11	0.955	0.945	0.930	0.919	0.909	0.859
12	0.947	0.934	0.917	0.905	0.893	0.834
13	0.936	0.923	0.903	0.889	0.876	0.807
14	0.929	0.912	0.889	0.872	0.857	0.778
15	0.918	0.899	0.873	0.855	0.837	0.748
16	0.908	0.886	0.867	0.836	0.816	0.717
17	0.897	0.873	0.840	0.817	0.795	0.684
18	0.885	0.859	0.823	0.797	0.772	0.651
19	0.873	0.844	0.804	0.776	0.749	0.617
20	0.860	0.828	0.785	0.755	0.726	0.582
22	0.833	0.796	0.746	0.710	0.667	0.510
24	0.805	0.763	0.705	0.666	0.625	0.436
26	0.776	0.728	0.663	0.618	0.574	0.363
28	0.745	0.692	0.621	0.570	0.522	0.290
30	0.714	0.655	0.577	0.522	0.470	0.219
32	0.682	0.619	0.534	0.475	0.419	0.151
34	0.649	0.582	0.492	0.428	0.369	0.085
36	0.617	0.545	0.450	0.383	0.321	0.025
38	0.584	0.509	0.409	0.340	0.276	-0.031
40	0.552	0.473	0.370	0.298	0.231	-0.083
42	0.519	0.438	0.332	0.258	0.190	-0.129
44	0.488	0.405	0.296	0.221	0.162	-0.170
46	0.457	0.372	0.262	0.187	0.117	-0.205
48	0.427	0.341	0.230	0.135	0.085	-0.235
50	0.397	0.311	0.201	0.126	0.056	-0.259
52	0.369	0.283	0.174	0.099	0.031	-0.278
54	0.341	0.257	0.149	0.076	0.009	-0.291
56	0.316	0.232	0.126	0.055	-0.010	-0.300
58	0.289	0.208	0.106	0.037	-0.026	-0.304
60	0.265	0.186	0.087	0.027	-0.039	-0.304
62				0.008	-0.049	-0.300
64				-0.003	-0.056	-0.292
66				-0.011	-0.062	-0.281
68				-0.017	-0.064	-0.267
70				-0.022	-0.065	-0.250
72				-0.025	-0.064	-0.231
74				-0.025	-0.061	-0.210
76				-0.026	-0.056	-0.138
78				-0.024	-0.051	-0.163
80				-0.022	-0.044	-0.138

Note : When the negative sign (-) appears in the Table, it signifies only the existence of a secondary lobe having the opposite phase from the main lobe in the vertical radiation pattern. In order to perform the calculation, ignore the negative (-) and use only the absolute value of f(θ) from the Table.

ANNEX 2 - FIGURE 4

Skywave Field Strength Versus Distance for Characteristic Field Strength of 100 MV/M at 1 KM - 50% of the time

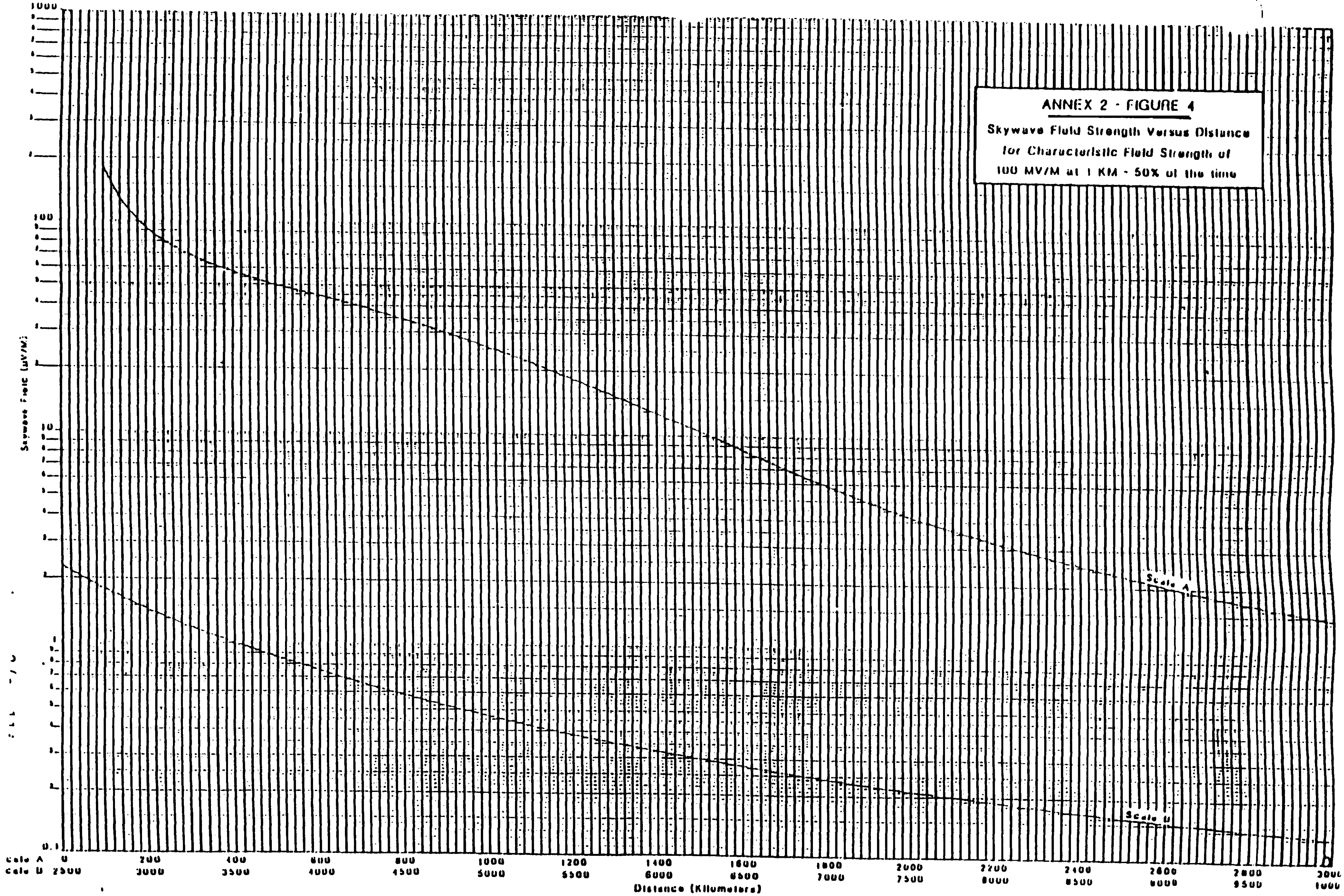


TABLE III - Skywave field strength vs distance (from 100 to 10,000 km) for a characteristic field strength of 100 mV/m at 1 km.

d(km)	F_c (uV/m) 50%	d(km)	F_c (uV/m) 50%
100	179.11	3000	1.43
150	117.18	3100	1.33
200	92.06	3200	1.23
250	77.54	3300	1.15
300	68.82	3400	1.07
350	62.06	3500	1.00
400	57.08	3600	0.94
450	52.86	3700	0.88
500	49.65	3800	0.83
550	46.78	3900	0.79
600	44.36	4000	0.75
650	41.95	4100	0.71
700	39.54	4200	0.67
750	36.81	4300	0.64
800	34.40	4400	0.61
850	32.30	4500	0.58
900	29.89	4600	0.55
950	27.63	4700	0.53
1000	25.54	4800	0.51
1050	23.56	4900	0.48
1100	21.84	5000	0.46
1150	19.91	5100	0.45
1200	18.30	5200	0.43
1250	16.70	5300	0.41
1300	15.32	5400	0.40
1350	13.97	5500	0.38
1400	12.71	5600	0.37
1450	11.55	5700	0.36
1500	10 .SO	5800	0.34
1550	9.53	5900	0.33
1600	8.57	6000	0.32
1650	7.72	6200	0.30
1700	6.98	6400	0.28
1750	6.34	6600	0.27
1800	5.30	6800	0.25
1850	5.32	7000	0.24
1900	4.49	7200	0.23
1950	4.49	7400	0.22
2000	4.14	7600	0.21
2100	3.61	7800	0.20
2200	3.18	8000	0.19
2300	2.79	8200	0.18
2400	2.55	8400	0.17
2500	2.26	8600	0.17
2600	2.03	8800	0.16
2700	1.85	9000	0.15
2800	1.69	9200	0.15
2900	L.55	9400	0.14
		9600	0.14
		9800	0.13
		L0000	0.13

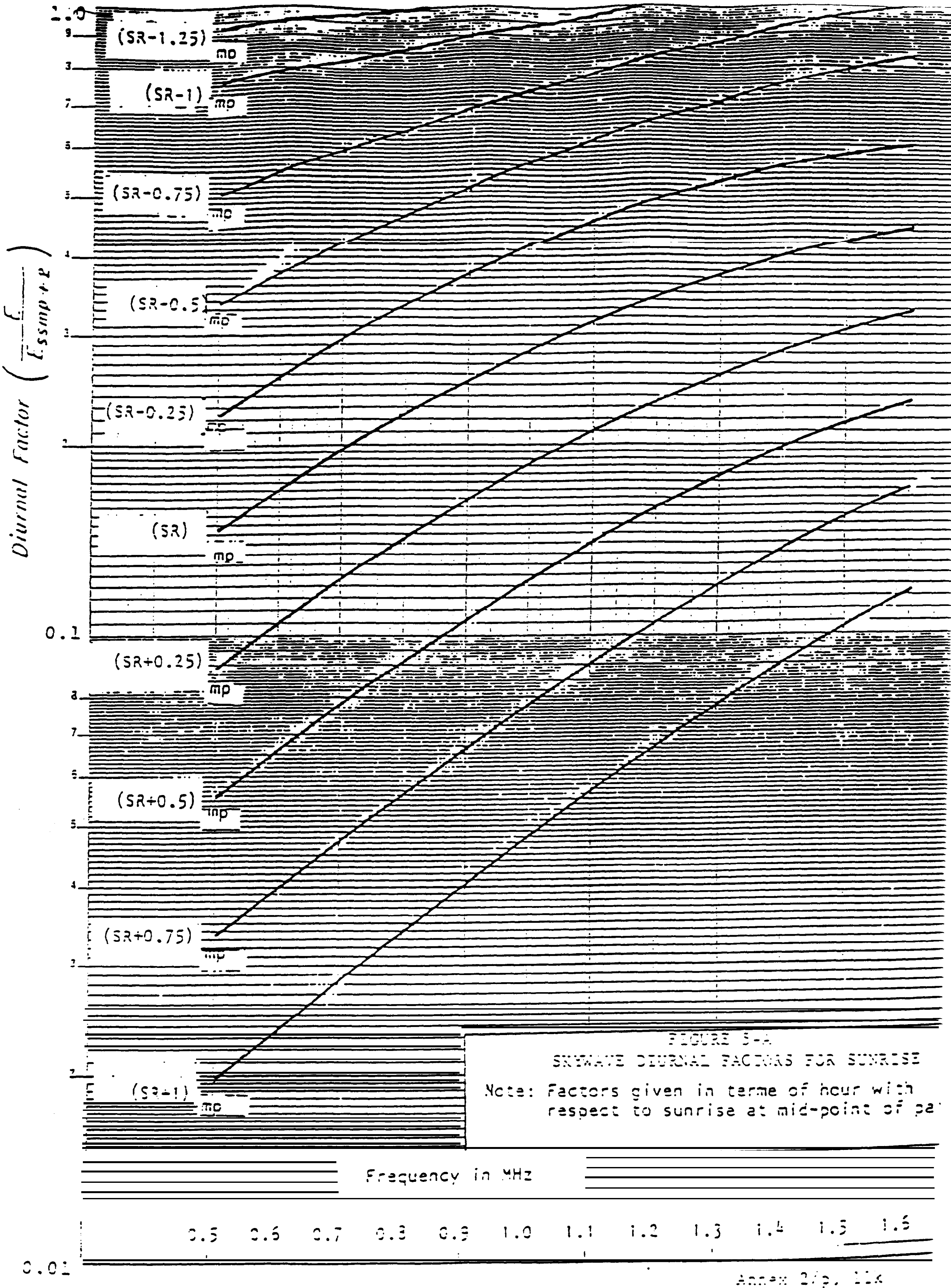


FIGURE 5-A
SKYWAVE DIURNAL FACTORS FOR SUNRISE

Note: Factors given in terms of hour with respect to sunrise at mid-point of pa

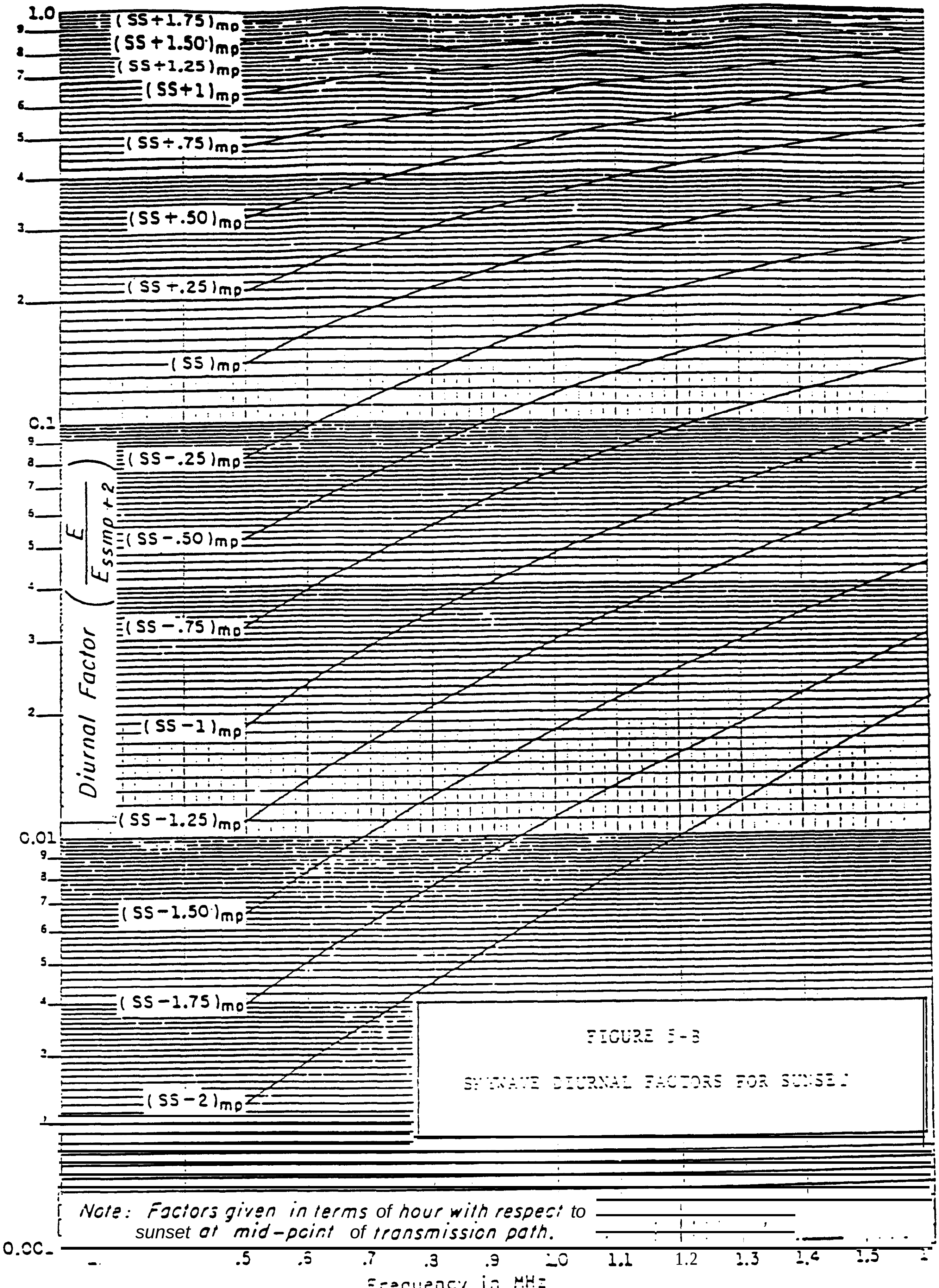


FIGURE 5-8

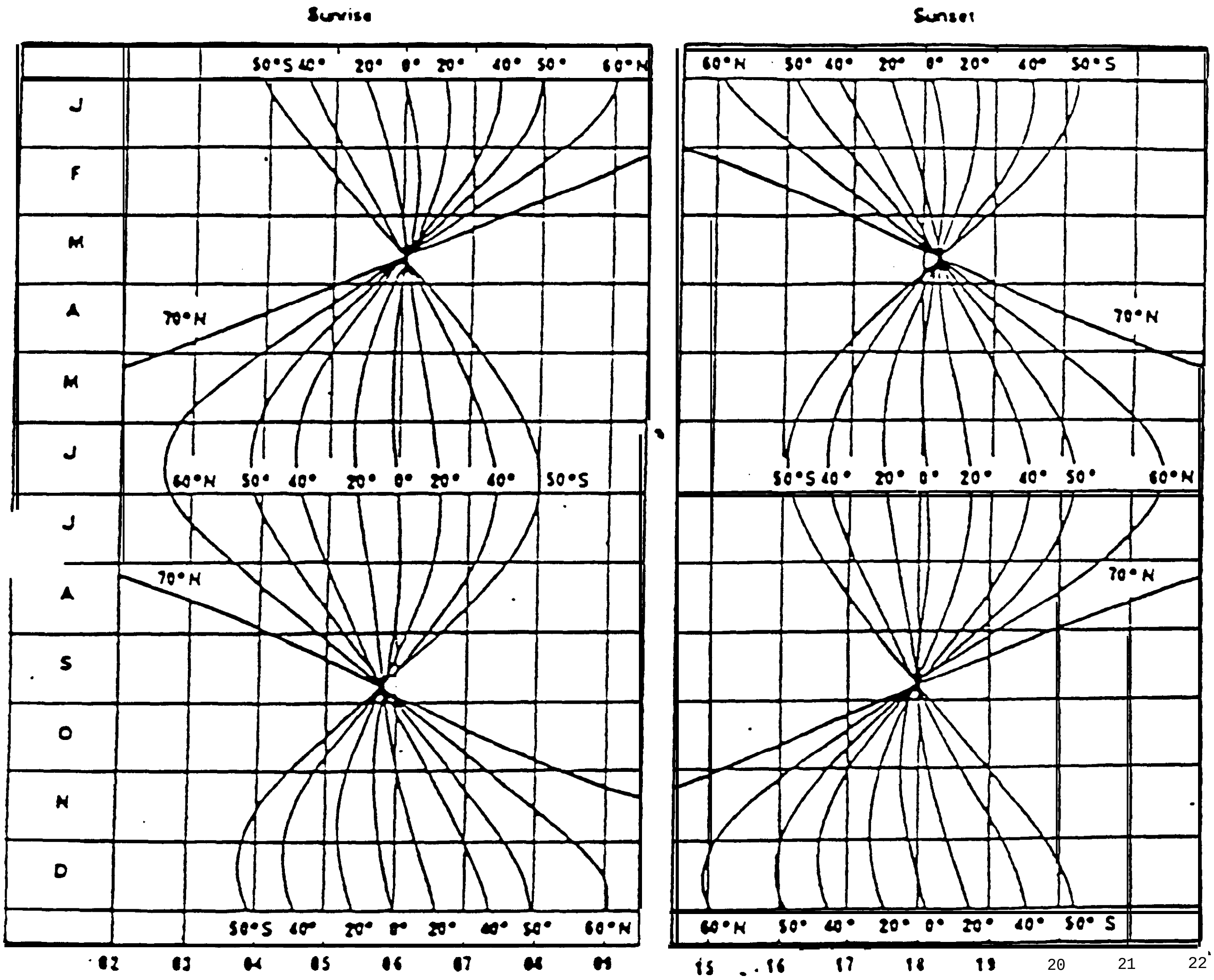
SKYWAVE DIURNAL FACTORS FOR SUNSET

TABLE IV

Presunrise Constants				
T_{mp}	a	b	c	d
-2	1.3084	.0083	-.0155	.0144
-1.75	I.3165	-.4919	.6011	-.1884
-1.5	1.0079	.0296	.1488	-.0452
-1.25	.7773	.3751	-.1911	.0736
-1	.6230	.1547	.2654	-.1006
-.75	.3718	.1178	.3632	-.1172
-.5				
-.25	.2051	-.0737	.4167	-.2577
SR	.1504	-.2325	.5374	-.1729
+.25	.1057	-.2092	.4148	-.1239
+.5	.0642	-.1295	.2583	-.0699
+.75	.0446	-.1002	.1754	-.0405
+1	.0148	-.0135	.0462	.0010

TABLE V

Post Sunset Constants				
T_{mp}	a	b	C	d
1.75	.9495	-.0187	.0720	-.0290
1.5	.7196	-3583	-.2280	.0611
1.25	.6756	.1518	.0279	-.0163
1.0	.5486	.1401	.0952	-.0288
.75	.3003	.4050	-.0961	.0256
.5	.1186	.4281	-.0799	.0197
.25	.0382	.3706	-.0673	.0171
ss	.0002	JO24	-.0540	.0086
-.25	.0278	.0458	.1473	-.0486
-.5	.0203	.0132	.1166	-.0340
-.75	.0152	-.0002	.0786	-.0185
-1 .o	-.0043	.0452	-.0040	.0103
-1.25	.0010	.0135	.0103	.0047
-1.5	.0018	.0052	.0069	.0042
-1.75	-.0012	.0122	-.0076	.0076
-2.0	-.0024	.0141	-.0141	.0091



Local time at reflection point (hours)

FIGURE 6 - Times of sunrise and sunset for various months and geographical latitudes

CHAPTER 4

Broadcasting Standards

4.1 Separation of Channels

This Agreement is based on a channel spacing of 10 kHz and carrier frequencies which are integral multiples of LO kHz, beginning at 540 kHz.

4.2 Class of emlsslon

This Agreement is based upon double-sideband amplitude modulation with full carrier A3E.

Classes of emission other than A3E, for instance to accommodate stereophonic systems, could also be used on condition that the energy level outside the necessary bandwidth does not exceed that normally expected in A3E emission and that the emlsslon is receivable by conventional receivers employing envelope detectors without increasing appreciably the level of distortion.

4.3 Bandwidth of emlsslon

This Agreement assumes a necessary bandwidth of 10 kHz, for which only a 5 kHz audio bandwidth can be obtained.

Note: It is noted that some stations have successfully employed wider bandwidth systems hating occupied bandwidths of the order of 20 kHz without adverse effects.

4.3.1 Frequency tolerance: ±20 Hz. However, both Administrations recognize chat it is desirable to implement the tolerance of ±10 Hz in accordance with the ITU Radio Regulations (1982).

4.4 Station power

4.4.1 Class A

- The power of any Class A station exceeding 100 kW day/50 kW night shall not be increased.

- The power of any Class A station not exceeding 100 kW day/SO kW night may be increased but shall not exceed those values.

- Any new Class A station shall have a power not exceeding LOO kW day / 50 kW night.

4.4.2 Class 3

- The maximum statlon power shall be 50 kW.

4.4.3 Class c

- The maximum station power shall be 1 kW.

4.5 Skywave interference calculations

The values of interfering skywave signals shall be calculated on the basis of 10% of the time, in the manner prescribed in section 3.6.

4.6 Nominal usable field strength

4.6.1 Class A station (1)

Groundwave

Daytime: co-channel 100 µV/m and adjacent channel 500 µV/m

Nighttime: 500 µV/m

Skyvave

Nightime: 500 µV/m, 50% of the time

4.6.2 Class B station (2)

Groundwave

Daytime: 500 µV/m

Nighttime: 2500 µV/m

4.6.3 Class C station (2)

Groundwave

Daytime: 500 µV/m

Nighttime: 4000 µV/m

Note (1) : The nighttime contours, groundwave or skywave which ever is further are to be protected in the case of class A stations.

Note (2) : The protected contour during nighttime operation for class B and C stations shall be the higher of the grounduave contour in 4.6.2 and 4.6.3 respectively, or the groundwave contour corresponding to the usable field strength of the station as set forth in 4.7.

4.7 Use of the root sum square (RSS) method to determine the usable field strength resulting from the weighted interfering signals 1/

4.7.1 General

The overall usable fleld strength E_u due to two or more individual interference contributions is calculated on an RSS basis, uslng the expression:

$$E_u = \sqrt{(a_1E_1)^2 + (a_2E_2)^2 + \ldots (a_iE_i)^2} \qquad (1)$$

where:

E_i is the field strength of the ith interfering transmitter (in µV/m)

a_i is the radio-frequency protecton ratio associated with the ith interfering transmitter, expressed as a numerical ratio of field strengths.

4.7.2.1 50% exclusion principle

The 50% exclusion principle allows a significant reduction in the number of calculations .

4.7.2.2 According to this principle, the values of the individual usable field strength contributions are arranged in descending order of magnitude. If the second value is less than 50% of the first value, the second value and all subsequent values are neglected. Otherwise an RSS value is calculated for the first and second values. The calculated RSS value is then compared with the third value in the same manner by vhlch the first value was compared to the second and a nev RSS value is calculated lf required. The process is continued until the next value to be compared is less than 50% of the last calculated RSS value. At that polnt the last calculated RSS value is considered to be the usable field strength E_u.

4.7.2.3 Except as provided in section 4.7.2.4, if the contribution of a new station is greater than the smallest value previously considered in calculating the RSS value of assignments in the Plan, the contribution of the new station adversely affects assignments in conformity with this Agreement even if it is less than 50% of the RSS value. Hovever, the new contribution does not adversely affect assignments in conformity with this Agreement if the RSS value determined by inserting the contribution of the new station in the list of contributors is smaller than the nominal usable field strength E_{nom}.

4.7.2.4 The contribution of a station engaging in extended Sours of operation under Article VI of this Agreement shall not be taken into account in the calculation of the E_u.

1/ in due time, in accordante with Paragraph 5.2 of Article V of the present Agreement, consideration should be given to the contributions of stations of other countries in Region 2.

4.8 Channel protection ratios (desired to undesired)

4.8.1 Co-channel protection ratio

The co-channel protection ratio is 20:1

4.8.2 Adjacent channel protection ratio

The protection ratio for the first adjacent channel is 1:1

The protection ratio for the second adjacent channel is 1:30

4.8.3 Synchronized networks

In addition to the standards specified in this Agreement, the following additional standards apply to synchronized networks.

for the purpose of determining interference caused by synchronized networks, the following procedure shall be applied. If any two transmitters are less than 400 km apart, the network shall be treated as a single entity, the value of the composite signal being determined by the quadratic addition of the interfering signals from all the individual transmitters in the network. If the distances between all the transmitters are equal to or greater than 400 km, the network shall be treated as a set of individual transmitters.

For the purpose of determining skywave interference received by any one member of a network, the value of the interference caused by the other elements of the network shall be determined by the quadratic addition of the interfering signals from all of those elements. In any case, where groundwave Interference is a factor it shall be taken into account.

The co-channel protection ratio between stations belonging to a synchronized network is 2.5:1

4.9 Application of protection criteria

4.9.1 Value of protected contours

Within the national boundary of a country, the protected contour shall be determined by using the appropriate value of nominal usable field strength, or as otherwise determined in Note 2 to paragraph 4.6 for class B and C stations.

4.9.2 Co-channel protection 2/

4.9.2.1 Daytime protection of all classes of stations

During the daytime the groundwave contour of class A, B and C stations shall be protected against groundwave interference. The protected

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2/ See the matrix in Section 5 of Appendix 5 to Annex 2.

contour is the groundwave contour corresponding to the value of the nominal usable field strength. The maximum permissible interfering field strength at the protected contour is the value of the nominal usable field strength divided by the protection ratio. The effect of each interfering signal shall be evaluated separately. That is, notwithstanding the presence of interference from other stations, modifications or proposed assignments must protect a value corresponding to the nominal usable field strength. Where the protected contour would extend beyond the boundary of the country in which the station is located, the maximum permissible interfering field strength at the boundary is the calculated field strength of the protected station along the boundary divided by the protection ratio.

4.9.2.2 Nighttime protection of Class A stations

The groundwave contour or the skywave contour 50% of the time, whichever is farther from the site of the protected Class A station, shall be protected against skywave and possible groundwave interference during the nighttime.

The value of the protecccd contour corresponds to the nominal usable field strength. The maximum permissible interfering field strength at the protected contour is the value of the nominal usable field strength dtvlded by the protectloa ratio. However, for Class A stations notified after *the* date of signing of this Agreement, the value of the protected contour corresponds to the nominal usable field strength or the usable field strength, whichever is greater.

The effect of each interfering signal shall be evaluated separately. Where the protected contour would extend beyond the boundary of the country in which the station is located, the maximum permissible interfering field strength at the boundary is the calculated field strength of the protected station along the boundary divided by the protection ratio. Two special cases of applying this principle are as follows:

(a) Where the primary service area extends beyond the boundary, the protected contour is calculated using the groundwave field strength, and the skywave contour is protected outside the primary service area.

(b) In cases where the protected skywave contour would extend beyond the boundary, the groundwave contour shall also be protected.

4.9.2.3 Nighttime protection of class B and C stations

During the nighttime, the groundwave contour or' class 3 and C stations will be protected against skywave and possible groundwave interference. The protected contour is the groundwave contour corresponding to the value of the *greater* of the nominal usable field strength or the usable field strength resulting from the Plan of Annex 1 to this Agreement as determined at the site of the protected station in accordance with 4.7. The maximum permissible interfering field strength calculated at the site of the protected station in accordance ● dth 4.7 shall not be exceeded at the protected contour where the protected contour is located within the boundary of the country in which the station is located. Where the protected contour would extend beyond the boundary of the country in which the station is located, the protected contour shall follow that part of the boundary and have a value as calculated at the border. Where the maximum permissible interfering field strength is already exceeded at the protected contour by an existing station, any proposal for a change to that existing station shall not cause an increase in the interfering field strength at that portion of the protected contour.

4.9.2.4 Modification of assignments

If a station of one Administration causes interference to a station of the other Administration and such interference is permitted in accordance with the terms of this Agreement, then in the event of a modification being proposed to the assignment corresponding to the former station, it will not be necessary to protect the assignment corresponding to the latter station beyond the level provided before the proposed modification.

4.9.3 Adjacent channel protection 3/

During the daytime and nighttime, the groundwave contour of class A, B and C stations shall be protected against groundwave interference. The protected contour is the groundwave contour corresponding to the value of the nominal usable field strength determined as follows:

- for daytime protection of class A stations, the value specified in 4.6.1 for adjacent channel daytime groundwave;

- for nighttime protection of class A stations, the value specified in 4.6.1 for nighttime groundwave;

- for daytime and nighttime protection of class B stations, the value specified in 4.62 for daytime groundwave;

- for daytime and nighttime protection of class C stations, the value specified in 4.6.3 for daytime groundwave;

The maximum permissible interfering field strength at the protected contour is the value of the nominal usable field strength divided by the protection ratio. The effect of each interfering signal shall be evaluated separately.

Where the protected contour would extend beyond the boundary of the country in which the station is located, the maximum permissible interfering field strength at the boundary is the calculated field strength of the protected assignment along the boundary divided by the protection ratio.

If a station of one Administration causes interference to a station of the other Administration and such interference is permitted in accordance with the terms of this Agreement, then in the event of a modification being proposed to the assignment corresponding to the former station, it will not be necessary to protect the assignment corresponding to the latter station beyond the level provided before the proposed modification.

3/ See the matrix in section 5 of Appendix 5 to Annex 2.

4.9.4 Protection outside national boundaries

4.9.4.1 No station has the rlght to be protected beyond the boundary of the country in which the station is established.

4.9.4.2 No broadcasting station shall be assigned a nominal frequency with a separation of 10 or 20 kHz from that of a station in the other country if the 25,000 uV/m contours overlap.

4.9.4.3 In addltlon to the conditions described in 4.9.4.2, when the protected contour would extend beyond the boundary of the country in which the station is located, its asslgnmenc shall be protected in accordance with 4.9.2 and 4.9.3.

4.9.4.4 For protection purposes, the boundary of a country shall be deemed to encompass only its land area, including islands.

CHAPTER 5

Radiation Characteristics of Transmitting Antennas

5. In carrying out the calculations indicated in Chapters 2 and 3, the following shall be taken into account:

5.1 Omnidirectional antennas

Figure 1 of Chapter 3 shoos the characteristic field strength of a simple vertical antenna as a function of its length and of the radius of the ground sys tem.

It is clear that the characteristic field strength increases as the loss in the ground system is reduced to zero and as the antenna height is increased up to 0.625 wavelengths.

The increased characteristic field strength for antenna lengths up to 0.625 wavelengths is obtained at the expense of reducing radiation at high angles as shown graphically in Figure la and numerically in Table II of Chapter 3.

5.2 Considerations of the radiation patterns of directional antennas

The procedures for calculating theoretical, expanded and augmented (modified expanded) directional antenna patterns are given in Appendix 3.

5.3 Top-loaded and sectionalized antennas

5.3.1 Calculation procedures are given in Appendices 4 & 6.

5.3.2 Many stations employ top-loaded or sectionalized towers, either because of space limitations or to vary the radiation characteristics from those of a simple vertical antenna. This is done to achieve desired coverage or to reduce interference.

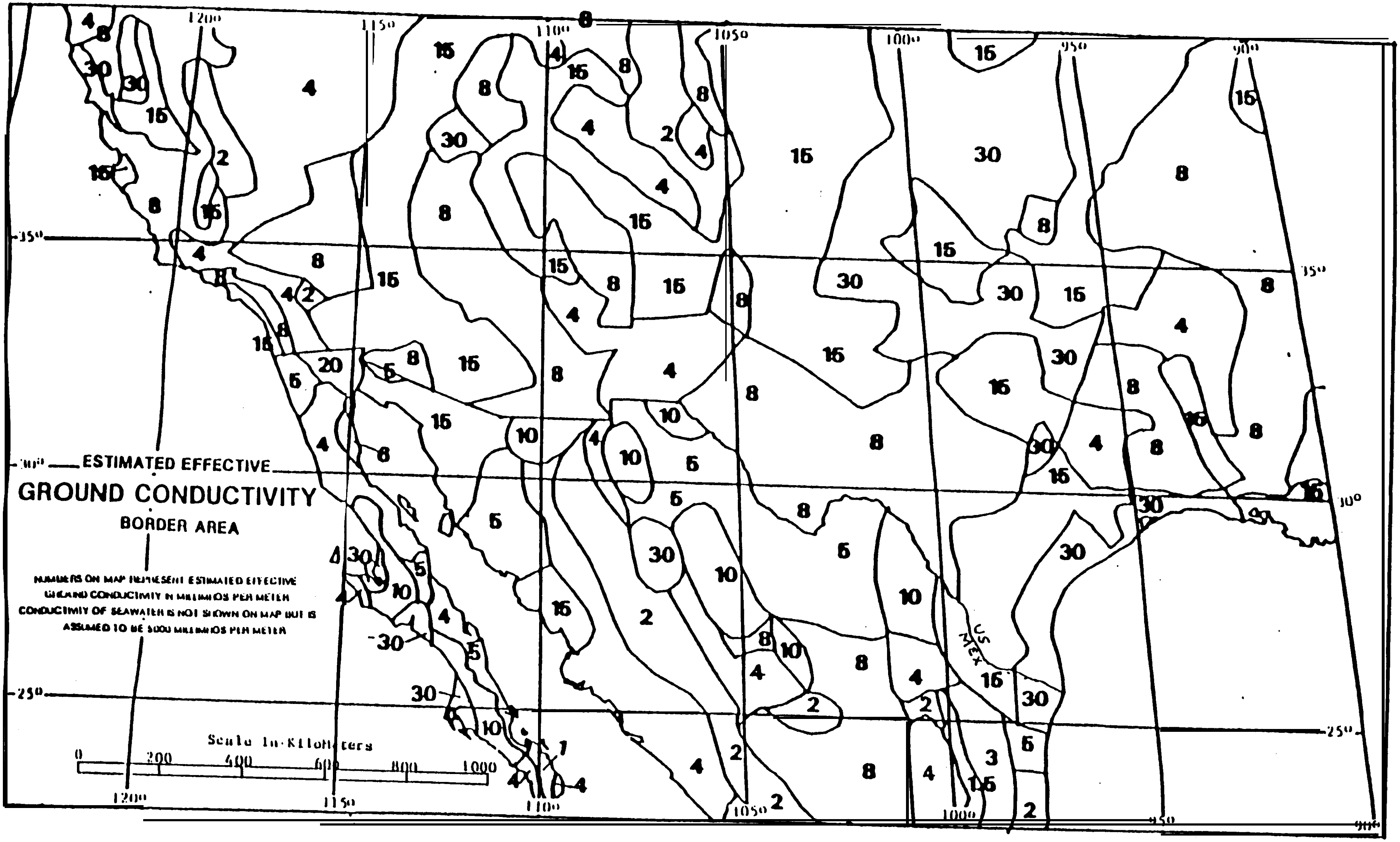
5.3.3. The Administration using top-loaded or sectionalized antennas shall supply information concerning the tower structure of the antennas. Normally, one of the equations in Appendices 4 & 6 shall be employed to determine the vertical radiation characteristics of the antennas. Other equations may also be proposed by an Administration and shall be used in determining the vertical radiation characteristics of the antennas of that Administration, subject to the agreement of the other Administration.

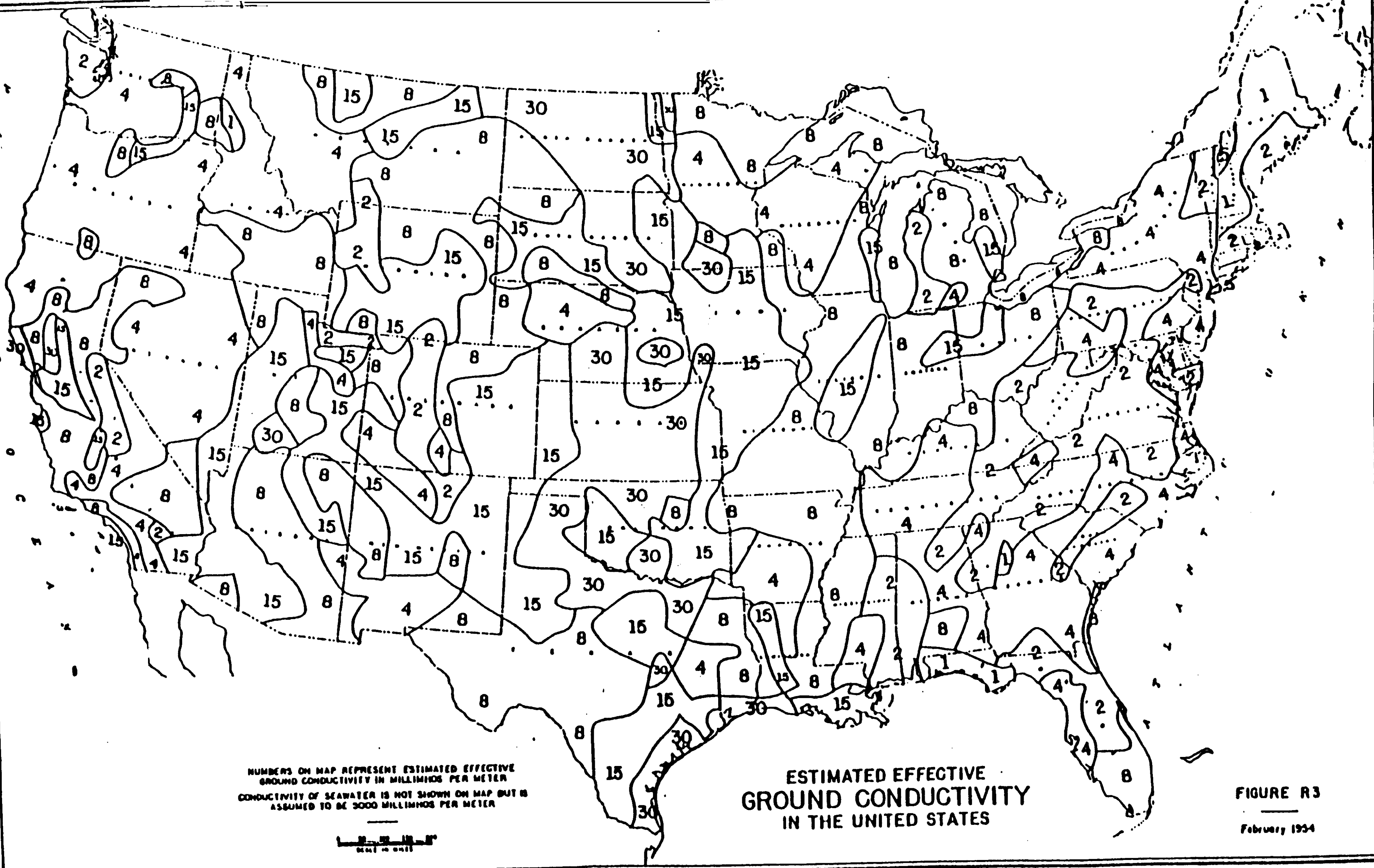
APPENDIX 1

(to annex 2)

MAPS OF GROUND CONDUCTIVITY FOR MEXICO

AND THE UNITED STATES OF AMERICA.


ESTIMATED EFFECTIVE
GROUND CONDUCTIVITY
BORDER AREA
NUMBERS ON MAP REPRESENT ESTIMATED EFFECTIVE GROUND CONDUCTIVITY IN MILLIMHOS PER METER
CONDUCTIVITY OF SEAWATER IS NOT SHOWN ON MAP BUT IS ASSUMED TO BE 5000 MILLIMHOS PER METER
Scale In Kilometers
0 200 400 600 800 1000
US
MEX



ESTIMATED EFFECTIVE
GROUND CONDUCTIVITY
IN THE UNITED STATES

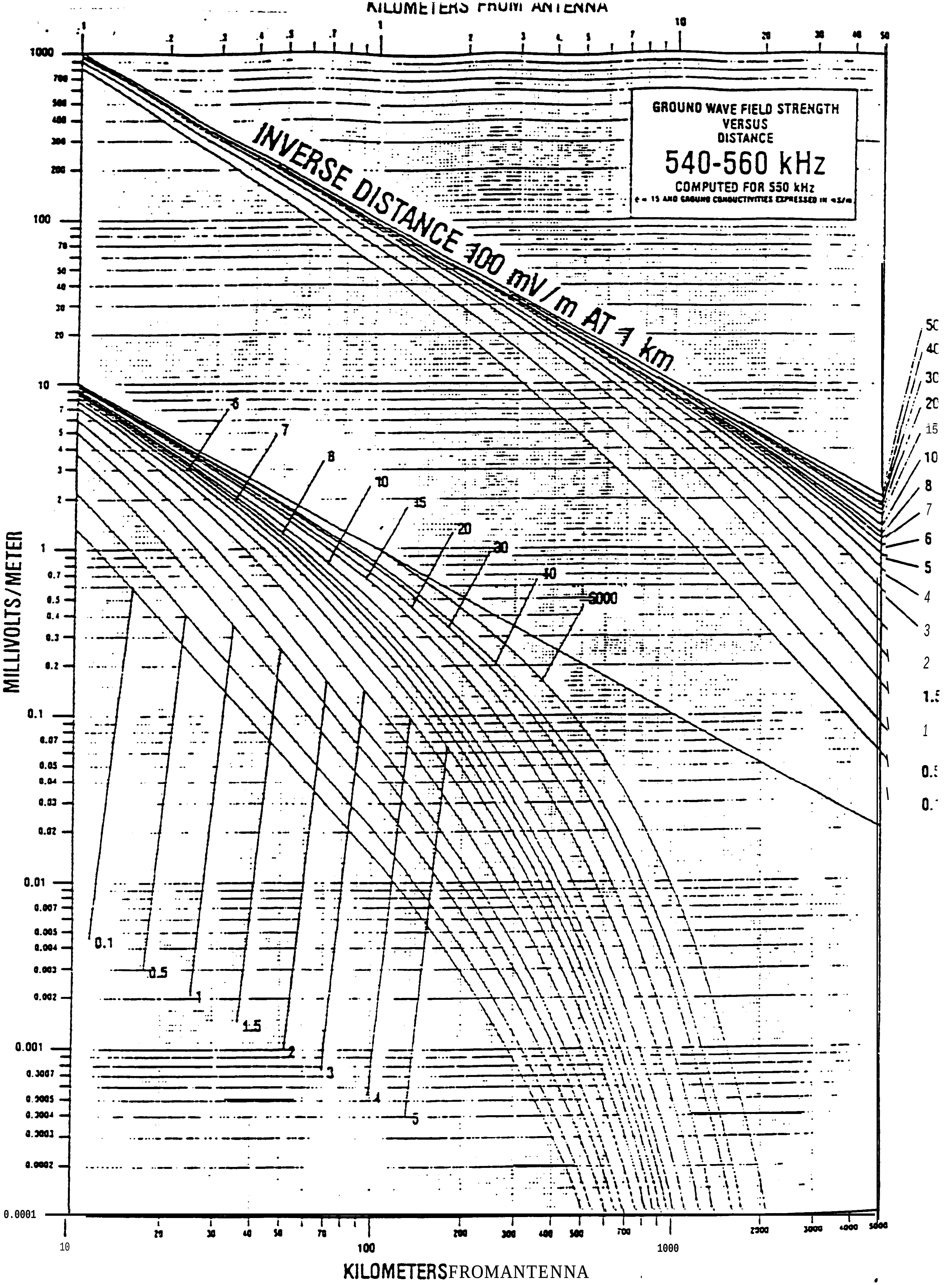
FIGURE R3

February 1954

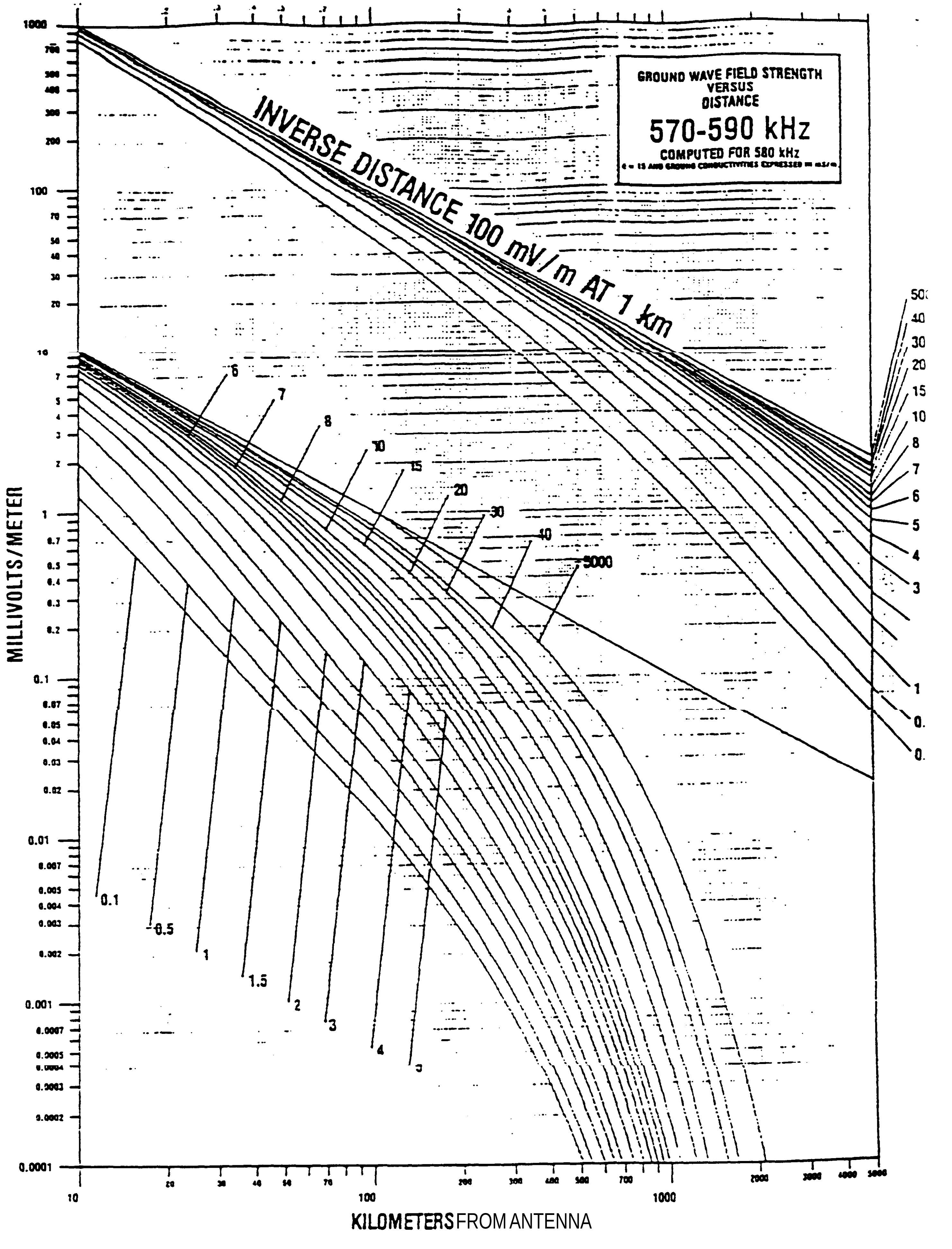
APPENDIX 2

(to Annex 2)

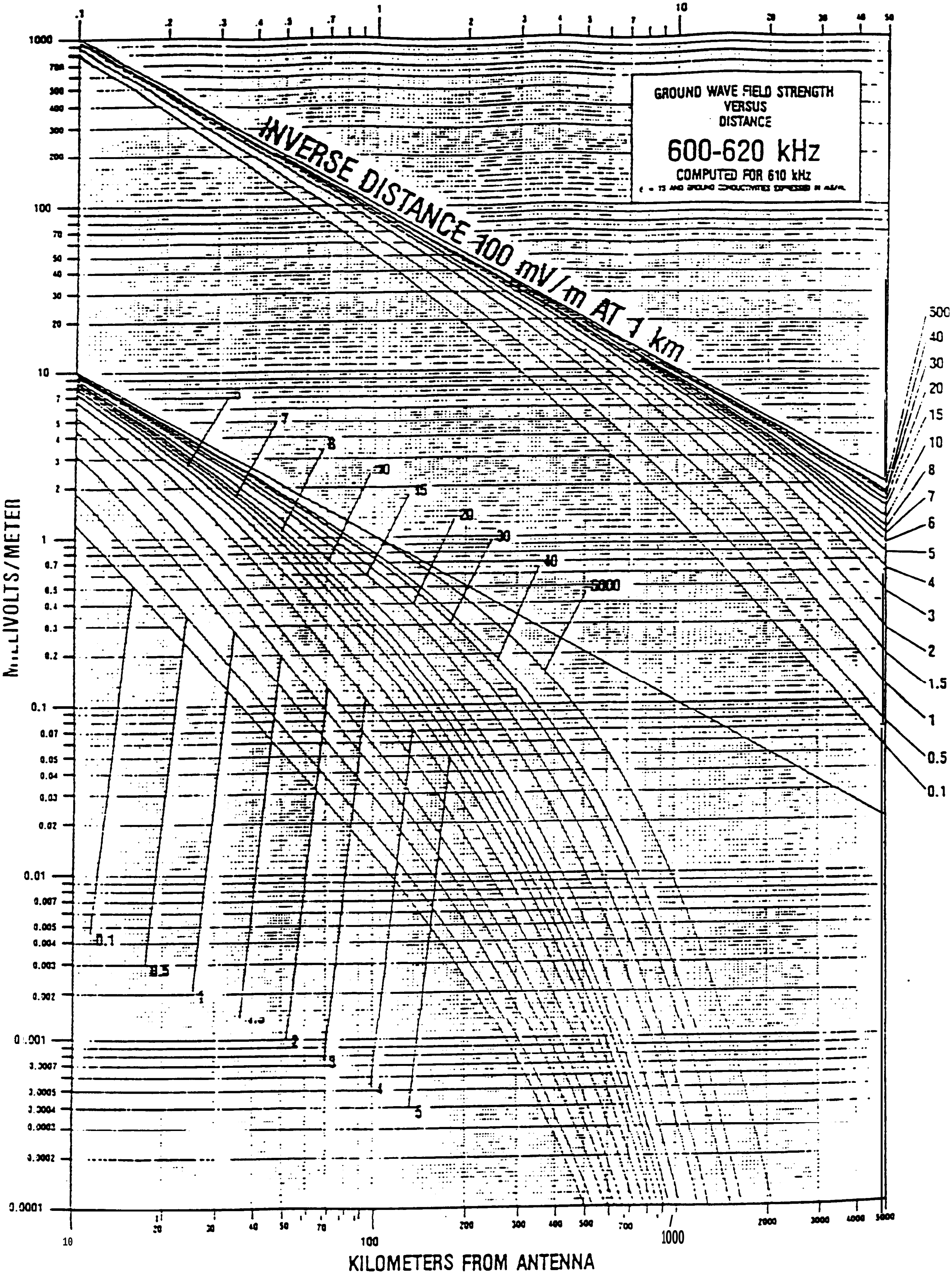
FIELD-STRENGTH CURVES FOR GROUNDWAVE PROPAGATION


KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
540-560 kHz
COMPUTED FOR 550 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

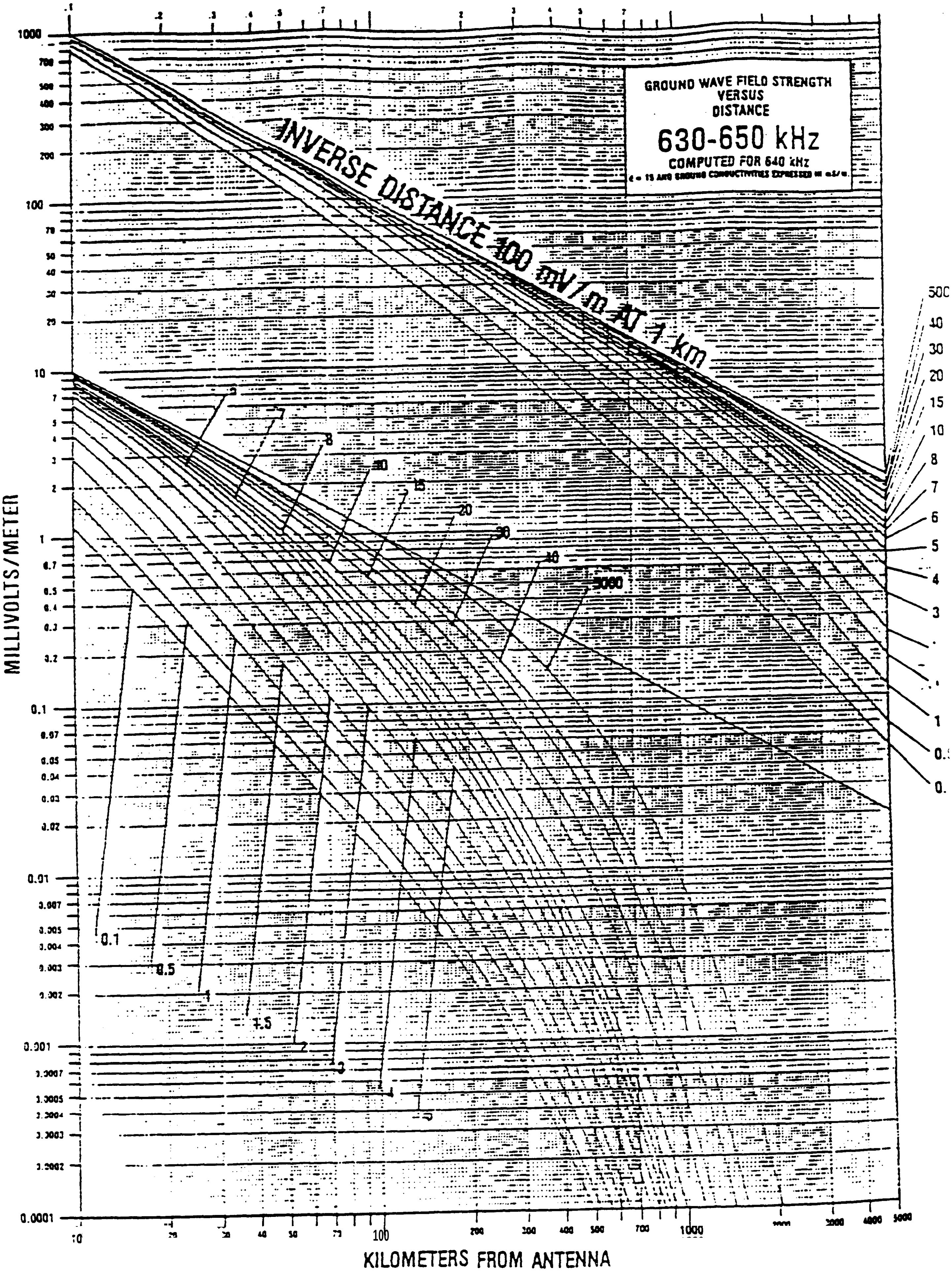
GRAPH 1


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
570-590 kHz
COMPUTED FOR 580 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

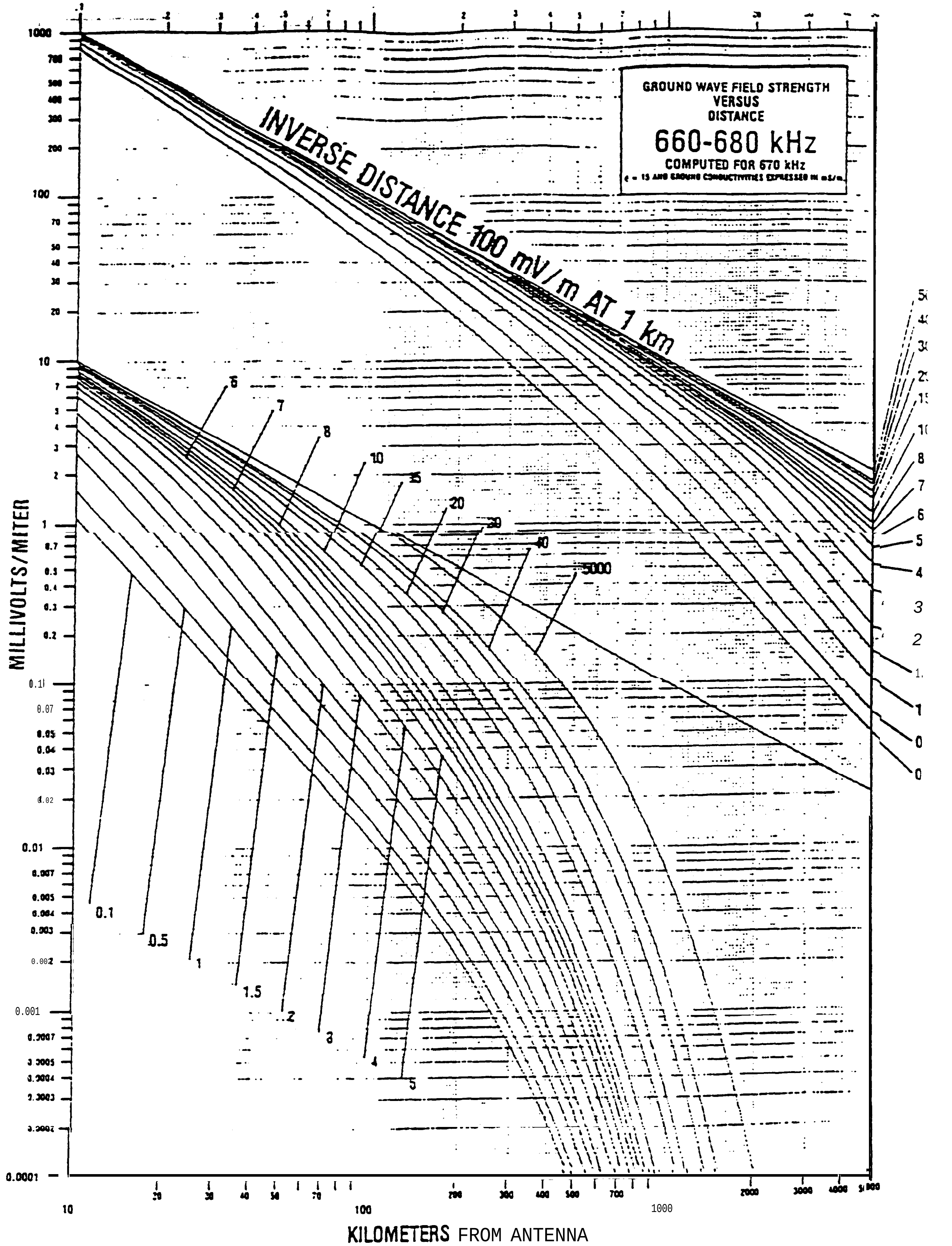
GRAPH 2


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
600-620 kHz
COMPUTED FOR 610 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

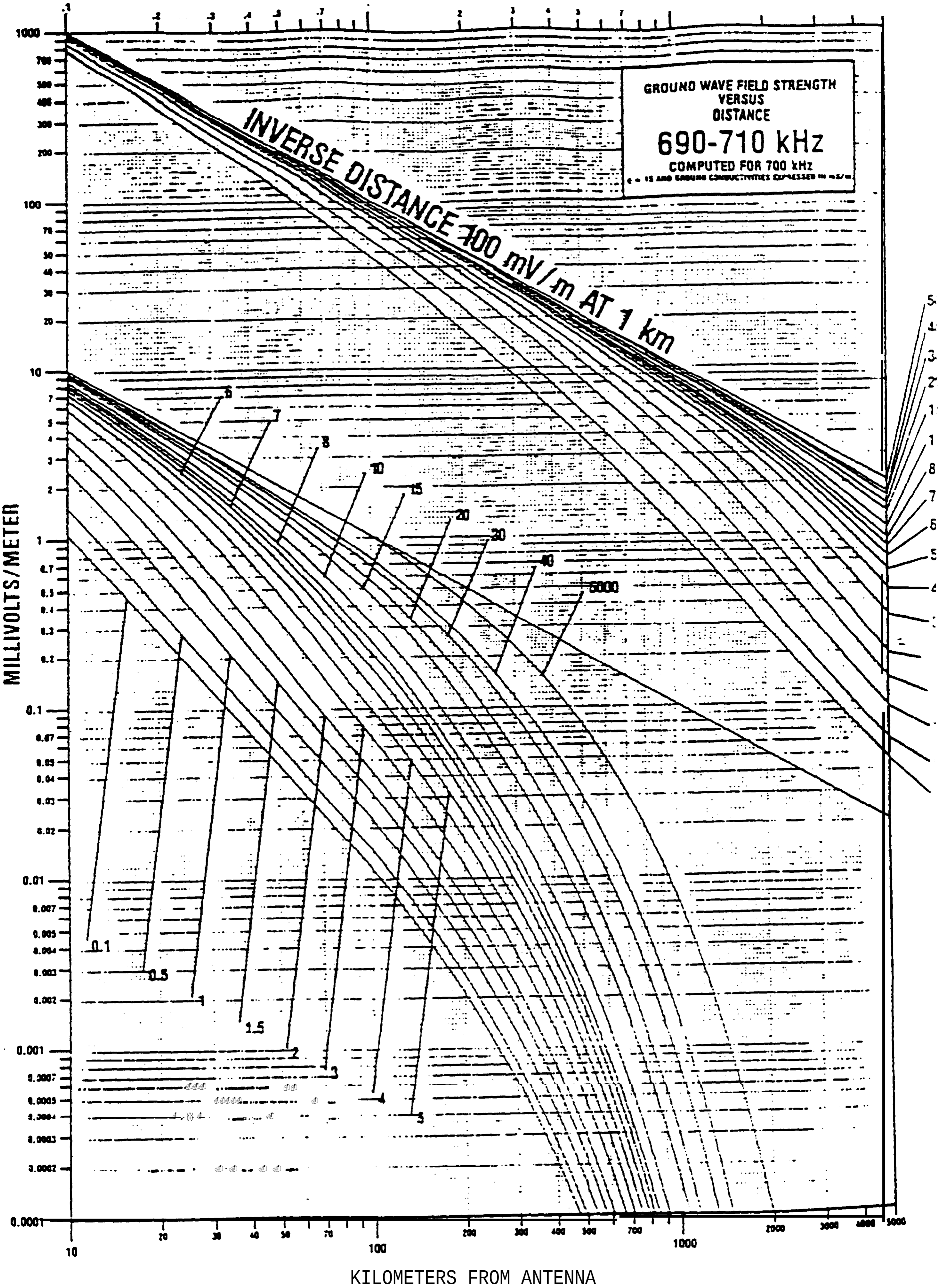
GRAPH 3


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
630-650 kHz
COMPUTED FOR 640 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

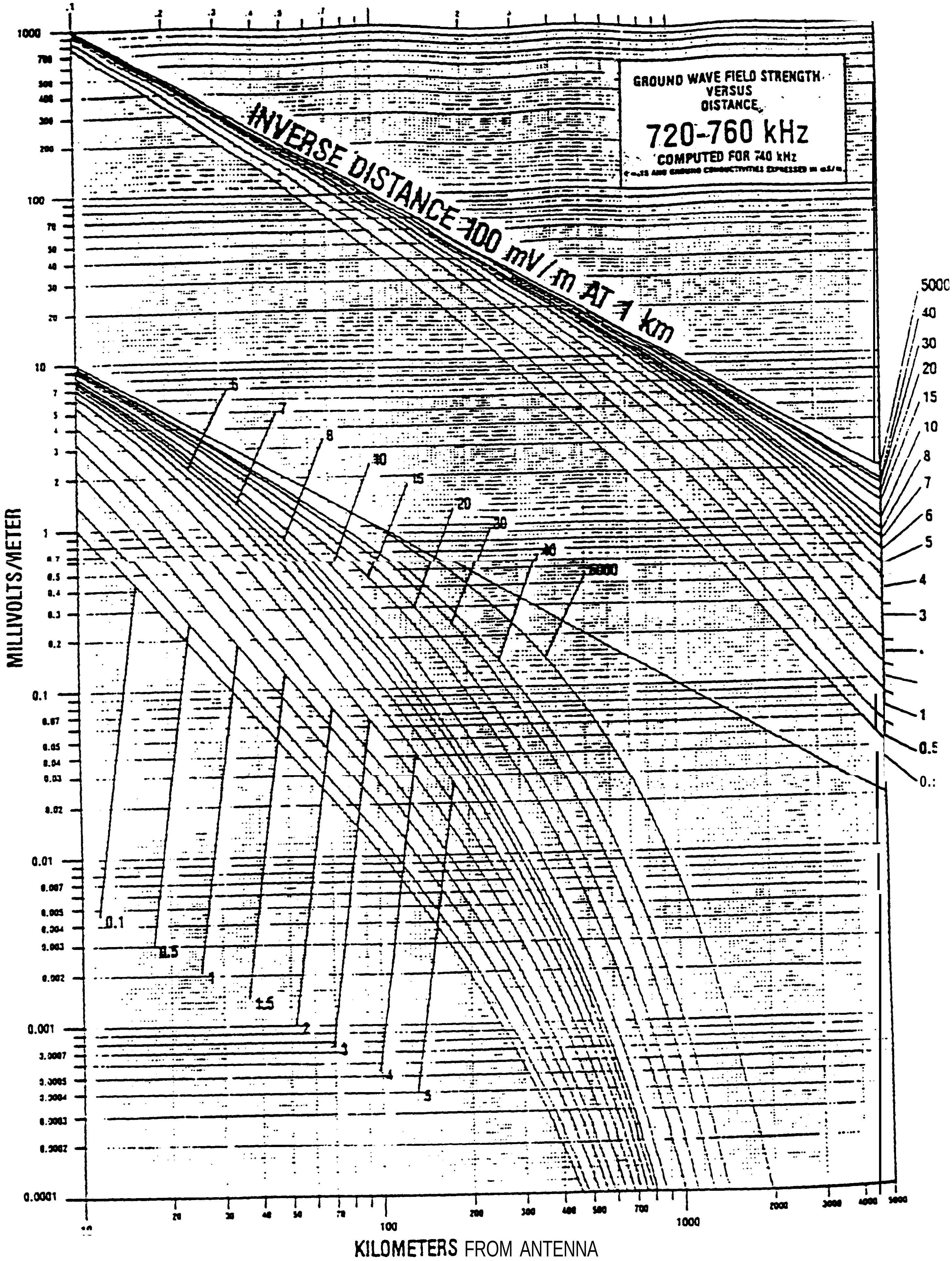
GRAPH 4


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
660-680 kHz
COMPUTED FOR 670 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/MITER
KILOMETERS FROM ANTENNA

GRAPH 5

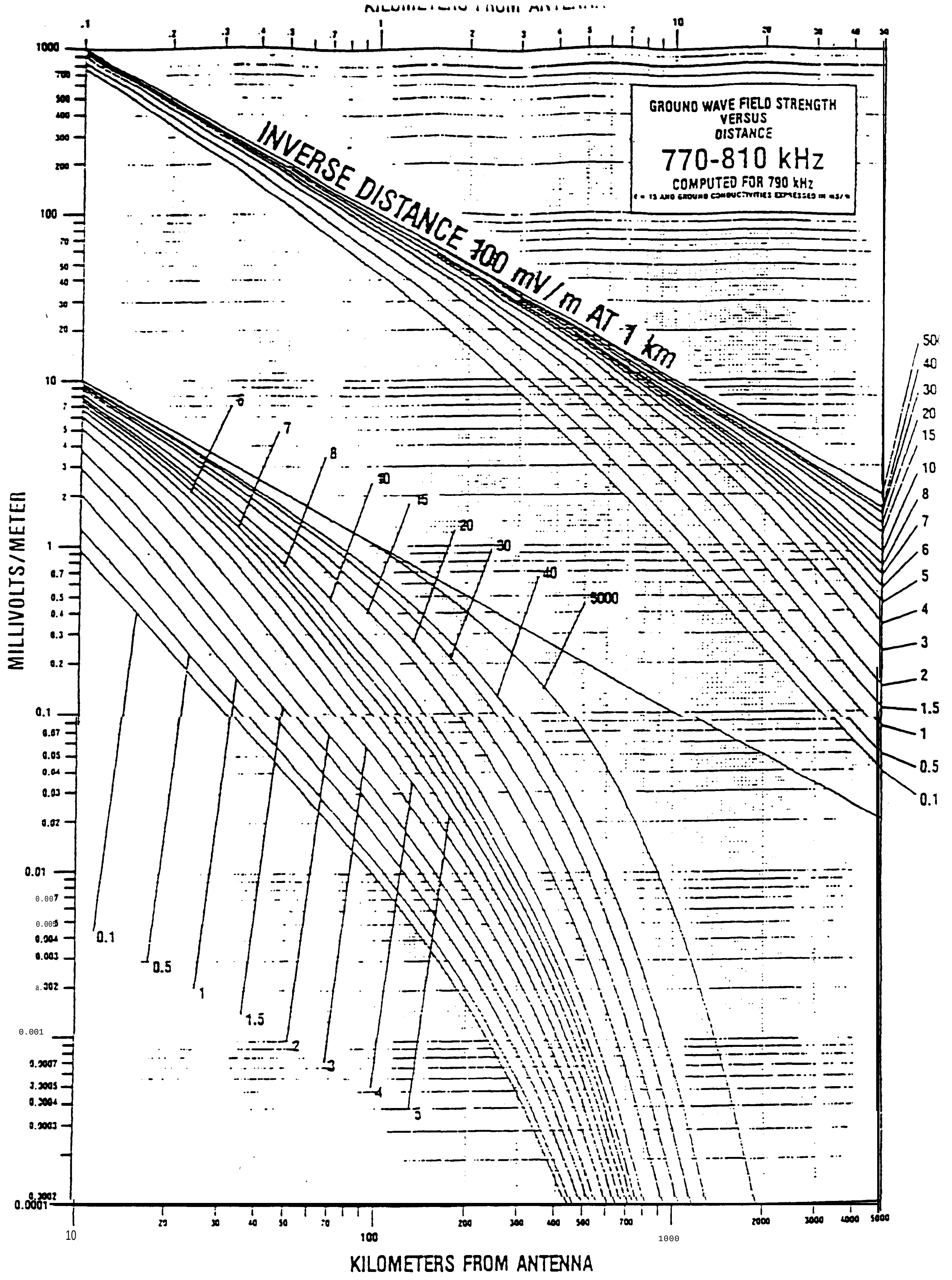

GROUND WAVE FIELD STRENGTH VERSUS DISTANCE
690-710 kHz
COMPUTED FOR 700 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH 6



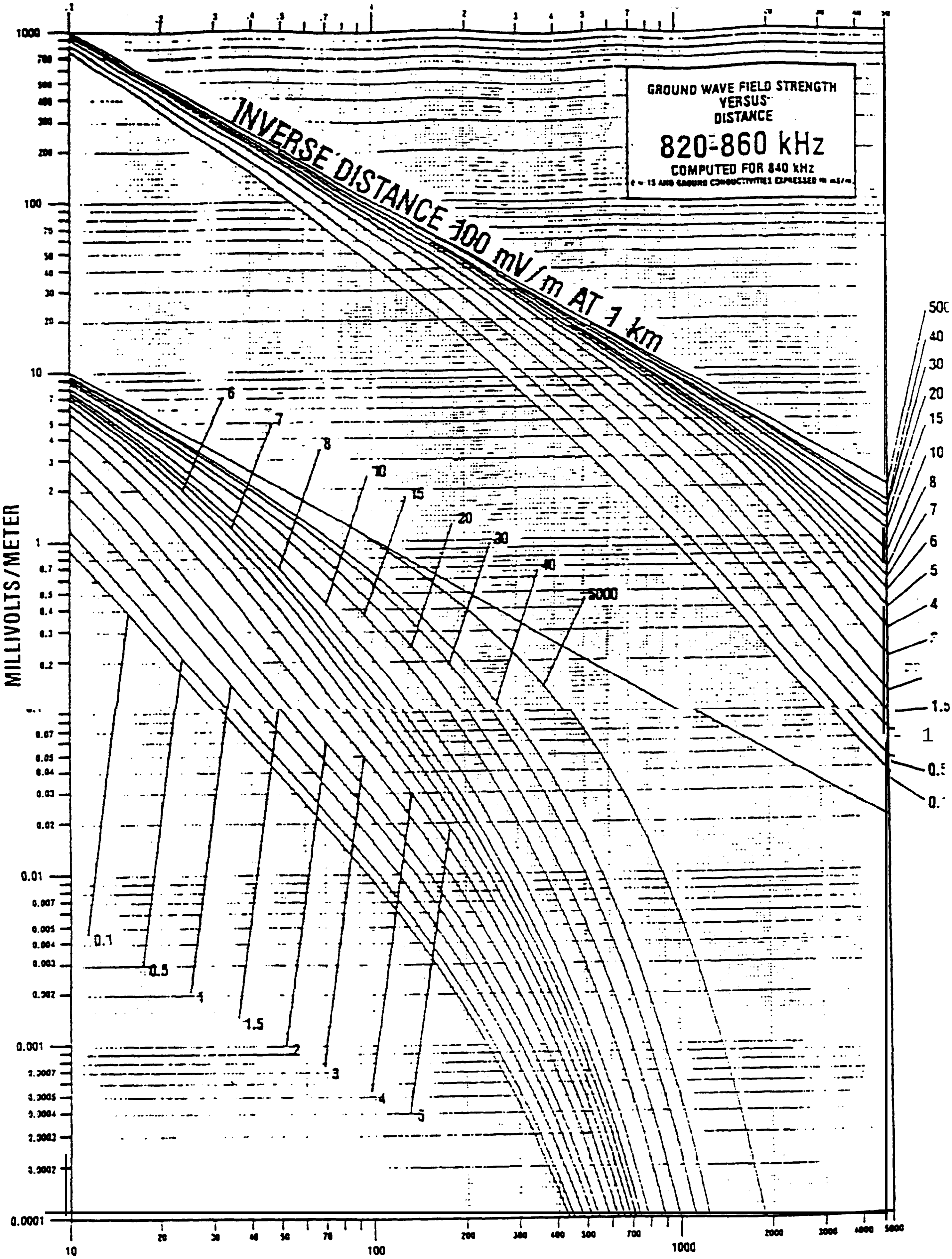
GROUND WAVE FIELD STRENGTH VERSUS DISTANCE
720-760 kHz
COMPUTED FOR 740 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH7



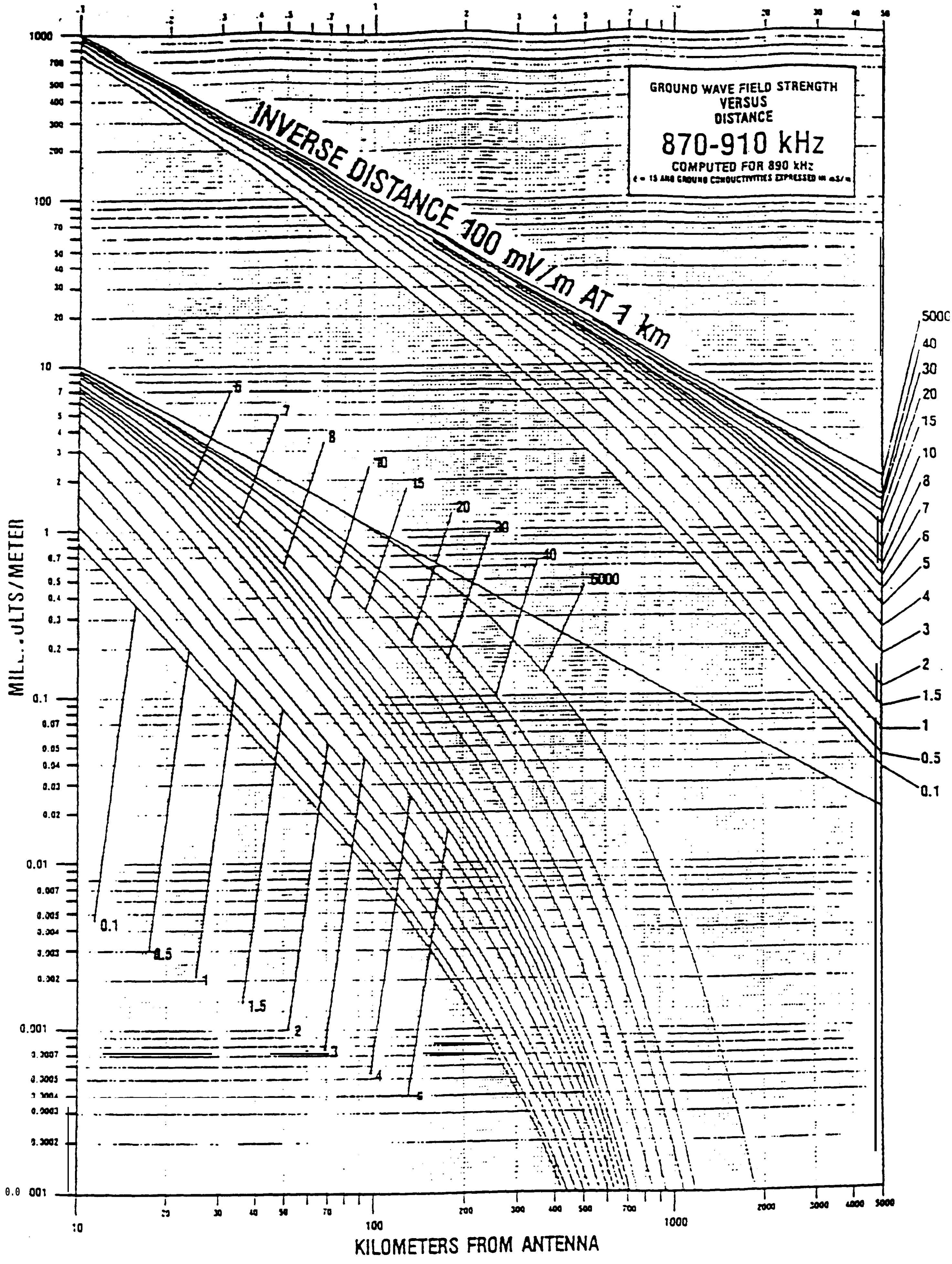
KILOMETERS FROM ANTENNA
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
770-810 kHz
COMPUTED FOR 790 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH 8

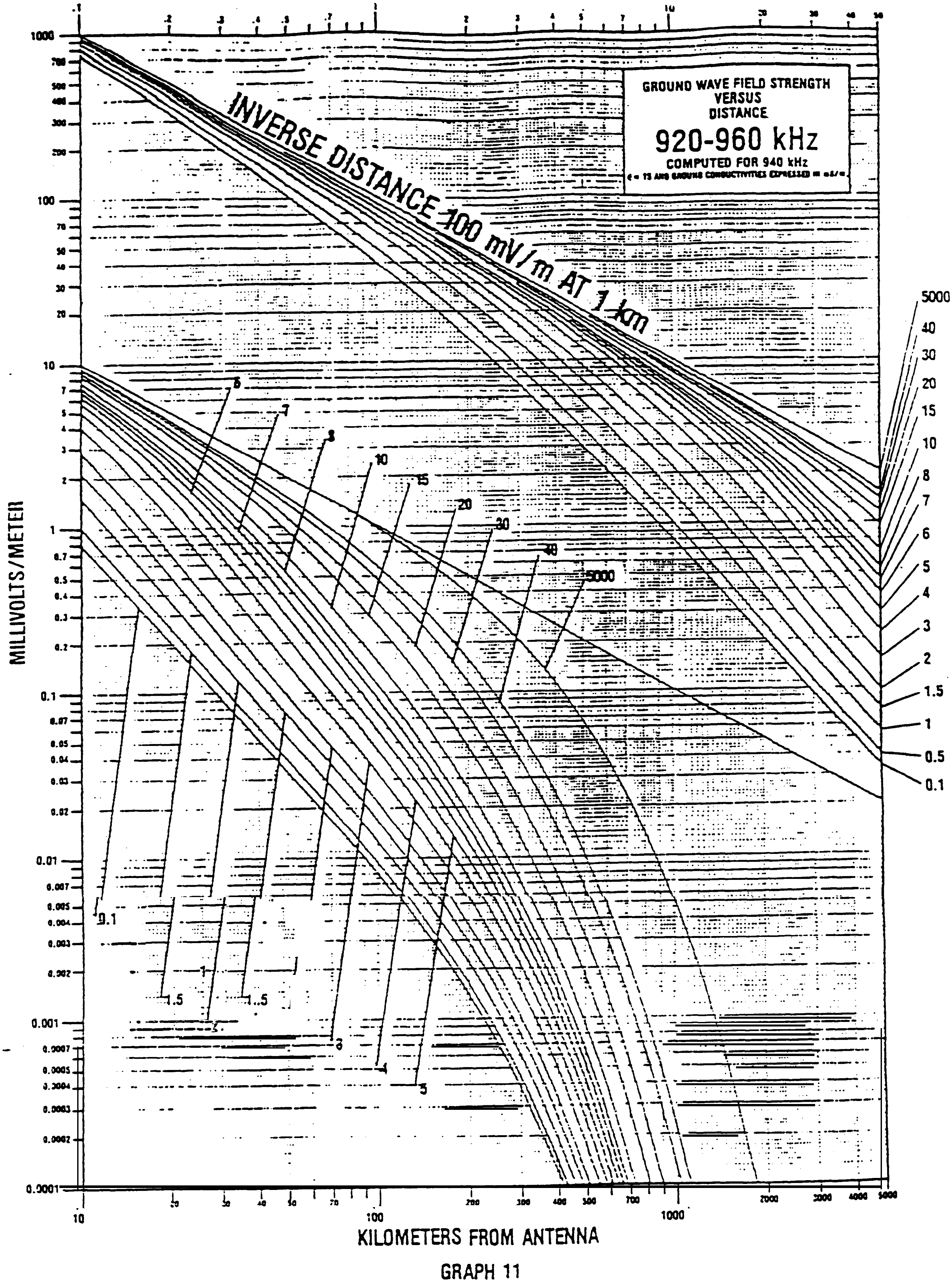


KILOMETERS FROM ANTENNA

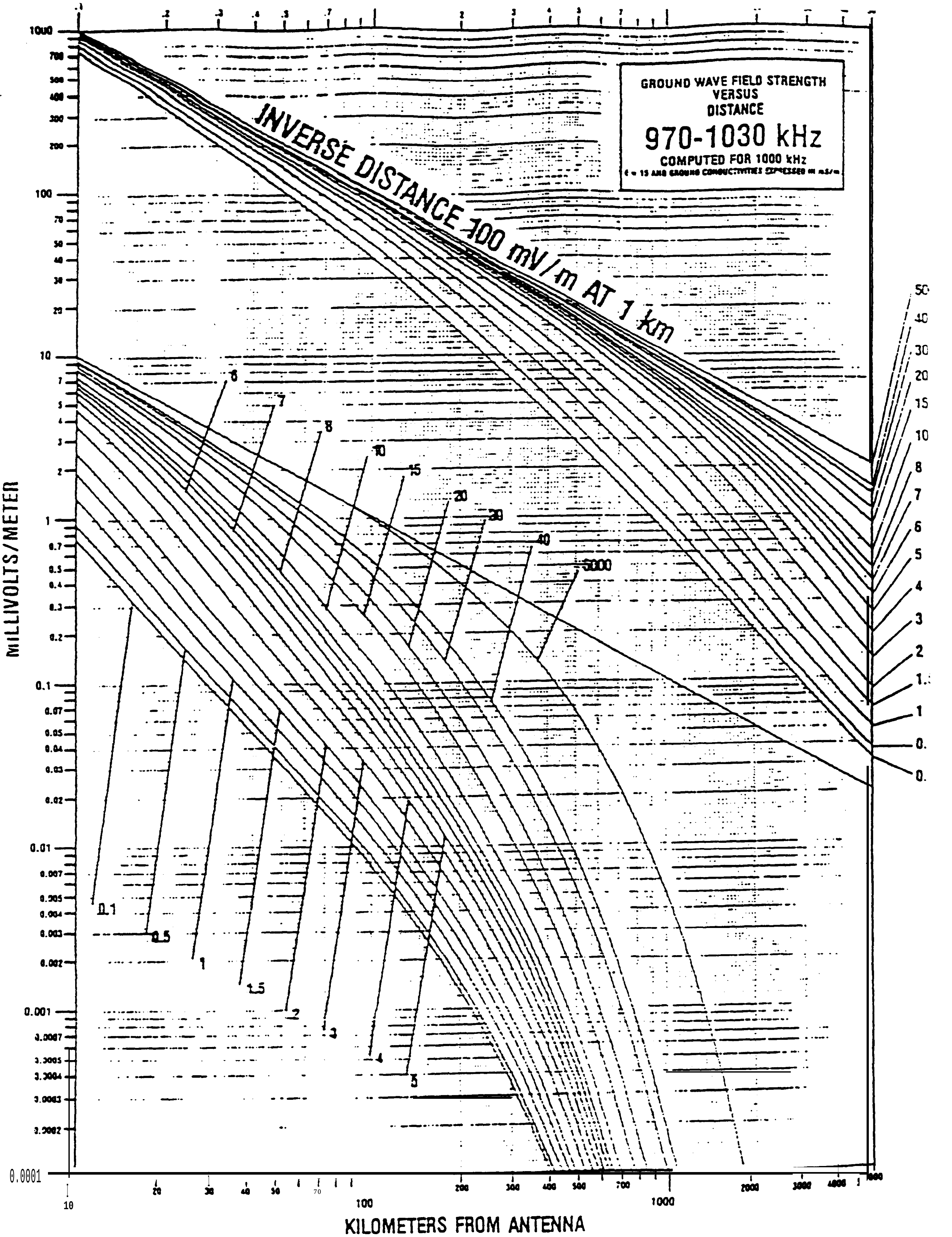
GRAPH9


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
870-910 kHz
COMPUTED FOR 890 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
KILOMETERS FROM ANTENNA
MILL...OLTS/METER

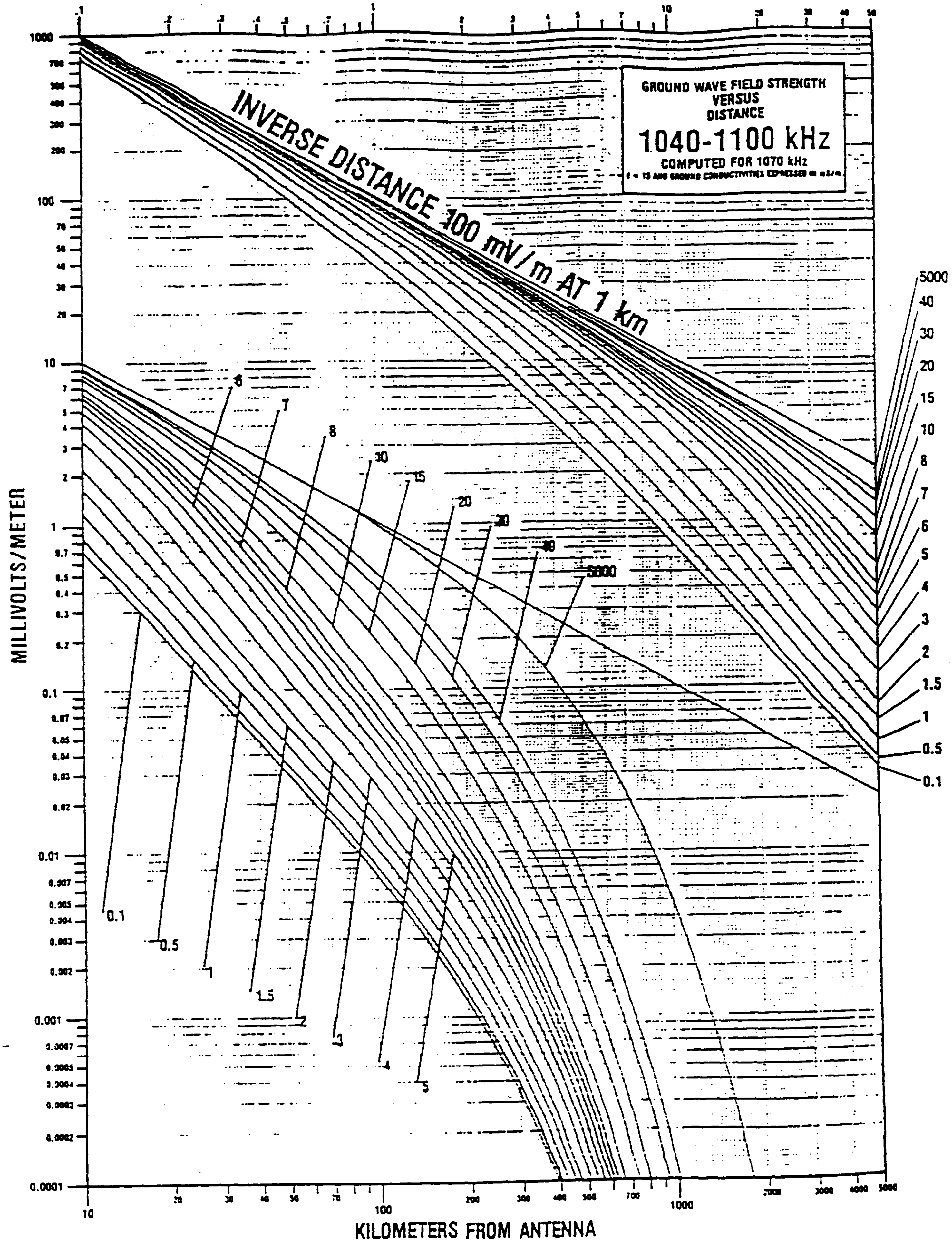
GRAPH 10


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
920-960 kHz
COMPUTED FOR 940 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA
1000
100
10
1
0.1
0.01
0.001
0.0001
10
100
1000
5000
40
30
20
15
10
8
7
6
5
4
3
2
1.5
1
0.5
0.1

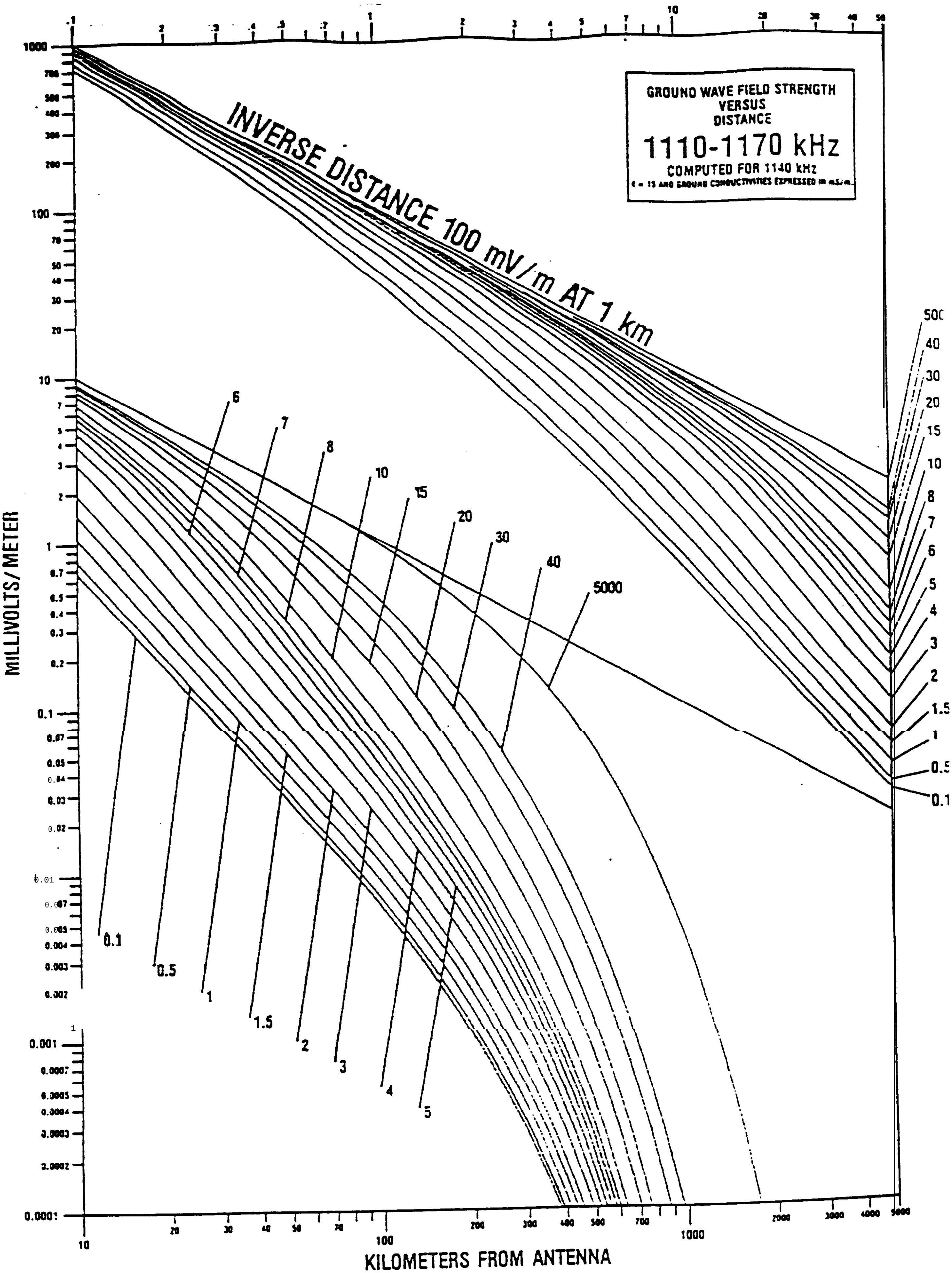
GRAPH 11


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
970-1030 kHz
COMPUTED FOR 1000 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA
10
100
1000

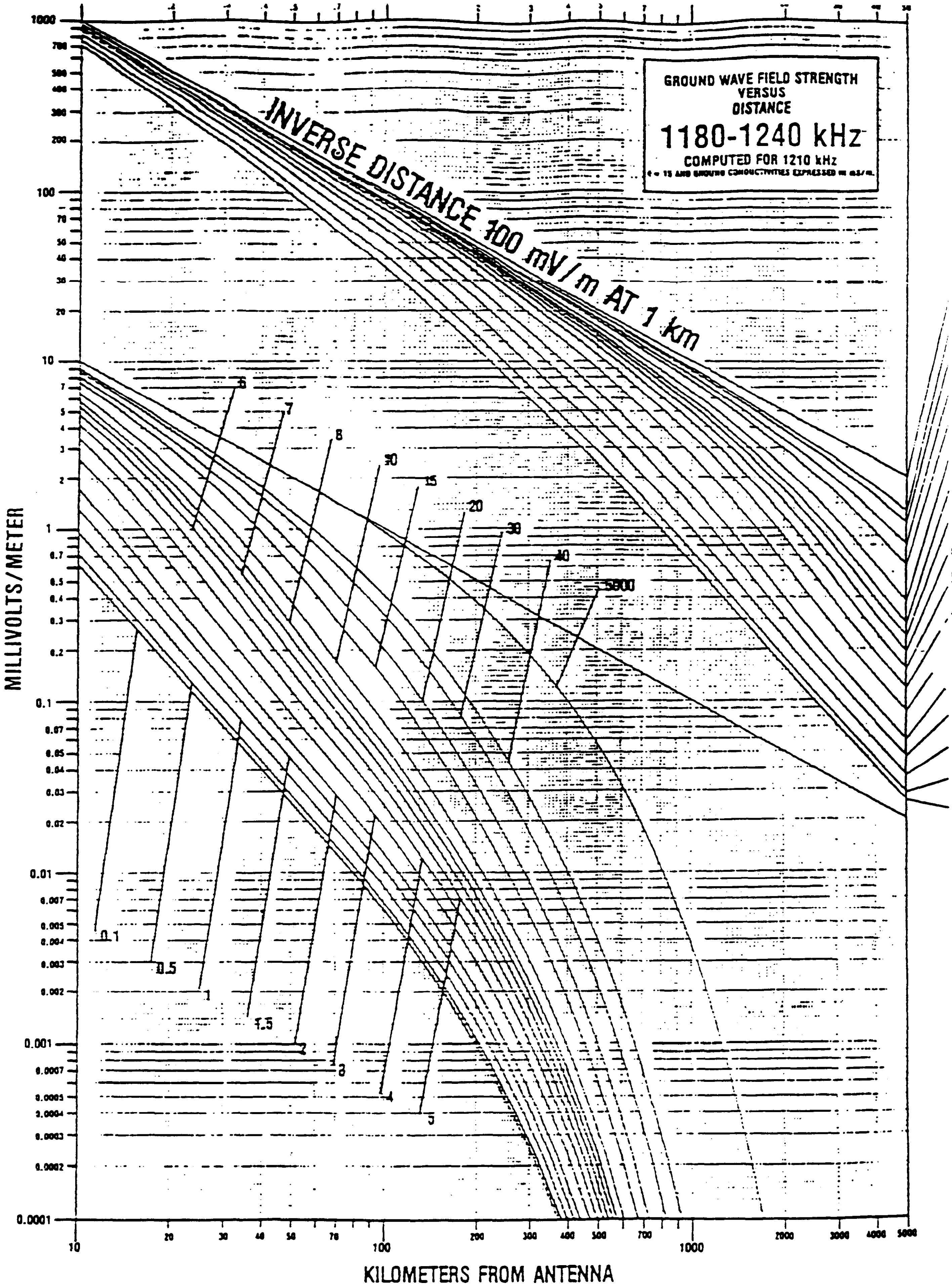
GRAPH 12


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1040-1100 kHz
COMPUTED FOR 1070 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA
5000
40
30
20
15
10
8
7
6
5
4
3
2
1.5
1
0.5
0.1

GRAPH 13

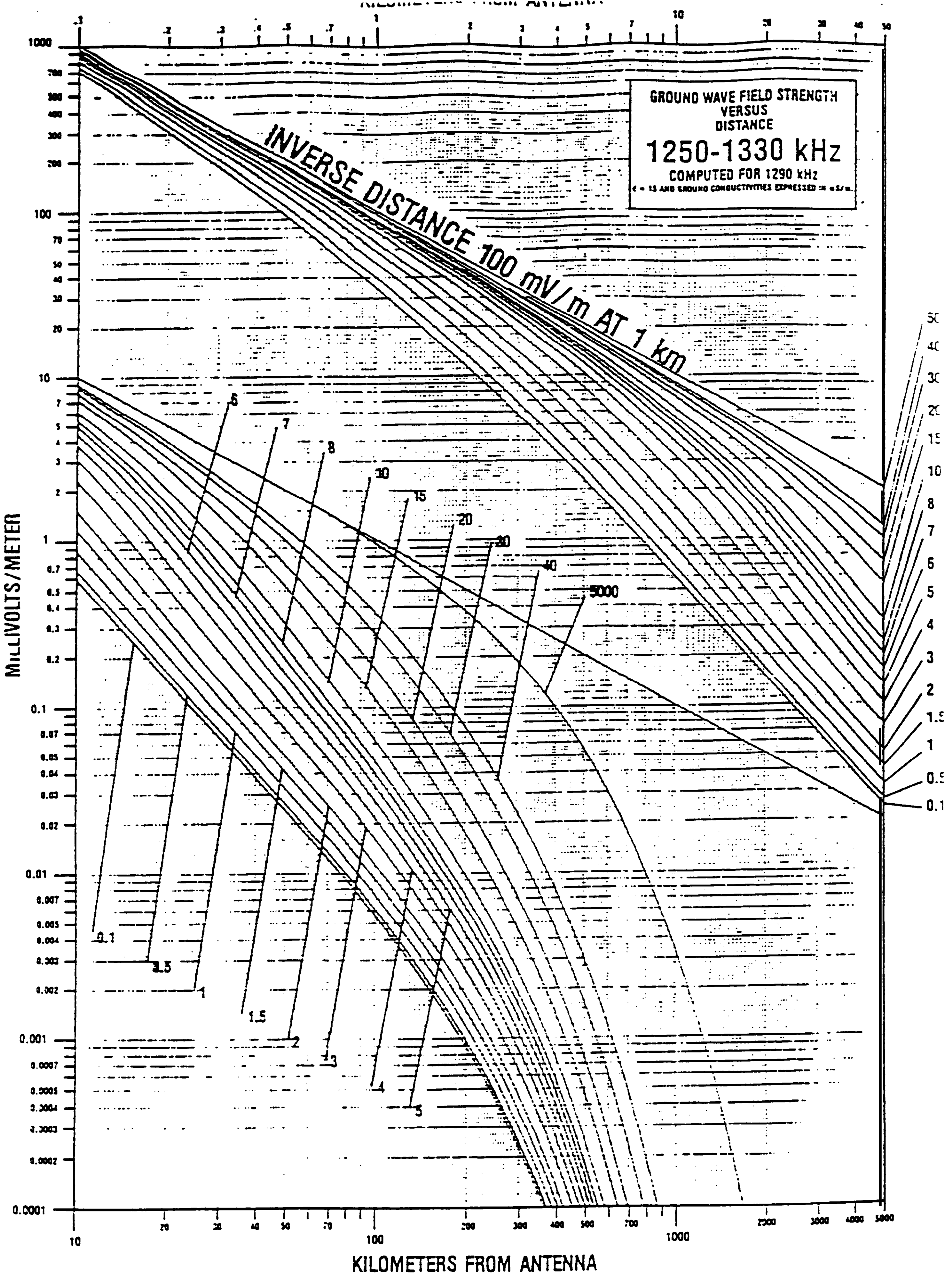

GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1110-1170 kHz
COMPUTED FOR 1140 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH 14



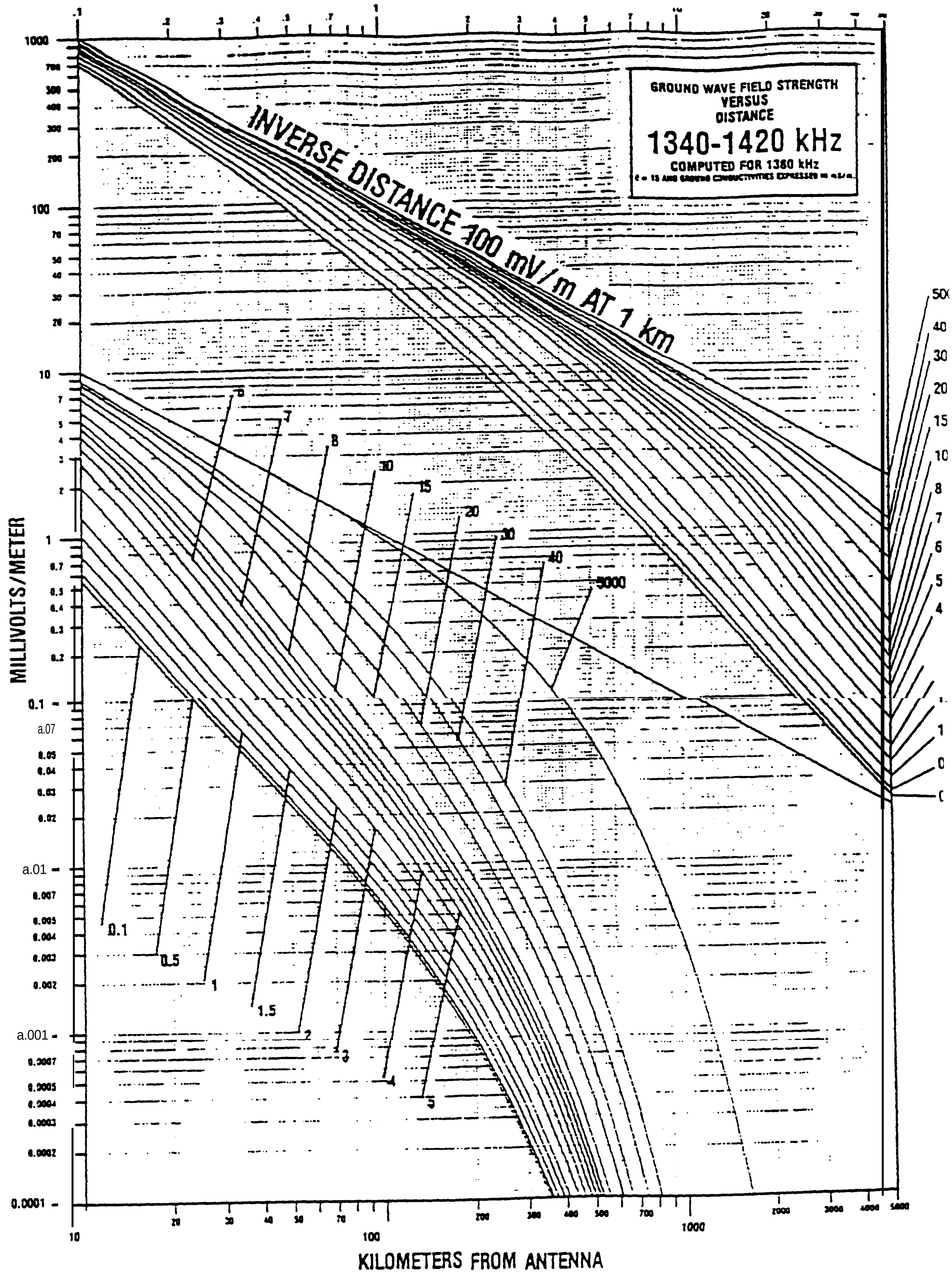
GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1180-1240 kHz
COMPUTED FOR 1210 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH 15

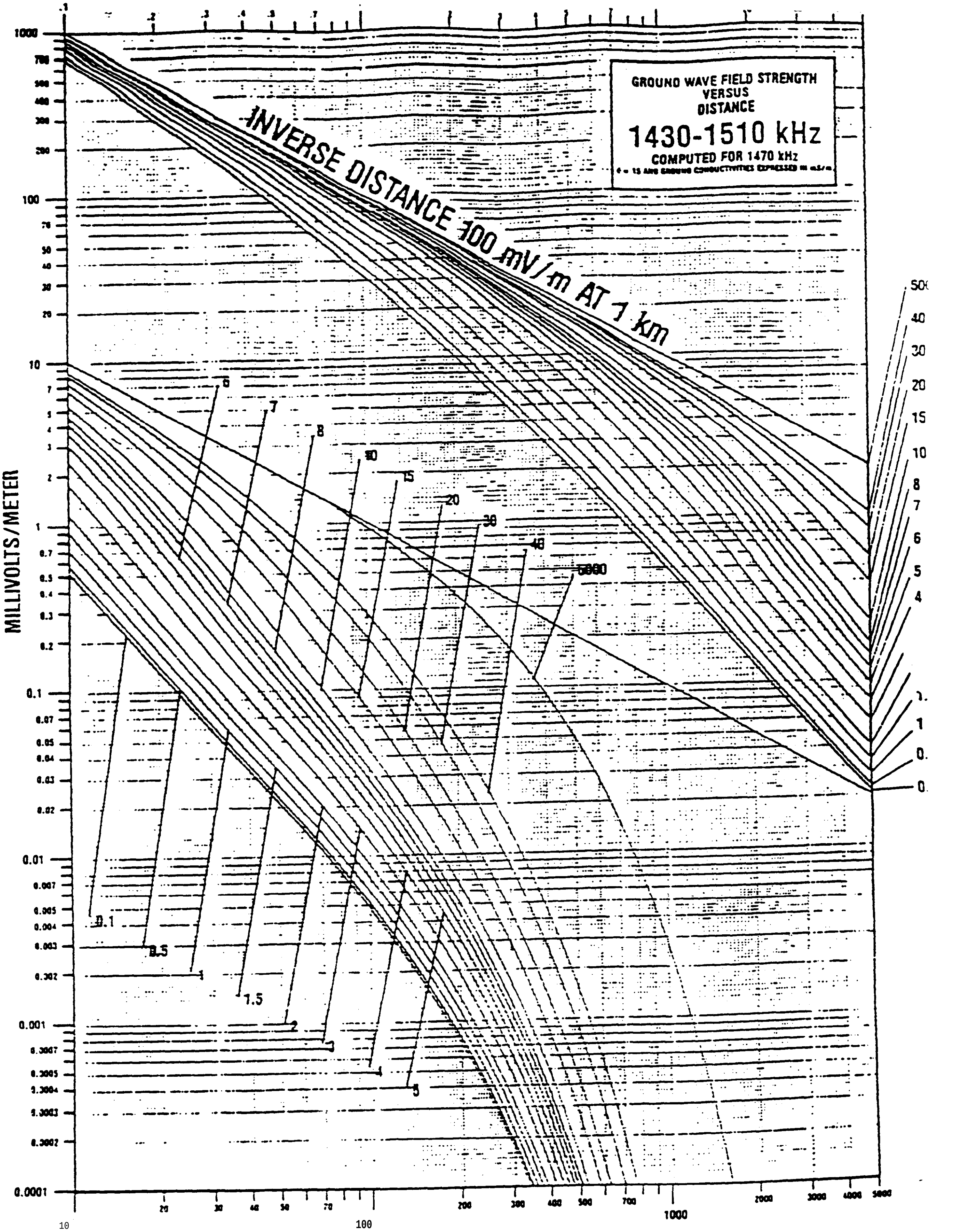


GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1250-1330 kHz
COMPUTED FOR 1290 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH 16

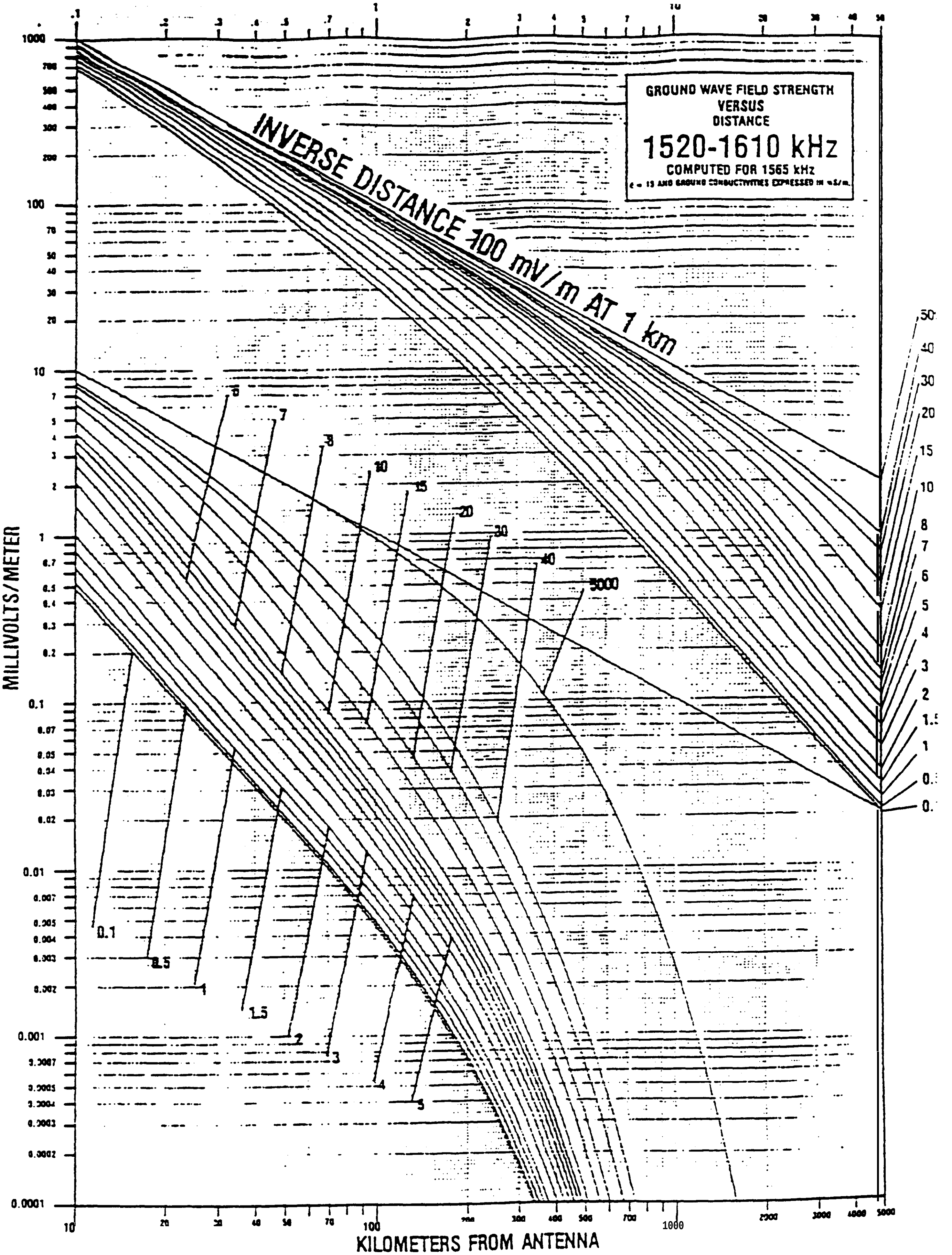

GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1340-1420 kHz
COMPUTED FOR 1380 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH 17



KILOMETERS FROM ANTENNA

GRAPH 18



GROUND WAVE FIELD STRENGTH
VERSUS
DISTANCE
1520-1610 kHz
COMPUTED FOR 1565 kHz
INVERSE DISTANCE 100 mV/m AT 1 km
MILLIVOLTS/METER
KILOMETERS FROM ANTENNA

GRAPH 19

APPENDIX 3

(to Annex 2)

Calculation of directional antenna patterns

INTRODUCTION

This Appendix describes methods to be employed in calculating the field strength produced by a directional antenna at a given point.

1. General equations

The theoretical directional antenna radiation pattern is calculated by means of the following equation, which sums the field strength from each element (tower) in the array :

$$E_T(\phi,\theta) = \left| K_L \sum_{i=1}^{n} F_i \, f_i(\theta) \, \underline{/\Psi_i + S_i \cos\theta \cos(\phi_i - \phi)} \right| \qquad (1)$$

where :

$$f_i(\theta) = \frac{\cos(G_i \sin\theta) - \cos G_i}{(1 - \cos G_i)\cos\theta} \qquad (2)$$

$E_T(\phi,\theta)$: theoretical inverse distance field strength at one kilometre in mV/m for the given azimuth and elevation;

K_L : multiplying constant in mV/m which determines the pattern size (see paragraph 2.5 below for derivation of K_L);

n : number of elements in the directional array;

i : denotes the ith element in the array;

F_i : ratio of the theoretical field strength due to the ith element in the array relative to the theoretical field strength due to the reference element;

θ : vertical elevation angle, in degrees, measured from the horizontal plane;

$f_i(\theta)$: ratio of vertical to horizontal plane field strength radiated by the ith element at elevation angle θ;

G_i : electrical height of the ith element in degrees ;

S_i : electrical spacing of the ith element from the reference in degrees ;

ϕ_i : orientation of the ith element from the reference element (with respect to True North), in degrees;

ϕ : azimuth (with respect to True North) in degrees;

Ψ_i : electrical phase angle of field strength due to the ith element (with respect to the reference element), in degrees.

Equations (1) and (2) assume that :

- the current distribution in the elements is sinusoidal,
- there are no losses in the elements or in the ground,
- the antenna elements are base-fed, and
- the distance to the computation point is large in relation to the size of the array.

2 Determination of values and constants.

2.1 Determination of the multiplying constant K for an array

The multiplying constant K for the loss-free case may be computed by integrating the power flow over the hemisphere, deriving an r.m.s. field strength and comparing the result with the case where the power is radiated uniformly in all directions over the hemisphere.

Thus :

$$K = \frac{E_s \cdot \sqrt{P}}{e_h} \quad \text{mV/m}$$

where :

K : no-loss multiplying constant (mV/m at 1 km);

E_s : reference level for uniform radiation over a hemisphere, equal to 244.95 mV/m at 1 km for 1 kW;

P : antenna input power (kW);

e_h : root mean square radiation pattern over the hemisphere which may be obtained by integrating e(θ) at each elevation angle over the hemisphere. The integration can be made using the trapezoidal method of approximation, as follows :

$$e_h = \left[\frac{\pi\Delta}{180}\left\{\tfrac{1}{2}\left[e(0)\right]^2 + \sum_{m=1}^{N}\left[e(m\Delta)\right]^2 \cos m\Delta\right\}\right]^{\frac{1}{2}} \qquad (3)$$

where :

Δ : interval, in degrees, between equally-spaced sampling points at different elevation angles θ;

m : an integer from 1 to N, which gives the elevation angle θ in degrees when multiplied by Δ, i.e. $\theta = m\Delta$;

N : one less than the number of intervals ($N = \frac{90}{\Delta} - 1$);

$e(\theta)$: root mean square radiation pattern given by equation (1) with K equal to 1 at the specified elevation angle θ (the value of θ is 0 in the first term of equation 3 and mΔ in the second term); e(θ) is computed using equation 4.

$$e(\theta) = \left[\sum_{i=1}^{n}\sum_{j=1}^{n} F_i f_i(\theta) F_j f_j(\theta) \cos \psi_{ij} J_0(S_{ij} \cos \theta)\right]^{\frac{1}{2}} \qquad (4)$$

where:

- i: denotes the ith element:
- j: denotes the jth element:
- n: number of elements in the array:
- ψ_{ij}: difference in phase angles of the field strengths from the ith and jth elements in the array:
- S_{ij}: angular spacing between the ith and jth elements in the array:
- $J_0(S_{ij} \cos \theta)$: the Bessel function of the first kind and zero order of the apparent spacing between the ith and jth elements. In equation (4), S_{ij} is in radians. However when special tables of Bessel functions giving the argument in degrees are used, the values of S_{ij} should then be in degrees.

2.2 Relationship between field strength and antenna current

The field strength resulting from a current *flowing* in a vertical antenna clement is:

$$E = \frac{R_r I\,[\cos (G \sin \theta) - \cos G\,]}{2\pi r \cos \theta} \times 10^3 \qquad \text{mV/m} \qquad (5)$$

where:

- E: field strength in mV/m:
- R_r: resistivity of free space ($R_r = 120\pi$ ohms):
- I: current *at* the current maximum. in amperes [1]:
- G: electrical height of the element, in degrees:
- r: distinct from the antenna, in metres:
- θ: venial elevation angle, in degrees.

At one kilometre and in the horizontal plane ($\theta = 0°$):

$$E = \frac{120\pi I(1 - \cos G) \times 10^3}{2\pi(1000)} \qquad \text{mV/m} \qquad (6)$$

hence:

$$E = 60\, I(1 - \cos G) \qquad \text{mV/m} \qquad (7)$$

[1] I is the current at the maximum of the sinusoidal distribution. If the electrical height of the clement is less than 90°, the base current will be less than I.

2.3 **Determination of no-loss current at Current maximum**

For a tower of uniform cross-section or for a similar type of directional array element, the no-loss current at the current maximum is:

$$I_i = \frac{KF_i}{60\,(1 - \cos G_i)} \qquad (8)$$

Where:

I_i : current at current maximum in amperes in the ith element:

K : no-loss multiplying constant computed as shown in paragraph 2.1 above;

The base current is given by $I_i \sin G_i$.

2.4 **Array power loss**

Power losses in a directional antenna system are of various types, including ground losses, antenna coupling losses, etc. The loss resistance for the array may be assumed to be inserted at the current maximum to allow for all losses. The power loss is:

$$P_L = \frac{1}{1000} \sum_{i=1}^{n} R_i I_i^2 \qquad (9)$$

Where:

P_L : total power loss in kilowatts;

R_i : assumed loss resistance in ohms (one ohm, unless otherwise indicated) for the ith tower*;

I_i : current at current maximum (or base current if the element is less than 90 degrees in electrical height) for the ith tower.

---

* The loss resistance shall in no way exceed a value such that the value of K_L (see paragraph 2.5) differs by more than ten percent from that calculated for a resistance of one ohm.

2.5 Determination of a corrected multiplying con...

To allow for power loss in the antenna system, the multiplying constant K can be modified, as follows:

$$K_L = K \left(\frac{P}{P + P_L} \right)^{1/2} \qquad (10)$$

where:

K_L : multiplying constant after correction for the assumed loss resistances

K : no-loss multiplying constant canputed in paragraph 2.1 above;

P : array input power (kw)

P_L : total paver loss (kw)

2.6 r.m.s. value of radiation to be notified for directional antennas

The radiation (E_r) for directional antennas is determined as follows:

$$E_r = K_L \; e(\theta) \quad \text{mV/m at 1 kilometre}$$

2.7 Determination of expanded pattern values

The expanded pattern is determined as follows:

$$E_{EXP}(\phi,\theta) = 1.05 \left\{ \left[E_T(\phi,\theta) \right]^2 + Q^2 \right\}^{1/2} \qquad (11)$$

where:

$E_{EXP}(\phi,\theta)$ = expanded pattern radiation at a particular azimuth, ϕ and a particular elevation angle, θ;

$E_T(\phi,\theta)$ = theoretical pattern radiation at a particular azimuth, ϕ, and a particular elevation angle, θ;

Q = quadrature factor, canputed as :

$$Q = Q_o \; g(\theta)$$

where

Q_o is the Q on the horizontal plane, and is normally the greatest of the following three quantities:

10.0 ; $10\sqrt{P}$ or $0.25 K_L \left[\sum_{i=1}^{n} F_i^2 \right]^{1/2}$

Annex 2/p.

If the electrical height of the shortest tower is less than or equal to 180 degrees, then: $g(\theta) = f(\theta)$ for the shortes tower.

If the electrical height of the shortest tower is greater than 180 degrees, then:

$$g(\theta) = \frac{\sqrt{[f(\theta)]^2 + 0.0625}}{1.030776}$$

where f(4) for the shortesttower is used.

Note: In comparing the electrical height6 of the antenna towers to determine the ehortest tower, the total apparent height (as determined by current distribution) is used for top-loaded and sectionalized towers.

2.0 <u>Determination of augmented (modified expanded) pattern values</u>

The purpose of the augmented (modified expanded) pattern 16 to put one or more "patches" on an expanded pattern. Each 'patch" 16 referred to a6 an "augmentation". The augmentation may be positive (resulting is more radiation than that of the expanded pattern) or negative (resulting in less radiation that that of the expanded pattern). In no case shall the augmentation be 60 negative that the augmented (modified expanded) pattern radiation is below the theoretical radiation pattern.

Spans of augmentation may overlap. That is, an augmentation may itself be augmented by a subsequent augmentation. To ensure that the calculations are properly made, the augmentations are handled In increasing order of central azimuth of augmentation, starting at True North. If several augmentations have the same central azimuth, then they are considered in order of decreasing span (i.e. the one with the largest span is handled first). If more than one augmentation has the same central azimuth and the same span, then they are considered in ascending order of their effect.

$$E_{MOD}(\varphi,\theta) = \left\{ [E_{EXP}(\varphi,\theta)]^2 + g^2(\theta) \sum_{i=1}^{a} A_i \cos^2 (180\, \Delta_i / \alpha_i) \right\}^{\frac{1}{2}} \quad (12)$$

where:

$E_{MOD}(\varphi,\theta)$: augmented (modified expanded) pattern radiation at a particular azimuth, φ, and a particular elevation angle, θ;

$E_{EXP}(\varphi,\theta)$: expanded pattern radiation at a particular azimuth, φ, and a particular elevation angle, θ;

$g(\theta)$: same parameter as described for the expanded pattern (see paragraph 2.7);

a: number of augmentations;

Δ_i: difference between the azimuth at which the radiation is desired φ, and the central azimuth of augmentation of the ith augmentation. It will be noted that Δ_i must be less than or equal to one-half of α_i;

α_i: total span of the ith augmentation;

A_i: is the value of the augmentation given by the expression:

$$A_i = [E_{MOD}(\varphi_i,\theta)]^2 - [E_{INT}(\varphi_i,\theta)]^2 \quad (13)$$

where:

φ_i: central azimuth of the ith augmentation;

$E_{MOD}(\varphi_i,\theta)$: augmented (modified expanded) horizontal plane radiation at the central azimuth of the *ith* augmentation, after applying the ith augmentation, but before applying subsequent augmentations;

$E_{INT}(\varphi_i,\theta)$: an interim value of radiation in the horizontal plane at the central azimuth of the ith augmentation. The interim value is the radiation obtained from applying previous augmentations (if any) to the expanded pattern, but before applying the ith augmentation.

Equations for the calculation of the normalized vertical radiation from top-loaded and typical sectionalized antennas

Basically, the equation is:

$$f(\theta) = \frac{E_\theta}{E_0}$$

where:

E_θ : radiation at a desired elevation angle, θ;

E_0 : radiation in the horizontal plane.

Specific equations for top-loaded and typical sectionalized antennas arc given below.

These equations use one or more of four variables A, B, C and D, the values of which are given in columns 6, 7, 8 and 9 respectively, of Pan II-C of Annex I

1. *Top-loaded antenna* (when column 12 of Part II-A of Annex 1 is 1)

$$f(\theta) = \frac{\cos B \cos (A \sin \theta) - \sin \theta \sin B \sin (A \sin \theta) - \cos (A + B)}{\cos \theta [\cos B - \cos (A + B)]}$$

where:

A : electrical height of the antenna tower:

B : difference between the apparent electrical height (based on current distribution) and the actual height (A):

θ : the elevation angle with respect co the horizontal plane.

Note : When *B* is zero (i.e., when there is no top-loading), the equation reduces to that of a simple vertical antenna.

2. *Sectionalized tower* (when column 12 of Part II-, Section 1)

$$f\theta = \frac{[\cos B \cos (A \sin \theta) - \cos (A + B)] \sin (C + D - A) + \sin B[\cos D \cos (C \sin \theta) - \sin \theta \sin D \sin (C \sin \theta) - \cos (C + D - A) \cos (A \sin \theta)]}{\cos \theta ([\cos B - \cos (A + B)] \sin (C + D - A) + \sin B[\cos D - \cos (C + D - A)])}$$

where:

A : actual height of the lower section:

B: difference between the apparent electrical height (based on current distribution) of the lower section and the actual height of the lower section (A):

C : actual rota! height of the antenna:

D : difference between the apparent electrical height (based on current distribution) of the total tower and the actual height of the coca! tower (C):

θ : vertical angle with respect co the horizontal plane.

3. The Administration proposing to use other types of antenna should furnish details or' their characteristics together vith a radiation. pattern.

APPENDIX 5
(to Annex 2)

Additional technical information

This Appendix contains additional technical material and examples of methods of calculation which may be of assistance to Administrations.

1. Examples of field strength calculations for homogeneous paths (see paragraph 2.3.1 of Annex 2)

a) Determination of the electrical field strength at a given distance from a station

Consider a station with a power of 5 kW at 1240 kHz. The antenna has a characteristic field strength for 1 kW of 306 mV/m.

The field strength at a distance of 40 km is to be determined for a conductivity of 4 mS/m throughout the path.

From graph 15 (1180 - 1240 kHz) we obtain a field strength of 188 µV/m from the curve corresponding to 4 mS/m.

Therefore

$$E = E_o \frac{E_c \sqrt{P}}{100} = \frac{(188)(306)\sqrt{5}}{100} = 1286 \ \mu V/m$$

b) Determination of the distance at which a given field strength is obtained

On the basis of the data from the preceding example, at what distance can a field strength of 500 µV/m be obtained?

Since the antenna involved has a characteristic field strength for 1 kW of 306 mV/m and the station power is 5 kW, i.e., conditions different, from those of graphs 1 to 19 (100 mV/m at 1 km), the field strength value must be determined before referring to the corresponding figure.

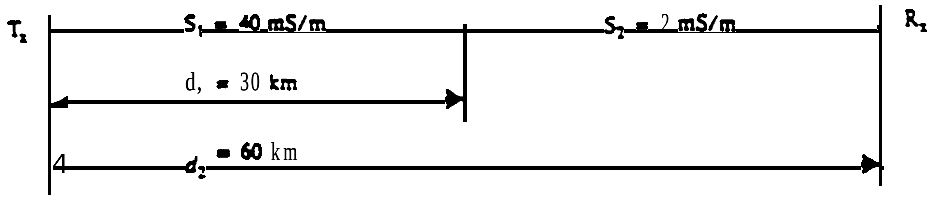
The calculated value is

$$E_o = \frac{100E}{E_c\sqrt{P}} = \frac{(100)(500)}{(306)\sqrt{5}} = 73.1 \ \mu V/m$$

Taking the corresponding curve at 4 mS/m in graph 15, we arrive at 73.1 µV/m at 62 km.

2. Example of a field strength calculation for non-homogeneous paths (see paragraph 2.3.2 of Annex 2).

Consider the following path:



a) For a 25 kW station at 1000 kHz and an antenna with a characteristic field strength of 100 mV/m, what field strength is obtained at 60 km?

In graph 12 we obtain on the 40 mS/m curve a field strength of 2.8 mV/m at the point of discontinuity (30 km).

We obtain the same field strength at 9.5 km (d = 9.5 km) on the 2 mS/m curve.

The equivalent distance for d_2 = 60 km, is d + $(d_2 - d_1)$ = 9.5 + (60-30) = 39.5 km.

From the 2 mS/m curve, we obtain a field of 141 μV/m at 39.5 km.

Lastly, we calculate the field strength:

$$E = (E_o)\frac{(E_c)}{100}\sqrt{P} = (141)\frac{(100)}{100}\sqrt{25} = 705\ \mu V/m$$

b) Taking the preceding example, at what distance will the 500 μV/m contour be?

First we determine the field strength:

$$E_o = \frac{100\,E}{E_c\sqrt{P}} = \frac{(100)}{(100)\sqrt{25}}(500) = 100\ \mu V/m$$

Following the 40 mS/m curve of graph 12, we note chat at 30 km the field strength is 2.8 mV/m. This value is higher than the one we seek (0.1 mV/m) and therefore ve shall have a distance greater than 30 km.

The equivalent distance for a 2 mS/m conductivity is 9.5 km.

Following the 2 mS/m curve, we find the 100 μV/m contour at 66 km giving us the equivalent distance. The true distance is 46 + (30 - 9.5) = 66.5 km.

3. Path parameters

If a_T and b_T respectively are the latitude and longitude of the transmitting terminal, and a_R and b_R are those of the receiving terminal, the parameters of the short great-circle path may be calculated. The North and East coordinates are considered positive and the South and West coordinates negative.

3.1 Great-circle path distance

$$d = 111.18 \times d^\circ \quad \text{km}$$

where:

$$d^\circ = \arc\cos [\sin a_T \sin a_R + \cos a_T \cos a_R \cos (b_R - b_T)]$$

3.2 Azimuth of the path from either terminal

For the transmitting terminal, for example,

$$\alpha_T = \arc\cos \left[\frac{\sin a_R - \cos d^\circ \sin a_T}{\sin d^\circ \cos a_T} \right]$$

determined such that 0° < α <180°. The geographical bearing in degrees East of North to the receiving terminal is α_T if $\sin (b_R - b_T) \geq 0$ or is $(360^\circ - \alpha_T)$ if $\sin (b_R - b_T) < 0$. The same equation, with the latitudes reversed, is used for the receiving terminal.

3.3 Coordinates of a point on a given great-circle path at a distance, "d", km, from a transmitter:

$$a = \arc\sin [\sin a_T \cos d^\circ + \cos a_T \sin d^\circ \cos \alpha_T]$$

$$b = b_T + k$$

where:

$$d^\circ = \frac{d}{111.18} \quad \text{km}$$

$$k = \arc\cos \left(\frac{\cos d^\circ - \sin a_T \sin a}{\cos a_T \cos a} \right), \text{ if } \sin (b_R - b_T) \geq 0$$

$$k = - \arc\cos \left(\frac{\cos d^\circ - \sin a_T \sin a}{\cos a_T \cos a} \right), \text{ if } \sin (b_R - b_T) < 0$$

Note that the transmitting location was used in these equations for a and b, but alternatively the receiving location may be used.

4. Example illustrating the application of the 50% exclusion principle (see Section 4.7.2).

Interfering Signal (1)	Interfering Field Strength (μV/m)	Protection Ratio	Individual Interference Contribution (μV/m)	Calculated RSS (μV/m)	Remarks
A	140	20 : 1	2800		
C	130	20 : 1	2600	3821	$\sqrt{A^2 + C^2}$
B	125	20 : 1	2500	4566	Individual contribution greater than 50% of $\sqrt{A^2 + C^2}$ therefore, $\sqrt{A^2 + C^2 + B^2}$
D	65	20 : 1	1300		Individual contribution less than 50% of $\sqrt{A^2 + C^2 + B^2}$ therefore, disregard
E	52	20 : 1	1040		idem

(1) In descending order of individual interference contribution.

5. The following matrix shows the conditions of application of the protection criteria as indicated in Sections 4. 9.2 and 4. 9.3

Section number	4. 9.2.1	4. 9.2.2	4. 9.2.3	4. 9.3	4. 9.3	4. 9.3
Channel relationship	co-channel	co-channel	co-channel	adjacent channel	adjacent channel	adjacent channel
Time	daytime	nighttime	nighttime	daytime	nighttime	day and night
Class of protected station	A, B, C	A IC criteria	B, C	A	A	B, C
Protected from	groundwave	skywave	skywave	groundwave	groundwave	groundwave
Protected contour	groundwave E_{nom}	E_{nom} 1)	groundwave contour corresponding to the greater of E_{nom} or E_u	groundwave E_{nom}	groundwave E_{nom}	groundwave contour corresponding to value of daytime E_{nom}
Value to be protected	E_{nom} 2)	E_{nom} 2)	greater of E_{nom} or E_u	Adjacent channel daytime groundwave E_{nom} 2)	nighttime groundwave E_{nom} 2)	daytime groundwave E_{nom}
How E_u is calculated	Not applicable	Not applicable	4.7	Not applicable	Not applicable	Not applicable
Where E_u is calculated	Not applicable	Not applicable	Station site	Not applicable	Not applicable	Not applicable
How protection is applied	E_{nom} / Protection ratio applied separately	E_{nom} / Protection ratio applied separately	Using 4.7 the maximum permissible field strength at the station site is not to be exceeded at the protected contour	E_{nom} / Protection ratio applied separately	E_{nom} / Protection ratio applied separately	E_{nom} / Protection ratio applied separately

Notes: 1) groundwave or 50% skywave contour, whichever is farther from the site.

2) For Class A stations notified after the date of signing of this Agreement, the value of the protected contour corresponds to the usable field strength, E_u

APPENDIX 6

(to Annex 2)

Method Used for Calculating Sectionalized Antenna Radiation Characteristics

(The columns referred to below are those of Part II, Section 1 Of Annex 1)

1. Sectionalized tower, when the value entered in column 12 is 3.

$$f(\theta) = \frac{2 \cos (PO \sin 8) \cos [(A + 90) \sin \theta] + \cos (A \sin \theta) - \cos A}{\cos \theta (3 - \cos A)}$$

where:

A : electrical height of bottom section:

θ : elevation angle.

2. Sectionalized tower, when the value entered in column 12 is 4.

$$f(\theta) = \frac{\cos (A \sin \theta) [\cos (A \sin \theta) - \cos A]}{\cos \theta (1 - \cos A)}$$

where:

A: electrical height of bottom section:

θ : elevation angle.

3. Sectionalized tower. when the value entered in column 12 is 5.

$$f(\theta) = \frac{\dfrac{\cos (A \sin \theta) - \cos A}{\cos 8} + \dfrac{CD \cos \theta \{\cos (A \sin \theta) + \{\cos [(A + B) \sin \theta]\}}{C^2 - \sin^2 \theta}}{1 + \dfrac{2D}{C} - \cos A}$$

where:

A : electrical height of bottom section:

B : electrical height of top section:

C: current distribution factor:

D : ratio of maximum current in top section to maximum current in bottom section:

θ : elevation angle.

4. **Sectionalized tower, when the value entered in column 12 is 6.**

$$f(\theta) = \frac{\cos(A \sin\theta) - \cos(A - B)\cos(B \sin\theta) + \sin\theta \sin(A - B)\sin(B \sin\theta)}{\cos\theta\,[1 - \cos(A - B)]}$$

where:

- A : total electrical height of tower:
- B : electrical height of lower section:
- θ : elevation angle.

5. Sectionalized tower, when the value entered in column 12 is 7.

$$f(\theta) = \frac{C\,[\cos(A \sin\theta) - \cos A] + \cos(B \sin\theta) - [\cos(B - A)\cos(A \sin 6) + \sin(B - A)\sin\theta \sin(A \sin\theta)]}{C\,[1 - \cos A] + \cos\theta\,[1 - \cos(B - A)]}$$

where:

- A : electrical height of lower section:
- B : total electrical height of antenna:
- C : ratio of the loop currents in the two sections;
- θ : elevation angle.

Sectionalized tower, when the value entered in column 12 is 8.

If $\theta = 0$: $f(\theta) = 1$

If $\theta > 0$: $$f(\theta) = \frac{\sqrt{\text{real component}^2 + \text{imaginary component}^2}}{C}$$

The real component is equal to:

$$\left[\frac{2.28\cos\theta}{1.14^2 - \sin^2\theta}\right]\{-\cos[1.14(B - A)] + 2\cos(1.14B)\cos(A\sin\theta) - \cos((A + B)\sin\theta)\}$$

The imaginary component is equal to:

$$D\cos\theta\left\{\frac{\sin[(A + B)\sin\theta]}{\sin\theta} + \frac{1.14}{1.14^2 - \sin^2\theta}\left[\sin[1.14(B - A)] - 2\sin(1.14B)\cos(A\sin\theta) + \frac{\sin\theta\ \sin((A + B)\sin\theta)}{1.14}\right]\right\}$$

where:

- A : electrical height of lower section of tower:
- B : electrical height of upper section of tower:
- C : scaling factor so that $f(\theta)$ is 1 in horizontal plane:
- D : absolute ratio of the real component of current to the imaginary component of current at the point of maximum amplitude;
- θ : elevation angle.

Note: 1.14 is the ratio of velocity of light to propagation velocity along radiator.

7. Sectionalized tower, when the value entered in column 12 is 9.

$$f(\theta) = \frac{\cos(A \sin\theta)\,[\cos(B \sin\theta) + 2\cos(A \sin\theta)]}{3\cos\theta}$$

where:

A : electrical height of centrt of bottom dipole:

B : electrical height of centre of top dipole:

θ : elevation angle.

APPENDIX 7

(To Annex 2)

EXTENDED HOURS OF OPERATION

This Appendix contains special technical and operational criteria that apply to stations authorized for extended hours of operation pursuant to Article VI of this Agreement. Additionally; methods used for conducting interference calculations regarding such operations are described and exemplified.

Special criteria

A station authorized for extended hours of operation shall not receive protection for that operation.

During extended hours of operation, a station shall use its daytime or nighttime facilities with radiation adjusted downward as necessary to meet the protection requirements of Annex 2.

During extended hours of operation, a station shall provide full protection to each duly notified and accepted co-channel nighttime station in the other country in accordance with Annex 2 and this appendix. This protection is to be provided without regard to when the notification is made. Hence, it may be necessary to further adjust the operation of an extended hours station as a result of subsequent notifications.

Permissible levels of radiation from stations engaging in extended hours of operation may be determined by application of diurnal factors.

Diurnal factors are calculated from the formulas contained in Section 3.5 of Annex 2, and are represented graphically in Figures 5A and 5B of Annex 2.

Power radiated during extended hours of operation shall not exceed the highest power that provides the required protection and, in any event, shall not exceed 500 watts.

BASIC PROCEDURE

The following basic procedure and illustration describe the application of the diurnal curves vhen calculating protection required pursuant to Section 6.9.2.3 of Annex 2 for a class B station from a daytime-only station operating during the post-sunset period. A similar procedure may be used for the pre-sunrise period. If the protected station is a class A station, a similar approach for applying diurnal factors 16 applied except that protection will be determined in accordance with Section 4.9.2.2 of Annex 2.

1. Determine the nighttime RSS limitation of the co-channel nighttime station6 vhlch may be affected by the proposed extended hours operation of the subject station. The individual limits vhlch determine the RSS limitations of these nighttime stations shall also be identified.

2. The permissible interfering 10% skywave limit from the post-sunset operation of the subject station must not exceed either 50% of the existing RSS of the nighttime stations or the lowest individual limits which are part of the RSS determinations. Identify the most restrictive skywave limit vhlch will not increase the RSS of any affected nighttime stations. Based on this most restrictive limit determine the permissible radiation from the subject station vhlch will not exceed this limit tovard the pertinent protected station for full nighttime protection.

3. Use of the diurnal curves will generally increase the permissible radlatlon of the proposed post-sunset operation. In order to apply the diurnal curves, it is necessary to determine the time Of sunset at the mid-point of the path betveen the site of the subject station proposing extended hours operatfon and the site of the nighttime station to be protected. First, add the proposed period of extended operatlon to the local sunset time of the station proposing extended operation, then subtract the sunset time of the path mid-point from the time of the extended operation. With this time difference enter the diurnal factor curves, Ffgure 5B of Annex 2, with the appropriate frequency, and read the diurnal factor, or use the formula contained in Paragraph 3.5 of Annex 2 to calculate the proper diurnal factor. Diurnal factors greater than one shall not be used. The sunrise and sunset times for each month shall be determined as of the 15th day of each month and adjusted to the nearest quarter-hour.

4. Divide the permissible interfering 10% skywave signal toward the protected station on the path selected, by the diurnal factor. This produce6 the permissible signal adjusted by the diurnal factor, vhlch can be radiated during the post-sunset operating period. With the proposed permitted signal increased by the diurnal factor, the proposed post-sunset power may be calculated by direct ratio (using the square root of the power).

5. *In* lieu of making monthly power adjustments, a station may operate year-round with a uniform power not to exceed the pover calculated on the basis of the "worstcase" month.

ILLUSTRATION

Assume that a daytime-only station operates in the state of Chihuahua with the following particulars:

Frequency: 1590 kHz; Power: 1 kW; RMS: 309 mV/m
Coordinates: 28°16'36" N 105°29'16" W
Antenna: Non-directional with height of 90°

It is assumed further that it is desired to operate the station 60 minutes past sunset and it is necessary to determine the maximum power permissible using the daytime antenna system that will provide requisite protection in accordance with Section 4.9 of Annex 2. The first step is to determine the nighttime RSS limits of affected nighttime co-channel stations. In order to demonstrate calculation procedures in accordance with Section 4.9 of Annex 2, assume that there is a nighttime station in the state of Texas.

Assume, for example, that the RSS limitation of the station in Texas is determined to be 4.58 mV/m and that the smallest contributor is 3.1 mV/m. The maximum new contribution may not exceed 50% of the nighttime RSS (which would be 2.29 mV/m) or the smallest contributor that is already in the RSS limitation (in this case 3.1 mV/m). Thus, the maximum new contribution permitted is 2.29 mV/m. A summary of the calculations is as follows:

(a) Coordinates of protected Texas station: 33°31'16" N; 101°46'28" W.

(b) Site-to-site distance between stations: 682.68 km.
(From Appendix 5, Annex 2)

(c) Coordinates of path mid-point: 30°54'43" N; 103°40'21" W.
(From Appendix 5, Annex 2)

(d) Calculated sunset at Chihuahua site for December 15: 17:07.57 CST.
(From 3.6, Annex 2)

(e) Calculated sunset at path mid-point for December 15: 16:54.50 CST.
(From 3.6, Annex 2)

(f) The 10% skywave field strength (SWF) at 682.68 km: 0.102 mV/m per 100 mV/m at 1 km. (From 3.4, Annex 2)

(g) Elevation angle θ: 14°. (From 3.2, Annex 2)

(h) f(θ) is 0.95. (From 3.2, Annex 2)

From the foregoing it is seen that when it is 60 minutes past sunset at the Chihuahua site it is 73.07 minutes (or 1.218 hr) past sunset at the path mid-point ($SS + 1.213\ hr)_{mp}$. Using this value and Fig. 5B or Formula (6) the diurnal factor to be applied for the path to the Texas station is determined to be 0.9185.

Since the maximum ncv contribution must not exceed 2.29 mV/m in this example, the maximum 10% interfering signal under full nighttime condition6 is 2.29/20 or 0.1165 mV/m. Therefore, at the vertical angle, the permissible . radiation for thfs condition Is:

$$\frac{(0.1145)(100)}{(SW?)} = \frac{11.45}{0.102} = 112.26 \text{ mV/m}$$

In the horizontal plane the permissible radiation is:

$$\frac{112.26}{f(\theta)} = \frac{112\ \ 25}{(0.95)} = 118.16 \text{ mV/m}$$

However, since the diurnal factor is less than one, it can be applied to increase the radiation that is permitted: (118.16) / (0.9186) = 128.63 mV/m which is the maximum post-sunset radiation permitted. Since this value is less than the 309 mV/m radiated by the station using its daytime 1 kW facilities, the pover must be adjusted downward for the extended hours operation. This can be calculated as follows:

$$\frac{(\text{permissible radiation})^2 (1000)}{(\text{antenna radfatlon @ 1 kW})^2} = \frac{(128.63)^2 (1000)}{(309)^2} = 173.3 \text{ Watts}$$

Thus, it is shown that the maximum pover that the' Chihuahua station could use during extended hours of operation is 173 Watts.

This same procedure vould be applied to each of the affected co-channel nighttime stations. The lowest power calculated in this manner would be that which vould be permitted.